Silicon's Second World:
Scarcity, Political Indifference and Innovation in Czechoslovak Computing, 1964-1994

By
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Abstract

How societies invent, adopt, adapt, distribute and innovate with computers is an important puzzle for historians of technology, economists, educators and government planners alike. This dissertation examines the developmental path of Czechoslovakia from when its premier computer scientist, Antonín Svoboda, emigrated in 1964 to slightly beyond state dissolution in 1993. An industrialized consumer society with little to consume, as Jaroslav Švelch noted, Czechoslovakia illustrates both the still-understudied history of computing in state socialist societies and the global story of innovation and adaptation in liminal spaces that provide human capital and emerging markets for the West.

An alternate modernity emerged in what Martin Müller calls the 'Global East,' constituted by users living in scarcity, skeptical of state and capital power and maintaining the countercultural community values articulated by exponents like Stewart Brand, Ted Nelson and Buckminster Fuller. This work contributes to the ongoing turn in the history of technology away from Silicon Valley-centered narratives of invention toward the maintenance, adaptation and second-order innovation better representative of technological encounters globally. Czech and Slovak computer users are the focus: Their social origins, personal politics, creativity and negotiated autonomy framed the shape of computing in their country. Their stories are told often by themselves—in extensive oral interviews with key scientists, prominent dissidents and black marketeers—and in the pages of their community's magazines, journals and newsletters, in television interviews, in their jokes and ribald songs. Their voices are part of a global chorus of hobbyism, tinkering, maintenance and technological communities informed by scholars like Jaroslav Švelch, Melanie Swalwell, Honghong Tinn, Helena Durnová, Patryk Wasiak, Ksenia Tatarchenko and Nathan Ensmenger.

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Glossary of Terms

ACM: Association for Computing Machinery, international computing society founded in 1947 and headquartered in New York City. Its monthly journal, *Communications of the ACM*, was widely read by Czech and Slovak computer technologists during the Cold War.

ADT: Analog/Digital Technology, a line of hybrid computers with analog and digital components produced in Czechoslovakia beginning in 1973 at the ZPA Čakovice and ZPA Trutnov plants.

ALGOL 60: Algorithmic Language 1960, a computer programming language designed by a committee of research scientists in Paris to be one of the first internationally standardized programming languages. It was enthusiastically adopted in Czechoslovakia alongside COBOL.

***Amatérské Rádio*:** A monthly magazine for radio and electronics amateur enthusiasts published in Czechoslovakia since 1952 by civil defense agency Svazarm.

ANALOGON: An advanced prototype electromechanical analog computer developed by VÚMS in 1960 but which never entered serial production due to a shift in the industry toward transistors.

Aritma: Before World War II, Aritma was a firm located in Prague that specialized in precision machinery, especially the production of punch-card machines for data processing. It was incorporated into the national enterprise for office equipment, KNSP, in 1951 and produced thousands of punch-card and analog computers in Czechoslovakia.

ARPAnet: Precursor to the contemporary Internet, ARPAnet was developed by scientists at the Department of Defense's Advanced Research Projects Agency. The first four network node computers in Utah and California were linked together in 1969.

Atari 800: An 8-bit early home computer released in November 1979, the Atari 800's relatively advanced MOS 6502 CPU, extensive software catalog and easy modifiability made it one of the most popular home computers in Czechoslovakia until the end of the 1990s.

Avast: The world's largest anti-malware and computer security services provider, based in Prague and founded by Pavel Baudiš and Eduard Kučera in 1988 at VÚMS as a cooperative.

Basic: Beginners' All-Purpose Symbolic Instruction Code, a high-level programming language designed for ease of use by John Kemeny and Thomas Kurtz at Dartmouth in 1964. Basic became especially important during the early microcomputer era of the late 1970s and early 1980s, as it was the default programming language for user-machine interaction.

Baťa: Founded in Zlín, Moravia in 1894, the Baťa shoe company became a successful international footwear conglomerate during the 20th century.

BESM-6: *Bolshaya Elektronno-Schetnaya Mashina*, or Large Electronic Computing Machine, the BESM series of Soviet mainframe computers originates in 1952, but did not achieve wide-scale use until 1968 with the transistor-based BESM-6. Soviet industry produced hundreds of units and the BESM-6 formed the backbone of USSR computing until the end of the 1980s.

Burroughs: One of the 'Seven Dwarves' that unsuccessfully competed against IBM's market dominance in computing during the 1960s and 1970s, Burroughs was founded in 1886 as American Arithmometer in St. Louis, Missouri and originally specialized in mechanical adding machines.

CAD/CAM: Computer-Aided Design/Computer-Aided Manufacturing is the use of computers as tools to assist in the design and production of (usually industrial or commercial-grade) products such as dental implants and die cast parts. The practice has origins in the mid-to-late 1960s in the aerospace and automotive industries.

CDC: Founded in Minneapolis, Minnesota in 1957, Control Data Corporation was an early pioneer in both minicomputers and supercomputing, sustained by contracts with the U.S. Navy. One of nine major American computer companies in the mid-20th century.

Čedok: *Československá dopravní kancelář*, or the Czechoslovak Travel Bureau, first opened in 1920 in Prague as a joint project of private investors, the Czechoslovak government and Czech Railways. International offices in London, Vienna and Paris opened by 1922.

Charter 77: A reform manifesto critical of the Czechoslovak government's failure to uphold the human rights obligations of the 1975 Helsinki Accords. Circulated as *samizdat* in the winter of 1976-77 and signed by many of the country's prominent intellectuals, including Václav Havel, Jan Patočka and Pavel Kohout, Charter 77 was a declaration of principles for Czechoslovak dissidents.

Chata: A feature of life in East Central and Northern Europe is the cabin or summer cottage outside the city, called *chata* in Czech. Increasingly significant after the Prague Spring in Czechoslovakia as a retreat away from official politics and state surveillance.

Civic Forum: Short-lived but significant political party in the Czech lands founded in November 1989 by Václav Havel as an umbrella organization for anti-Communist dissidents during the Velvet Revolution that overthrew the Czechoslovak government.

CMEA: The Council for Mutual Economic Assistance, also frequently referred to as COMECON, was a Soviet-led economic bloc organized in 1949. The later Unified System of Electronic Computers in the 1960s and 1970s was coordinated under its aegis.

COBOL: Common Business-Oriented [Programming] Language, designed in 1959 in the United States by computer scientists on behalf of the U.S. Department of Defense, it became one of two early international standard programming languages (*see* ALGOL 60).

CoCom: The Paris-based Coordinating Committee on Multilateral Export Controls, founded in 1949, organized Western countries under U.S leadership to embargo potentially sensitive military technology, including computers, from the members of the Soviet-led CMEA.

Commodore 64: Most popular computer model ever produced. The Commodore 64 was an 8-bit home computer with a MOS 6510 CPU released by Commodore Business Machines in August 1982. Much like the Atari 800, its availability, affordability and software catalog kept it in widespread use in the Czech Republic and Slovakia until the end of the 1990s.

CP/M: Written in 1974 by Gary Kildall for early 8-bit microcomputers based on Intel's revolutionary 8080 microprocessor, Control Program for Microcomputers became a widely-used operating system for home computers, later overtaken by IBM's DOS.

ČSVTS: *Československé Vědecko-Technické Společnosti*, the Czechoslovak Scientific-Technical Society, was a division of the Czechoslovak Academy of Sciences which, during the Cold War, funded and organized conferences and travel for scientists and researchers.

ČVÚT: *České vysoké učení technické*, or the Czech Technical University in Prague, was established in 1806 as the Prague Polytechnic. Its Faculty of Electrical Engineering, founded in 1950, was an early incubator of computing talent in Czechoslovakia.

DATASAAB: One of a number of "national champion" computer companies in Europe, Swedish Datasaab was a division of the Saab aerospace company created in 1954.

DDM: *Dům Dětí a Mládeže*, the Children's and Youth's Home, was established in Czechoslovakia by the 1948 scholastic law. At locations around the country, it organized educational and recreational activities for young children (prior to secondary school).

DEC: Digital Equipment Corporation, in Maynard, Massachusetts from 1957, was an American computer company focused on the mini-computer market. Its PDP-8 and PDP-11 mini-computers enjoyed widespread commercial success beginning in the 1960s, and were the architectural inspiration for the Soviet-led Unified System of Small Computers (SMEP).

Didaktik: A small company based in Skalica, Slovakia originally dedicated to producing teaching aids for classrooms and which became well-known in Czechoslovakia after 1986 for manufacturing a series of successful clones of Western 8-bit home computers.

DIY: An acronym for "do it yourself" which encompassed a broad range of home and commercial tinkering, repair, model and kit construction activities in the 20th century.

DOS: Disk Operating System, a platform-agnostic operating system for micro-computers, gradually replaced CP/M and associated with the dominant IBM PC in the 1980s, which ran a version (MS-DOS) developed by Bill Gates and his Microsoft company.

DP-100: An early example of a successfully mass-produced Czechoslovak analog computer (over two hundred were built), the DP-100 was designed at VÚMS and manufactured at Aritma's Vokovice facility in the mid-1960s.

EC 1021: The primary Czechoslovak contribution to the Unified System, the EC 1021, originally the ZPA 6000/20, was the last autochthonous Czech-designed computer and retained special control instructions preventing its compatibility with CMEA computers.

EC OS: The Soviet-developed fork of IBM's OS/360 software from 1966, initially derivative of IBM's code but increasingly modified and localized with time, which ran the IBM

Sys/360-based line of mainframe computers developed in Soviet bloc countries as part of its Unified System effort.

Elliott: Before it was swallowed up by English Electric in 1967, Elliott Brothers was briefly a prominent computer manufacturer in the United Kingdom famous for its mid-sized, transistor-based Elliott 803 computers.

EMAL: Electronic Machine Automatically Computing, an incomplete Polish prototype computer based on British EDSAC and under construction from 1953 to 1955 at the Polish Academy of Sciences.

EPOS: *Elektronický Počítač Střední*, or mid-sized electronic computer, was a series of two (EPOS-1, EPOS-2) all-electronic digital computers which developed from the designs of Czech computer scientist Svoboda and his research cohort at VÚMS in the early 1960s. EPOS-2 was a true second-generation computer, based on transistors rather than vacuum tubes, and pioneered fail-safe circuits when mass-manufactured as the ZPA-600.

FORTRAN: A precursor to Basic, FORTRAN is an all-purpose general programming language developed at IBM in the 1950s which continues to be iteratively developed. It was suitable for scientific and mathematical computation and was often employed by universities and research institutions.

GDR: The German Democratic Republic, or East Germany, was a state socialist country in East Central Europe from 1949 until reintegration with West Germany in 1990. It was a technically sophisticated CMEA member and participant in the Unified System.

General Electric: Established in 1892 in Schenectady, New York, General Electric competed with IBM in the 1960s with a line of general-purpose small mainframe computers before exiting the market in 1970 by selling off its computer production to Honeywell.

GIER: Danish *Geodætisk Institut Elektronisk Regnemaskine* was a mainframe computer developed by and assembled at the Danish Academy for Technical Science beginning in 1961, transistorized but based on architecture from the earlier Swedish BESK mainframe.

Glasnost: Meaning "openness" this term is most associated with a period of relatively open political speech championed by Soviet premier Mikhail Gorbachev beginning in the mid-1980s and extending until the dissolution of the USSR in 1991.

GUI: The Graphical User Interface is a term for software and hardware elements (the computer mouse, software 'windows' on a 'desktop'), developed in the mid-1960s at Xerox PARC and by Douglas Engelbart, which allow users to interact intuitively with computers.

I/O: Input/Output is communication between the outside world, the computer (as an interface), and the products of the computer based on those communications. I/O is associated with peripherals, such as keyboards (input devices) and printers (output devices).

IBM: International Business Machines, originally the Computing-Tabulating-Recording company (CTR), was established in 1924 in New York. For much of the mid-to-late 20th century, it was the world's foremost computer company. The Soviet Unified System computers were based on the design of IBM's popular System/360 mainframe family of the late 1960s and early 1970s.

ICL: International Computers Limited was a British company that manufactured mainframe computers beginning in 1968. Formed from a merger of English Electric, Leo, ICT and Elliott, it was one of a number of European "national champions" that struggled against IBM's market dominance.

IEEE: The Institute of Electrical and Electronics Engineers is an international association of technical professionals formed in 1963 in New York. Its committees establish worldwide standards, promote technical education and publish literature in field-related research.

INORGA: The Institute of Industrial Management of Automation, based in Prague, was responsible for the development of software and program implementation at government ministries, state-owned industries and offices. Not responsible for hardware, equipment purchases nevertheless *de facto* had to be approved by their office prior to installation.

Intel 8080: The microprocessor that kicked off the PC revolution in April 1974. The chip's influence derived from its power and low price, its integration in the earliest hobbyist microcomputers, the MITS Altair 8800 and IMSAI 8080, and its CP/M operating system.

IQ 151: Batch production began in late 1984 at the ZPA Nový Bor facility. An 8-bit computer with the Tesla MHB8080A microprocessor (a reverse-engineered Czech clone of the Intel 8080) at its heart, plagued by quality problems, the government supplied it to schools beginning in 1985.

JSEP: *Jednotný systém elektronických počítačů*, Czech acronym for the Unified System of Electronic Computers, a Soviet-led, bloc-wide effort to produce standardized computers, software and peripherals based on IBM's Sys/360 during the 1970s and 1980s.

KNSP: *Kancelářské stroje národní průmysl*, or the National Office Machines Industry, responsible for producing or acquiring small and mid-size computers and data processing equipment for firms and government offices from the 1960s through the 1980s.

LEO: The Lyons Electronic Office, from 1951 the first business computer in the United Kingdom, was modelled on the earlier British EDSAC (much like Polish EMAL). The core product of Leo Computers Ltd before the company was swallowed up in the British ICL conglomerate in 1968.

***Logický vzato*:** Part of the Czechoslovak government's effort to encourage science, mathematics and computing education among young people, this television program aired regularly with a series of expert guest hosts (such as Božena Mannová) beginning in 1987.

MEDA: A transistorized, desktop modular construction hybrid digital/analog computer produced at Aritma in Prague during the 1970s and employed at industries across the CMEA bloc.

MESM: The Small Electronic Calculating Machine, created under the aegis of Sergei Lebedev at the Kyiv Institute of Electrotechnology in 1951, was the USSR's first programmable electronic computer. Powered by vacuum tubes, the prototype operated until 1957.

MFCS: International Symposium on Mathematical Foundations of Computer Science is an annual conference focused on theoretical computer science founded by Jozef Gruska in Czechoslovakia in 1972 for Polish, Czech and Slovak mathematicians, programmers and computer scientists.

***Mikrobáze*:** An English-Czech portmanteau implying a “data base” on micro-computing, this magazine was founded in 1985 by Svazarm as a spin-off of its better-established *Amatérské Rádio* magazine and aimed at computer hobbyists in Czechoslovakia.

MINSK II: A successful line of Soviet mainframe computers produced in the Belarussian SSR from 1959 to 1975. The Minsk II, which was transistorized, and its lineal descendants (Minsk 22, Minsk 23, Minsk 32) enjoyed wide employment in Soviet and CMEA research institutions and universities.

Normalizace: So-called “normalization” refers to the period, 1969-1987, of political conservatism, purges of the Communist party and suppression of reform and dissidence following the Soviet-led invasion of Czechoslovakia and end of the Prague Spring in August 1968.

NOTO: *Národní Organizace Technické Obsluhy* or National Organization of Technical Services was established in each CMEA member that participated in the Unified System of Computing. The bureau was responsible for supplying technical equipment, linking manufacturers and users across countries in the bloc, and providing repair services.

ODRA: The earliest mass-produced Polish computer, beginning in Wrocław in 1960, the ODRA was a small general-purpose transistorized computer named after the Odra river.

Pascal: Programming language developed by Niklaus Wirth in 1970, inspired by the earlier ALGOL 60 international programming language. It found primary employment in the growing minicomputer industry through the course of the 1970s.

PDP: The DEC Programmed Data Processor series of mini-computers dominated the market segment through the 1960s and 1970s, beginning with the popular PDP-1, an 18-bit machine produced in 1959 and on which the first computer game, *Spacewar*, was played.

Peripherals: Computer peripherals include an assortment of devices and software that increase the utility of the machine or allow more intuitive interface to users. These can include computer mice, printers, monitors, external storage drives and speakers.

PMD-85: Like its IQ 151 cousin, the PMD-85 was a micro-computer powered by the Tesla MHB8080A produced for schools beginning in 1985. It was of somewhat higher quality and enjoyed larger production runs and future iteratively improved models (the PMD 85-2, 85-3). It was produced in Slovakia by the Tesla Piešťany and Tesla Bratislava concerns and discontinued in 1989.

Prague Spring: A seven-month-long period of political liberalization in Czechoslovakia from January to August 1968 following the ascension to power of reform Premier Alexander Dubček and ending with the Soviet-led invasion of the country.

Přestavba: The Czech term analogous to Russian *perestroika*, or period of reconstruction/restructuring. Part of top-down reforms of Premier Mikhail Gorbachev in 1985, but only latterly and gingerly implemented in Czechoslovakia beginning in 1987.

RCA: The Radio Corporation of America was founded in 1919 and was a competitor in the mainframe computer market against IBM with its Spectra 70 line of machines, though the success of IBM's System/360 in the late 1960s squeezed the company out of the market.

Ronja: Innovative Czech DIY project of the late 1990s and early 2000s which built upon native traditions of tinkering and knowledgeable practitioners to build high speed line-of-sight optical computer networks in cities underserved or overcharged by private telecommunications companies.

Samizdat: The artifact, and practice, of underground—e.g., officially prohibited or censored—literature or material production, exchange and consumption within a defined space, usually a nation-state. For the circulation of outside materials subject to bans or censorship, see: *Tamizdat*.

SAPI-1: A modular prototype kit micro-computer designed by brothers Eduard and Tomáš Smutný and batch produced in low volume by Tesla in 1980, the SAPI-1 was the first native Czechoslovak micro-computer. It featured the reverse-engineered Tesla MHB8080A chip at its heart.

SAPO: *Samočinný počítač* or "automatic computer" was the first Czechoslovak computer, designed by Svoboda in the early 1950s and working between 1957 and 1960. Operating with electromechanical relays, it was the world's first fault-tolerant computer.

SCOT: The "social construction of technology," a prominent influence in the field of science and technology studies, argues that the behavior, prejudice and choices of human beings determine the use and direction of technologies. The theory is often associated with the work of Thomas P. Hughes, Wiebe E. Bijker and Trevor J. Pinch.

SIEMENS: German technological and industrial manufacturing conglomerate based in Berlin and founded in 1847. Siemens began producing computers at its Bavarian facility in 1957 with the Siemens 2002, was a "national champion" German computer manufacturer and touchstone for Czech and Slovak computer scientists in the 1960s and 1970s.

Škoda: Czechoslovak automotive manufacturer (now Czech, owned by Volkswagen AG) founded in 1895 as Laurin & Klement in Mladá Boleslav and nationalized as part of the industrial conglomerate Škoda Works in 1948 after the Communist coup.

SMEP: *Systém Malých Elektronických Počítačů*, or System of Small Electronic Computers, was the Soviet-led CMEA effort, beginning in 1975, to create reverse-engineered hardware clones software compatible with the popular DEC PDP-11 line of 16-bit minicomputers.

SOFSEM: Software Seminar, key annual conference for mathematicians, programmers and computer scientists organized by Jozef Gruska from 1974. Alongside MFCS the annual gathering, which lasted for two weeks at mountain resorts, played a role in professionalizing computerists and building a new community.

SPK: *Státní plánovací komise*, or the State Planning Commission, was the primary organ of state central planning of the economy in Czechoslovakia from its inception on July 22, 1959 until the collapse of the communist regime in the 1989 Velvet Revolution.

SSM: *Svaz socialistické mládeže*, Union of Socialist Youth, was the youth wing of the Communist Party from 1970 (it replaced the Union of Youth). Membership for students was *de facto* compulsory, it had over 1.5 million members by 1983, and it funded (alongside Svazarm) youth electronics and computing activities in the 1980s.

StB: *Státní bezpečnost*, or State Security, was the secret police in Czechoslovakia from 1945 until the formal end of Communist rule and the agency's dissolution in 1990.

STR: The Scientific-Technical Revolution is the theory that true socialist abundance might be achieved by central computers that would set quotas, take inventory, allocate goods efficiently and relieve drudgery. It has Marxist roots in John D. Bernal's 1954 book *Science in History*, and was popularized in Czechoslovakia by Radovan Richta.

Svazarm: *Svaz pro spolupráci s armádou*, or League for Cooperation with the Army, was a mixture of Cold War civil defense and paramilitary Boy Scouts. A military organization at its inception in 1951, it evolved into a million-member catch-all funder and organizer of hobbies as diverse as amateur radio and electronics, canoeing and Hi-Fi audio.

SVOČ: *Studentské Vědecké Odborné Činnosti*, or Student Scientific Technical Work, are annual competitions in the sciences held at Czechoslovak (now Czech) university faculties at which prizes and scholarships are distributed to meritorious student competitors.

Tamizdat*:* The artifact, and practice, of underground—officially prohibited or censored—literature or material exchange and consumption from outside a defined space, usually a nation-state. For circulation of domestic materials subject to bans, see: *Samizdat*.

Tesla 200: Built in Pardubice, this computer was a licensed copy of the French Bull-GE Gamma 140/145 from 1966, a mid-range prototype that, after some initial problems with its tape drives, GE killed off in favor of a more 'reliable' version from its American branch. Fixed and mass-produced by Czechs, the Tesla 200 became the backbone mainframe of scientific and technical work.

Tesla: The monopoly electronics firm in Czechoslovakia from 1946 to 1989, TESLA (which has sometimes been defined as an acronym, *technika slaboproudá*, or low-voltage technology) was originally established under a different name, Elektra, in 1921. Under state socialism, Tesla built everything from radios to television sets, doorbells, telephone transformers, and computers.

Tuzex: A series of government-administered closed shops, run from 1957 to 1992, which stocked imported or scarce consumer goods available only to customers who possessed *bony*, vouchers purchased with hard foreign currency, not Czechoslovak crowns.

UNIVAC: Universal Automatic Computer, name applied first to a line of mainframe computers initially constructed by the Eckert-Mauchly Computer Corporation in Pennsylvania, derived from the founders' work on ENIAC during and shortly following World War II.

VAX: Line of 32-bit "supermini" computers introduced by DEC in 1977 as an outgrowth of earlier success with the 16-bit PDP-11 mini-computers. A number of East European clones of VAX, including the Czechoslovak SM 52/12, were built as part of SMEP.

Velvet Revolution: Peaceful, rapid overthrow of the Czechoslovak Communist party in November-December 1989. Student protests on November 17th escalated to a general strike on the 27th. By December 29th arch-conservative communist Gustav Husák had resigned and dissident leader Václav Havel was elected president.

Vnye: Term of art from Alexei Yurchak describing the condition of a generational milieu of young professionals mutually embedded with each other and within state-dominated systems of political, economic and social power in late socialism. Here, it applies to the simultaneous insider/outsider status or feeling of the community of technological practitioners in Czechoslovakia organized around the computer and its ecology.

VÚAP: *Výzkumný ústav automatizačních prostředků*, or Research Institute for Automation Systems, based in the Karlín district of Prague. Responsible for developing peripherals, input/output devices and basic application software for computers meant to automate industrial practice.

VÚMS: *Výzkumný ústav matematických strojů*, or Research Institute for Mathematical Machines, was founded by Svoboda in 1950 in Prague. It was the central repository for computer hardware design and software development in Czechoslovakia until the Velvet Revolution.

WELL: The Whole Earth 'Lectronic Link is one of the oldest continuously operating virtual user communities in the world, established in February 1985. It featured the pioneering practice, then and now, of allowing users to own and even copyright their own data.

ZÁVT: *Závody automatizační a výpočetní techniky*, or Computer and Automation Works, was an industrial trust that overtook the previous responsibilities of ZPA after 1981. This included research and production of mainframes, minicomputers, microcomputers, process control computers, analog and hybrid computers, peripheral units, and data transmission equipment.

Zbrojovka: A pre-World War II firearms manufacturer in Brno, Czechoslovakia, Zbrojovka Brno was nationalized after the February 1948 Communist coup. The plant also produced office equipment, such as typewriters, leading to computer manufacturing in the 1970s and 1980s, such as the Consul 2717 clone of the Slovak PMD 85-2 microcomputer.

Zilog Z80: An iterative enhancement on the Intel 8080 microprocessor first marketed in mid-1976, the Z80 is one of a handful of revolutionary microchips (the MOS 6502 included) which powered myriad 8-bit home computer models in the late 1970s and early 1980s.

ZO: An acronym for *základní organizace* or "basic organization"—in this work, always referring to particular branches or local clubs of Svazarm, the paramilitary civil defense agency. Hobby life for Czech and Slovak computer enthusiasts in the 1980s relied on the activities of their ZO.

ZPA: *Závody přístrojů a automatizace*, or Instrument and Automation Works, was the consortium responsible for the manufacturing and distribution of computers, laboratory instruments and office machines within Czechoslovakia during the 1960s and 1970s; later subsumed into ZÁVT.

ZUSE: A company and line of eponymous computers named for their inventor, German engineer Konrad Zuse, who constructed the world's first programmable computer in 1941 and founded a company, Zuse KG, to produce computers for the commercial market beginning in 1949.

ZX Spectrum: Selling over 5 million units worldwide after its 1982 debut, Sinclair Research's 8-bit home computer was the most popular British machine of the 1980s. Its low price and extensive software catalog ensured its popularity in Czechoslovakia as well, with a number of domestic compatible clones developed in the late 1980s and early 1990s.

Dramatis Personae

Bartošek, Miroslav. (b. 1957), department head of Cybersecurity and Data Management division, Masaryk University Institute of Computer Science. Secretary for SOFSEM in the late 1980s. Former member of the Communist party. Interview by author conducted at subject's workplace in Brno on March 29, 2018.

Baudiš, Pavel. (b. 1960), co-founder of the Avast Antivirus company as a software cooperative with colleague Eduard Kučera in 1988. Formerly a programmer at Prague's Research Institute of Mathematical Machines (VÚMS) in the 1980s. Pioneer of the "freemium" software business model.

Beneš, Michal. (b. 1978), secondary school teacher (information technology) at Střední Průmyslová Škola Emila Kolbena in Rakovník. Interview conducted by author at subject's workplace in Rakovník, Czech Republic on March 8, 2018.

Brand, Stewart. (b. 1938), American countercultural writer and editor of *The Whole Earth Catalog* and co-founder of the WELL virtual community. Prominent exponent of liberatory technology and early evangelist of personal computing in the 1970s.

Buďa, Karel. (b. 1980), private collector of hardware, software and ephemera of Czechoslovak computing, and programmer at IBM Brno. Interview conducted in subject's home by author in Brno on March 29, 2018.

Čechlovský, Vladimír. A longtime reporter for the Communist party's daily newssheet *Rudé právo* during the 1980s, Čechlovský was a former party member who continued to cover politics, economics and technology for its post-revolutionary successor *Právo* in the 1990s and 2000s.

Chvatík, Ivan. (b. 1941), nuclear physicist, former Aritma employee, and longtime (1967-1989) former director of information technology at Prague's Machine Technology Factories. Chvatík was a dissident who ran underground seminars and organized and collected the writings of his close mentor, Czech philosopher Patočka. Interview conducted by author at the Center for Theoretical Studies in Prague on June 7, 2018.

Dvorníková-Krapková, Eva. A punched-tape computer operator at the Baťa shoe factory in Zlín throughout the 1960s, '70s and '80s, Dvorníková-Krapková later created a personal web log in the 2000s to document her experiences and archive personal photos from the period.

Ershov, Andrei. (b. 1931 – d. 1988), Soviet academician Andrei Ershov was a prominent 20th century computer scientist credited with revolutionary advances in programming languages. In the 1970s and 1980s he became a vocal international proponent of mathematics-oriented reform in computing instruction.

Felsenstein, Lee. (b. 1945), a founder of the famous countercultural Homebrew Computing Club in the California bay area in the late 1970s. Felsenstein is also the designer of the Osborne, the first mass-manufactured commercially successful portable computer.

Franěk, Jiří. (b. 1942 – d. 2011), a technology journalist, science fiction author and software programmer at J. E. Purkyně University's Institute of Computer Science who collaborated with Hořejš in the late 1980s on a series of critical articles discussing science fiction in *Mikrobáze*.

Fredkin, Ed. (b. 1934), a career professor at MIT, artificial intelligence expert, inventor of reversible computing, and protégé of J.C.R. Licklider at MIT's Lincoln Laboratory. Fredkin visited the Soviet Union in the early 1990s and favored the mathematics-oriented, centralized instruction and implementation of computing he saw there.

Fuka, František. (b. 1968), programmer from early childhood and featured on state television as the wunderkind representative of 1980s' youth, Fuka turned entrepreneurial at the end of the 1980s, not just distributing free copies of his own games like *Tetris 2* and *Indiana Jones a Chrám Zkázy* but also selling bootleg copies of dubbed Western movies and cracked British games on the Prague black market. Interview conducted by author in subject's favorite local pizza parlor in Prague on June 14, 2018.

Gruska, Jozef. (b. 1933), co-founder of the two key conferences that professionalized computer science and informatics in Czechoslovakia, MFCS and SOFSEM. Gruska is an expert on quantum computing and the pre-eminent living Slovak computer scientist. Interview conducted by author in subject's workplace in Brno on March 28, 2018.

Hájek, Petr. (b. 1940 – 2016), Czech logician and professor of mathematics at Charles University in Prague, Hájek was also an expert on artificial intelligence and set theory who co-wrote a series of articles with Ivan M. Havel on prospects and concepts for machine intelligence that appeared in *Mikrobáze* in 1988.

Havel, Ivan M. (b. 1938), Czech expert on artificial intelligence and theoretical computer science. Havel co-founded the political party Civic Forum in 1989 with his brother Václav, contributing to the overthrow of Communism in Czechoslovakia. Interview conducted by author in the subject's family home in Prague on June 6, 2018.

Holan, Petr. (b. 1957), one of the five co-founders of *Villoidus*, one of the first (April 1982) science fiction fanzines in Czechoslovakia (pre-dated only by the tramping settlement 'zine *Vega* in 1977 Plzeň and *Věstník*, circulated at the Teplice observatory early 1981). Holan was deeply involved in the local leadership of SSM youth groups, including computer clubs, throughout the 1980s. Interviews conducted by author at subject's favorite pub in Prague on October 30, 2017 and April 14, 2018.

Hořejš, Jiří. (b. 1933 – 2001), co-founder of SOFSEM along with Gruska, Hořejš was a principal figure in the establishment of computer science in Czechoslovakia. The founder of the Institute for Computer Science at Masaryk University in Brno, Hořejš in 1988 co-authored (with Franěk) a series of articles analyzing science fiction in Mikrobáze.

Kašpar, Jan. Professor at the Faculty of Mathematics and Physics, Charles University. Expert on database systems and principles of mathematics education. Sold Texas Instruments' calculators to colleagues around Czechoslovakia under the table during the 1970s and '80s, where he first met longtime friend, colleague and squash rival Pospišíl. Interview conducted by author at subject's workplace in Prague on December 6, 2017.

Kišš, Roman. Slovak engineer who designed the Tesla PMI-80, the PMD 85 and later the Didaktik Alfa in Piešťany and Skalica, Slovakia.

Kroupa, Josef. Secretary of Svazarm's 602nd ZO in Prague during the late 1980s, and therefore responsible for helping to organize and run *Mikrobáze* along with its editorial board, including editor-in-chief Jan Klabal and managing editor Zajíček.

Kubát, Milan. A university professor with experience working in semiconductor fabrication, Kubát was also the first and sole head of the Federal Electrotechnical Ministry, created by the Central Committee in 1979 as part of a larger re-organization of ZÁVT.

Kučera, Eduard. (b. 1953), Czech software engineer who co-founded Avast Antivirus alongside his partner Pavel Baudiš as an extension of their software cooperative and work at VÚMS on the Vienna virus in 1987 and 1988.

Mannová, Božena. (b. 1951), software programmer, author (*Programming in Pascal*), television moderator (*Logicky vzato*, *Nebojte se Počítačů*) and professor of computer science at the Czech Technical University. Mannová is also director of the Czech Miranda project, longtime member of SOFSEM and "grandmother of Czechoslovak computing". Interview conducted by author at subject's workplace in Prague on December 6, 2017.

Mareš, Martin. (b. 1976), assistant professor of applied mathematics at the Charles University Faculty of Math and Physics. Mareš was a young man in the late 1980s when he first encountered personal computers at the Dům Dětí a Mládeže club near his home in Kobylisy—Didaktiks, PMD 85s and the Ondra were available. Interview conducted by author at coffeeshop in the Malá Strana quarter, then subject's workplace, in Prague on November 10, 2017 and June 18, 2018.

Materna, Pavel. (b. 1930), professor emeritus at the Philosophical Faculty of Masaryk University in Brno, logician, and prominent underground educator and dissident during the normalization era in Czechoslovakia. Materna closely mentored Zlatuška during the 1970s and was a frequent contributor to SOFSEM at that time.

Moore, Gordon. (b. 1929), billionaire co-founder of the semiconductor fabrication giant Intel, Moore is most famous for his 1965 observation that the number of components, such as transistors, that could be fit on to an integrated circuit doubled approximately every year to two years—the eponymous Moore's Law.

Neff, Ondřej. (b. 1945), prominent Czech science fiction author known for his collection of short stories *Vejce Naruby* (1985) and novel *Tma* (1998), as well as contributions to science fiction translation, magazine editing and convention circuit speeches. A collaborator with Saudek and sci-fi *samizdat* publications in the 1980s.

Nelson, Ted. (b. 1937), the author of *Computer Lib/Dream Machines* (1974), editor of *Creative Computing* magazine, sociologist and evangelist for personal computing. Nelson's thinking influenced powerfully the early countercultural zeitgeist of the field, and he coined a number of neologisms that became widely adopted, including *hypertext*.

Pajas, Petr Jan. (b. 1937), president emeritus of Anglo-American University in Prague, Pajas is a physicist, formerly deputy head of the department of theoretical physics at the Institute for Nuclear Research in Řež (1963-1972). Pajas was the first director of the Charter 77 foundation in Czechoslovakia. Interview conducted by author at subject's workplace in Prague on November 28, 2017.

Patočka, Jan. (b. 1907 – d. 1977), a student of Martin Heidegger's and a towering figure in 20th century European philosophical thought, Patočka was suppressed from teaching by the Communist regime and became one of the original signatories and representatives of Charter 77 before his death. His writings were archived, in secret, by Ivan Chvatík; Patočka was also Sokol's father-in-law.

Pospišíl, Petr. (b. 1951), currently a software consultant on super-computing at ČVÚT's Computing and Information Center in Prague, Pospišíl prior to 1989 modeled complex weather systems at the Institute of the Physics of the Atmosphere of the Czechoslovak Academy of Sciences. Colleague and friend of Kašpar's, with whom he plays squash regularly. Interviews conducted by author at subject's workplace in Prague on December 15, 2017 and March 27, 2018.

Raichl, Jiří. (b. 1927 – d. 1990), author of foundational Czech textbooks on programming, particularly 1964's *Programování v jazyku ALGOL*, Raichl spent the core of his career (1958 – 1979) at the Center for Numerical Mathematics at Charles University. There he taught students like Pospišíl the fundamentals of emerging computer science.

Richta, Radovan. (b. 1924 – d. 1983), a Czech philosopher who coined the term 'socialism with a human face,' a motto widely adopted to describe the Prague Spring reform movement of 1968. Richta's 1966 work *Civilizace na rozcestí*, a compilation of scholars' essays describing the rapid developments and future prospects of the "scientific and technological revolution" of the 20th century, became the rhetorical touchstone of Czechoslovak technologists and government planners until the 1980s.

Saudek, Kája. (b. 1935 – d. 2015), the most influential Czech illustrator and graphic artist of the late 20th century. Although his work was always popular with the public, he was banned from publication by the Communist authorities from the mid-1970s and increasingly worked with *samizdat* and other informal publications such as Holan's *Villoidus* science fiction fanzine.

Smetana, Bedřich. (b. 1824 – d. 1884), Czech romantic and nationalist composer known for operas like *The Bartered Bride* and *Dalibor*, Smetana faced opposition within Czech musical circles led by his rival, František Rieger, for his 'Germanic' influences, particularly Richard Wagner.

Smutný, Eduard. (b. 1944 – d. 1993), perhaps the most well-known Czech hardware engineer of the late socialist period, Smutný designed a number of Czech computers in the early

1980s, most famously the Tesla SAPI-1 (1982), which was the foundation for the country's later production of the IQ-151 and PMD 85, and the Ondra (1985) named after his son. Smutný became a sharp critic of government technology policy by the late 1980s.

Smutný, Tomáš. (b. 1944), twin brother of Eduard Smutný, programmer, entrepreneur and repairman for coin-op arcade machines. Arrested by the Communist authorities for a side business, exceeding his local remit as a computer repairman around Benešov in the late '80s, Smutný wrote the software (his own Micro-Basic) for his brother's machines while hustling for a living on the technology gray markets of late socialism.

Sokol, Jan. (b. 1936), Czech software programmer, professor, former member of parliament, 2003 presidential candidate, political dissident and philosopher, Sokol was an early signatory and closely connected to the Charter 77 movement due to his relationship with his father-in-law, Patočka. He was a member of the software group at VÚMS in the 1970s and '80s along with Trojan and Žák. Interview conducted by author in subject's workplace at Charles University in Prague on June 12, 2018.

Studenka, Jaroslav. (b. 1948), now retired into private life, during the 1970s and 1980s a lead engineer in the design, programming, installation and maintenance of hybrid analog/digital computers at INORGA in Brno. Interview conducted by author at the Ouky Douky Café in Prague on April 3, 2018.

Svoboda, Antonín. (b. 1907 – d. 1980), founder of Czechoslovak computing and inventor of fault-tolerant computers such as SAPO, the first Czechoslovak computer. Svoboda established the Research Institute of Mathematical Machines (VÚMS) in Prague several years after his return to Czechoslovakia at the end of World War II in an effort to make his homeland a powerhouse in the budding industry. His emigration to the USA in 1964 was a devastating blow to the country's computing scene.

Trojan, Václav. (b. 1945), software programmer, external lector at Charles University Faculty of Mathematics, designer of 'X-definition' technology for use with XML documents. Trojan is the son of famous Czech composer Václav Trojan, responsible for the classical scores behind many Czech films, especially the beloved puppet shows of Jiří Trnka. Trojan became one of five signatories of Charter 77 in the VÚMS software group, alongside Žák, Sokol, Václav Benda and Vojtěch Sedláček. Interview conducted by author in subject's workplace in Prague on December 15, 2017.

Urda, Ivan. An engineer working on computer-controlled washing machines in the Strojsmalt state enterprise in Banská Bystrica, Slovakia in the late 1980s, Urda used his copious spare time to design a home computer aimed at children, the Maťo, based around the ubiquitous Tesla MHB8080A cloned microprocessor. His product was then picked up and produced by State Enterprise Závadka nad Hronom and later Tesla Bratislava.

Vaculík, Ludvík. (b. 1926 – d. 2015), former member of the Communist party, writer, journalist and dissident author of the famous Prague Spring reform manifesto *Dva tisíce slov* (Two Thousand Words) in 1968. In the mid-to-late 1970s, a young Zlatuška was part of the *Edice Petlice* (Padlock Edition) *samizdat* publishing circle that Vaculík directed.

Vávra, Daniel. (b. 1975), co-founder of Warhorse Studios, former participant in the computer cracking and hacking demoscene of the 1990s and early 2000s, author and designer behind successful million-selling games such as *Mafia*, *Mafia II* and *Kingdom Come: Deliverance*.

Zajíček, Ladislav. (b. 1947 – d. 2001), known by his sobriquet 'elzet,' was a Czech programmer, author (*Bity do bytu*, an influential 1988 guide to machine code), editor (of *Bajt*, a Czech version of *Byte*), and evangelist of personal computing. From 1985 until the regime fired him in 1989, he was managing editor of Czechoslovakia's only nationwide magazine for computer hobbyists and enthusiasts, *Mikrobáze*.

Žák, Václav. (b. 1945), Czech programmer, former politician, one of the original signatories to Charter 77, member of the software group at VÚMS alongside Sokol and Trojan, and from 2006 to 2009 chairman of the federal board of radio and television broadcasting in the Czech Republic. Interview conducted by author in restaurant Hybernia in Prague on June 7, 2018.

Zlatuška, Jiří. (b. 1957), Czech member of parliament, professor of informatics and computer science, founding figure (1994) and formerly dean of the Faculty of Informatics at Masaryk University in Brno (2015-2019). Zlatuška was, alongside his colleague Bartošek, one of the younger key figures involved in SOFSEM in the late socialist period. Interview conducted by author in subject's workplace in Brno on March 28, 2018.

Introduction: The Software Party

Frost obscured the windows of the bus as it inched up the mountain road. Jiří Wiedermann and his colleagues, a crew of Slovak programmers, mathematicians and computer scientists from Bratislava, huddled closely together to keep warm in the unheated vehicle. The scenic countryside of the High Tatra Mountains surrounded them as they drew closer to their resort destination of Ždiar, near the Polish border, but none of them bothered to wipe clear the windows. Instead they listened in rapt silence to the radio. It was November 26, 1989 and at the start of a bitter winter, the world as they knew it was melting away.[1]

For over forty years the Communist Party of Czechoslovakia had ruled the country unopposed. For over twenty years that rule had been enforced by the tanks, planes and bombs of a world superpower, the Soviet Union. Protest, expression and movement had all been controlled carefully. Those who spoke out were punished by the government. Sometimes they were thrown into prison, or their children lost the right to an education. Dissenting physicists could be stripped of their jobs and assigned to menial labor. Some of those took their own lives in despair.[2] Václav Havel, a Czech playwright and prominent dissident, felt that history seemed to have stopped, that Czechoslovak society appeared to be anaesthetized.[3] Life stirred underneath the surface of this frozen lake, however. In 1989, as the bus grumbled along the mountain road and Wiedermann listened, the radio reported strange, even incomprehensible events.

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[1] Jiří Wiedermann, "XXX Years of SOFSEM—How SOFSEM came into being," Sofsemovské texty, 30 Years of SOFSEM.

[2] Petr Jan Pajas, MSc., (President Emeritus – Anglo-American University), in discussion with the author. November 28, 2017.

[3] Václav Havel and Adam Michnik, *An Uncanny Era: Conversations between Václav Havel and Adam Michnik*, trans. Elžbieta Matynia, New Haven, Connecticut: Yale University Press, 2014: 45.

What had appeared to be a sleeping society was now fully roused. Less than ten days prior on November 17, thousands of peacefully marching students in Prague had been attacked by the police on their way from the nineteenth century poet Karel Mácha's grave to the city center. Students and theaters went on strike around the country and mass demonstrations began to hit the streets and grow more numerous. What would later be called the Velvet Revolution, the peaceful and rapid overthrow of the Communist party's monopoly on power, had begun. Nearby Wiedermann in the bus sat his friend Igor Prívara; he planned to spur his colleagues at the conference to action and had carefully concealed signs and posters from a protest group founded in Bratislava on November 19, Public Against Violence (*Verejnosť proti násiliu*), in his luggage.[4] On the radio there was news of a general strike planned for the following day.

In this atmosphere of electric uncertainty, Wiedermann and his colleagues arrived at their destination, the annual SOFSEM (software seminar) hosted that year at the Hotel Magura in Slovakia. They piled out of the bus to greet their comrades for the next two weeks. Some 150 attendees, they included academics, engineers, journalists and students who had come from all over the country—automobile assembly lines in Kopřivnice, the electrical engineering faculty in Prague, and the Zbrojovka arsenal in Brno.[5] What organized them all was a work, a hobby and a passion: the computer. Computer work, on both a professional and amateur basis, was a growing but still tight-knit field by the late 1980s in Czechoslovakia where perhaps only one-in-twenty people enjoyed access to one.[6] Conversation between these computer technologists quickly became an exchange of news, then an exchange of views, and finally an agreement that the

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[4] Wiedermann, "XXX Years of SOFSEM."
[5] Prof. RNDr. Jozef Gruska, DrSc., (Professor – Faculty of Informatics, Masaryk University), in discussion with the author. March 28, 2018.
[6] In fact, only 1.8 percent of households around the country claimed to have access in 1989. Jaroslav Švelch, *Gaming the Iron Curtain: How Teenagers and Amateurs in Communist Czechoslovakia Claimed the Medium of Computer Games*, Cambridge: The MIT Press, 2018: 1.

conference could not possibly go ahead as it always had since 1974. Events had overtaken them all. Instead of the normal round of 80 minute lectures, afternoon walks in the countryside and whiling away the evening with poetry and soft jazz performances, the computerists organized informational meetings and political discussion groups to include hotel employees and local townspeople. Prívara unpacked his posters.

At first glance, telling the story of this community of Czech and Slovak computerists as it grew in size and importance over the course of several decades may seem an exercise in merely esoteric curiosity. Polite puzzlement was the ordinary reaction to inquiries about the Czechoslovak computer industry at museums, libraries and government offices in the Czech Republic. The country's National Technical Museum, located in the Holešovice district of Prague, featured extensive displays of Czech-made automobiles, aircraft, motorcycles and bicycles as well as a fascinating exhibit on the steel industry, but nothing relating to the country's history of producing and using computers. For that, one had to travel to Brno, the country's second city, and visit the Technical Museum there. However, even that collection, the only one of its kind in the country, was incomplete.[7] Computers like the Maťo, of which thousands of units were manufactured from 1989 to 1992 in Slovakia, and the EC 1021—which constituted Czechoslovakia's main contribution to the Soviet-led System of Unified Electronic Computers that coordinated computer production, distribution, installation and software development across the state socialist bloc in the 1970s and 1980s—were missing.

Private collectors and hobbyists are often the only source of important material ephemera from the late socialist period (1968-1989 in Czechoslovakia). These include many of the materials that formed the primary source base of this dissertation: computer club newsletters,

[7] Appendix B: Photos from the Brno Technical Museum, 2017.

fanzines, cartoons, photo collections, songs, programming manuals, text adventure games (*textovky*), and hardware mods like tape loader cartridges.[8] Alongside these more ephemeral sources, typically encountered through chance personal connections and outside of libraries and archives, this work relies on twenty-one oral interviews conducted with a standardized questionnaire in-person between September 2017 and June 2018 with Czech and Slovak computer technologists. These individuals were often both professionals and hobbyists during the late socialist period—the distinction was blurred in Czechoslovakia, where professionals often acted as hobbyists: tinkering at work and home, organizing and supervising the computer youth clubs, and working on home computers with their children.

The bulk of primary source information for this research on the status of computers and computer work in late socialist Czechoslovakia, however, was drawn from the period's popular and professional press housed in the National Technology Library in Prague.[9] This included close reading of full or partial print runs from the 1960s to the 1990s of: popular science and technology publications aimed at youth enthusiasts, such as *ABC Mladých Techníků a Přírodovědců* (ABC of Young Technicians and Naturalists) and *Technický Magazín* (Technology Magazine); the mainstream socialist press like *Rudé právo* (Red Justice) and *Bratislava Pravda* (Bratislava Truth); professional journals and trade publications like *Sdělovací Technika* (Communications Technology) and *Jemná Mechanika a Optika* (Precision Mechanics and Optics); and especially the dedicated electronics hobbyist press, *Amatérské radio* (Amateur Radio) and *Mikrobáze: Technický Zpravodaj Svazarmu pro Zájemce o Mikropočítače* (Microcomputing Database: Svazarm's Technical Proceedings for Microcomputer Enthusiasts).

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[8] Appendix C: Photos from interview with collector Karel Buďa.

[9] Frequent and unfortunate record gaps in the collection of the National Technology Library were addressed by consulting the personal collection of technologist publications held by Jan Mikeš, of the Czech Institute for Informatics, Robotics and Cybernetics (CIIRC).

Analysis of the changing discourse about computing in these publications during the normalization period in Czechoslovakia, reflecting the growth of the computerist community, the material conditions of the computing scene, and the government's efforts to produce, diffuse, and integrate computers into national life, is a central throughline in this work. Finally, primary source material that informs this work was also drawn from museum visits to Prague, Brno and Kopřivnice; two weeks of research conducted in the Czech Statistical Office in Skalka; from the organized collection of songs, poetry, conference papers, and photographs of SOFSEM from 1974 to 2003 preserved at the Institute for Computer Science of Masaryk University in Brno; and from three weeks spent in the archives of Czechoslovak Television with the invaluable assistance of archivist Karel Sieber.

However, in addition to making use of these primary sources to address a gap in the historiography of computing in East Central Europe, this work also fits alongside an expanded scholarly interest over the last decade in recovering and representing histories of computing in East Central Europe. As James Cortada, a prominent historian of computing and senior research fellow at the University of Minnesota's Charles Babbage Institute, noted in 2012: "Our knowledge of the evolution of IT in European communist countries remains limited and fractured. This is largely due to the lack of access to archival materials, which have only started to become available to scholars in the past 15 years, opening up a vast new area of modern European history in general and, more specifically, the history of computing."[10] In response, scholars such as Helena Durnová and Jaroslav Švelch (Czechoslovakia), Ksenia Tatarchenko (USSR), Patryk Wasiak (Poland), Simon Donig (GDR), Victor Petrov (Bulgaria) and Máté Szabó (Hungary) have produced a raft of articles, contributions to edited volumes, and books that

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[10] James W. Cortada, "Information Technologies in the German Democratic Republic (GDR), 1949-1989," *IEEE Annals of the History of Computing* 34, no. 2 (April-June 2012): 34.

address the development of computing in the state socialist countries of East Central Europe.[11] This work, which grew out of an early collaboration with Švelch beginning in August 2014, and was augmented by a year of Fulbright-funded overseas research in the Czech Republic in 2017 and 2018, further participates in this international effort to narrate and interpret the still-understudied history of computing in the region.[12]

Moreover, Czechoslovakia's struggle to develop a computer industry sufficient to fulfill the growing needs of its military, industry, schools and bureaucracy was typical not only of its immediate neighbors in East Central Europe. This case study is an intervention in the global history of computing. Czechoslovakia in the late twentieth century was a small country in the shadow of Cold War superpowers. Its efforts to juggle import substitution, limited hard currency reserves, brain drain among skilled workers, political unrest and the imperative to modernize, or remain competitive economically and militarily through computerization, was neither exceptional nor exotic, but exemplary. As the work of Bernardo Bátiz-Lazo, Eden Medina and other scholars have shown, many countries in this period struggled to modernize their economies by acquiring computers. The Mexican relationship with Control Data Corporation (CDC) as a reliable outside contractor was, for example, similar to the Czechoslovak experience. Countries as different as Mexico and Czechoslovakia nevertheless shared similar problems that were

[11] A short list of prominent recent scholarship includes: Helena Durnová, "Sovietization of Czechoslovak Computing: The Rise and Fall of the SAPO Project," *IEEE Annals of the History of Computing* 32, no. 2 (April-June, 2010): 21-31; Helena Durnová, "Embracing the ALGOL Effort in Czechoslovakia," *IEEE Annals of the History of Computing* 36, no. 4 (October 2014): 26-37; Švelch, *Gaming the Iron Curtain*, 2018; Ksenia Tatarchenko, "'The Computer Does Not Believe in Tears': Soviet Programming, Professionalization, and the Gendering of Authority," *Kritika* 18, no. 4 (Fall 2017): 709-739; Patryk Wasiak, "Playing and Copying: Social Practices of Home Computer Users in Poland during the 1980s," in Gerard Alberts and Ruth Oldenziel, eds., *Hacking Europe: From Computer Cultures to Demoscenes*, London: Springer-Verlag, 2014: 129-150; Johan Söderberg, "Free Space Optics in the Czech Wireless Community: Shedding Some Light on the Role of Normativity for User-Initiated Innovations," *Science, Technology, & Human Values* 36, no. 4, 2011: 423-450; Benjamin Peters, *How Not to Network a Nation: The Uneasy History of the Soviet Internet*, Cambridge: The MIT Press, 2016.

[12] James W. Cortada, "How New Technologies Spread: Lessons from Computing Technologies," *Technology and Culture* 54, no. 2 (2013): 249.

difficult to overcome, such as language friction (hardware and software manuals were rarely in Czech or Spanish), the absence of speedy, reliable technical support and a lack of spare parts.[13]

Yet if Czechoslovak computing during the late twentieth century is a field that shares a great deal with similar national computing efforts in other countries, it retains unique points of interest that offer an instructive case for historians in several respects. This period includes the explosion in popular home computing that began in the middle 1980s, succeeded the age of first national computers and establishment of research institutes in the 1950s, and was dominated by a Soviet-led Unified System of Electronic Computers that ultimately failed to achieve its own stated goals of production, distribution and integration. Historians often dismiss the late socialist period in Czechoslovakia as a time of stagnation, hitching technological history to the political history of so-called normalization, the era between 1968 and 1989 under which hardline conservatives dominated the leadership of the Communist Party of Czechoslovakia and political reforms to state socialism were out of the question.[14]

This history re-frames that conventional and Western-focused historiography of computing, as represented by Paul Ceruzzi's *A History of Modern Computing* (2003), James Cortada's *Digital Flood* (2012), Paul Freiberger and Michael Swaine's *Fire in the Valley* (2014),

[13] A contract with Control Data Corporation, a leading provider of mini-computers in the 1960s, ran into trouble when the Minnesota company "promised to build up capabilities to deliver highly reliable and swift engineering support for Mexican companies. Its Mexican engineering support and servicing teams, however, were not set up to deliver on its promises. Engineers and spare parts often had to be flown in from the US, which delayed solutions." Cold War trade and travel restrictions provided another layer for Czechoslovakia to negotiate with. Bernardo Bátiz-Lazo and Thomas Haigh, "Engineering Change: The Appropriation of Computer Technology at Grupo ICA in Mexico (1965-1971)," *IEEE Annals of the History of Computing* 34, no. 2 (2012): 28.

[14] This consensus view of technological stagnation during the 1970s may be found, *inter alia*, in these publications: Amy Wilson, "Computer Gap: The Soviet Union's Missed Revolution and its Implications for Russian Technology Policy," *Problems of Post-Communism* 56, no. 4 (2009): 41-51; James W. Cortada, *The Digital Flood: The Diffusion of Information Technology across the US, Europe, and Asia*, Oxford: Oxford University Press, 2012; Rudolf Zahradnik, "Research and education in Czechoslovakia: A Few Remarks," *Technology in Society* 15, no. 1 (1993): 41-52; Peter Havlik, "Information and related technologies and their impact on East-West relations," *Information technology: Impacts, Policies and Future Perspectives* (1990): 197-215; Ivan Szelenyi and Balazs Szelenyi, "Why Socialism Failed: Toward a Theory of System Breakdown-Causes of Disintegration of East European State Socialism," *Theory and Society* (1994): 216.

as well as a number of popular hagiographies of individuals by Walter Isaacson (*Steve Jobs* in 2011, *The Innovators* in 2014) and companies (*In the Plex*, a 2012 profile of Google by Steven Levy) in the following ways. It prioritizes attention geographically to the margins, to Czechoslovakia, which was both like other emerging countries such as Mexico, Korea, India and Brazil and unlike these places—silicon's second world. History from the margins demands comparative historical analysis, which in this dissertation often focuses on a juxtaposition of Czechoslovakia and the United States. In part this is a function of the rich and well-developed secondary source base that exists for the history of computing in North America. However, this must be qualified by the observation that the two societies were remarkably different in their standards of living, political and economic systems, size, demography and histories.

Similar problems exist when conducting comparative analysis between Czechoslovakia and poorer market economies in Latin America and Asia. Nonetheless, comparative analysis limited solely between Czechoslovakia and its state socialist neighbors would unnecessarily restrict inquiry without sharpening insight: internal variation in industrial development and living standards within the CMEA (Council for Mutual Economic Assistance) bloc of state socialist countries in East Central Europe was notable, with more highly developed economies (Czechoslovakia, East Germany) paired with those less developed (Romania, Bulgaria).[15] A qualified and careful series of analogies between the computing community in Czechoslovakia and countries both larger and wealthier (the United States, France) and smaller (Finland) and poorer (India, Brazil) may therefore afford insights that a more shallow well of secondary source

[15] Victor Petrov, "A Cyber-Socialism at Home and Abroad: Bulgarian Modernisation, Computers, and the World, 1967-1989," Ph.D. dissertation, Columbia University, 2017: 59.

scholarship would not.[16] Living in an industrially developed society and surrounded by rhetoric promising a scientific and technological revolution just around the corner, computer technologists in Czechoslovakia found themselves on the outside looking in, just as technologists did in most countries in the late twentieth century that were not Japan or the United States. They enjoyed ready access to computers in their work, but those computers were frequently older, or of poorer quality, than what they knew to be the state of the art.

On the one hand, they were rich in knowledge but, on the other, they often lacked the proper tools to practice their craft. This combination of low material availability and high technical skill shaped both ethos and praxis in the community over the course of several decades. Thus *bricolage* is a fundamental analytical concept of this work. A term stemming from Claude Lévi-Strauss (*The Savage Mind*, 1962) but adapted by cultural studies scholars such as Dick Hebdige (*Subculture: The Meaning of Style*, 1979), bricolage refers here to material objects like the computer which have been appropriated or "symbolically 'repossessed' in everyday life, and endowed with implicitly oppositional meanings, by the very groups who originally produced them."[17] Originally intended as an artifact of command and control for the government, the military and large industrial enterprises, the computer in state socialist Czechoslovakia was

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[16] Comparative analysis ranges widely in this work: (Netherlands) Frank Veraart, "Losing Meanings: Computer Games in Dutch Domestic Use, 1975-2000," *IEEE Annals of the History of Computing* 33, no. 1 (January-March 2011): 52-65; (Taiwan) Honghong Tinn, "From DIY Computers to Illegal Copies: The Controversy over Tinkering with Microcomputers in Taiwan, 1980-1984," *IEEE Annals of the History of Computing* 33, no. 2 (April - June 2012): 75-88; (Chile) Eden Medina, *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile*, Cambridge: The MIT Press, 2011; (France) Julien Mailland and Kevin Driscoll, *Minitel: Welcome to the Internet*, Cambridge, Massachusetts: The MIT Press, 2017; (Greece) Theodoros Lekkas, "Legal Pirates Ltd: Home Computing Cultures in Early 1980s Greece," in Gerard Alberts and Ruth Oldenziel, eds., *Hacking Europe: From Computer Cultures to Demoscenes*, New York: Springer, 2014: 73-106; (USA) Katie Hafner and Matthew Lyon, *Where Wizards Stay Up Late: The Origins of the Internet*, New York: Simon & Schuster, 1996; (UK) Alison Gazzard, *Now the Chips Are Down: The BBC Micro*, Cambridge, Massachusetts: The MIT Press, 2016; (Cuba) Michaelanne Dye, David Nemer, Neha Kumar, et al., "If it Rains, Ask Grandma to Disconnect the Nano: Maintenance & Care in Havana's StreetNet," *Proceedings of the ACM on Human-Computer Interaction* 3, no. CSCW (2019): 1-27; and (India) Ross Bassett, "Aligning India in the Cold War Era: Indian Technical Elites, the Indian Institution of Technology at Kanpur, and Computing in India and the United States," *Technology and Culture* 50, no. 4 (October 2009): 783-810.

[17] Dick Hebdige, *Subculture: The Meaning of Style*, London: Routledge, 1996: 16.

adopted and its meaning re-appropriated by the community of computer technologists over the course of a revolution in microelectronics that promised newly distributed and egalitarian access to the machine.[18]

In the 1980s home computers became objects in which resided technologists' hopes for the future. They were a reflection of and guide to their community's own values of efficiency, logic and order, and ultimately an important barometer of the country's health and future prospects. It may seem tautological to argue that the computer user community in Czechoslovakia constituted a subculture organized around the computer artifact. It may therefore be more useful to consider computerist subculture as potentially a whole way of life composed by the homology between the computer-artifact, its texts (games, manuals, programs, newsletters), its symbolic heft as representative of modernity and futurity, employment (feelings of belonging, utility) and entertainment (feelings of joy or diversion) deriving from it, and the value system of orderly rationality it originated from and which it suggested to its users.[19]

In computer-scarce Czechoslovakia as elsewhere, users in the subculture gauged each other and the state by metrics of production, affordability, quality, features and ease of use. Failure to measure up meant a failure to be *modern*—the computer was, according to historian of technology Thomas Misa, a "symbol-making" and "culture-changing" technology "at the core of modernity because their presence and their promoters' promises have seemingly offered proof of

[18] "… the desire to computerize was often driven by the need for centralized administrative control [for the government, the military and large corporations], or to advance individual or professional agendas, or simply to appear cutting-edge and 'shiny.'" Nathan Ensmenger, "The Digital Construction of Technology: Rethinking the History of Computers in Society," *Technology and Culture* 53, no. 4 (October 2012): 760.
[19] Following Hebdige, one can even explain why computerists often failed to present obviously across most societies as a subcultural style or countercultural grouping, in terms of fashion, music, or oppositional public behavior: "different youths bring different degrees of commitment to a subculture. It can represent a major dimension in people's lives—an axis erected in the face of the family around which a secret and immaculate identity can be made to cohere—or it can be a slight distraction, a bit of light relief from the monotonous but none the less paramount realities of school, home and work." Hebdige, *Subculture*, 113, 122.

the modernist storyline that society is incessantly changing, ever progressing, transcending frontiers without an end in sight."[20] Whether a term like modernity was defined in the minds of its beholders as speed, ceaseless social and economic change, enhanced global connectivity or organized processes of scientific rationality, enthusiasts appropriated the computer as the concept's flexible symbol.

Furthermore, this work subscribes to the argument Švelch advanced in his recent work *Gaming the Iron Curtain* (2018), that Czechs and Slovaks under late socialism engaged in bricolage not just as cultural appropriation, but as a material tactic and adaptation to conditions of scarcity. Although computer professionals in Czechoslovakia participated in the international networks of scientific and intellectual exchange, and although young hobbyists eagerly consumed the machines, software and texts of Western computing, their country's Cold War circumstances forced them into a world of adaptation, into "tiny interventions, poaching, imitations, and transformations … they used technology that seemed to embody the triumph of modernity, [but] their tactics diverged from the modernist paradigm."[21] They used modems and electronic mail to speak to colleagues in Israel and the United States, but they spent dozens of hours building the modems themselves using local off-the-shelf telephone transformers hand-wired into a home computer sold as a cheap toy for British school-children.[22]

Czechs and Slovaks responded to their desire to participate in global computing developments by becoming *bricoleurs*. They engaged in bricolage first when assembling a national computing industry in the throes of the computer crisis of the 1960s. Later in the 1980s,

[20] Thomas J. Misa, "The Compelling Tangle of Modernity and Technology," in Thomas J. Misa, Philip Brey and Andrew Feenberg, eds., *Modernity and Technology*, Cambridge, Massachusetts: The MIT Press, 2002: 11-12.
[21] Švelch, *Gaming the Iron Curtain*, 218-219.
[22] Ing. Václav Trojan, (Lecturer – Faculty of Mathematics, Charles University; formerly software programmer at Research Institute of Mathematical Machines), in discussion with the author. December 15, 2017.

when institutions proved incapable of repeating their earlier success in creating a stable computing environment during the 1970s, Czechs and Slovaks created a home computing scene that reflected contemporary developments abroad but adapted to local circumstances, cobbled together and carefully maintained with the materials at hand.

This dissertation was inspired to study their technicians' community through the work of David Edgerton, and particularly Kevin Borg, whose 2007 work *Auto Mechanics: Technology and Expertise in Twentieth-Century America* identified a similar community of amateur technicians (chauffeurs and tinkerers) who gradually professionalized into the cadre of auto mechanics, gaining social power through technical expertise. "Studying the maintenance and repair of technology," Borg noted "can thus provide rich narratives that bridge the 'macro' deterministic view that technological change drives social change and the 'micro' social constructivist view that human choices determine which technologies get developed."[23] By following the interpersonal connections, rhetorical exchanges, scientific collaboration and computer work as it flowed within and between the heterarchical network of mid-tier institutions that technologists inhabited—university faculties, research institutions, industrial enterprises, government ministries, conferences, and publications—this work aims to provide Borg's "rich narratives" of everyday life and computing practice in Czechoslovakia. Technologists' scramble for computers there was one stage in a frantic global relay; countries leaping over "missile gaps" and running dangerously even in "arms" and "space" races.

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[23] Kevin L. Borg, *Auto Mechanics: Technology and Expertise in Twentieth-Century America*, Baltimore, Maryland: Johns Hopkins University, 2007: 173; Edgerton's admonition to pay attention to "alternative technologies, alternative paths of invention" than what has been represented in Silicon Valley-centric works was a challenge to which this work attempts to respond. David Edgerton, *The Shock of the Old: Technology and Global History since 1900*, Oxford, UK: Oxford University Press, 2011: 210.

Governments and businesses increasingly felt the same way around the world. The rapid change in access to computing brought about by smaller, more affordable microprocessors promised efficient administration, nimbler supply chains and a more potent military.[24] Much as the airplane had been "both an instrument and symbol of modernization," in the 1920s' Soviet Union, and the automobile industry's "presence or absence in a national economy" at mid-century marked "the level and power of that economy," computer enthusiasts and the socialist state agreed that computers were the totemic technology of the late 20th century. Indeed they may have supplanted the rocket in the popular imagination once the space race had run its course, public doubts about the "master narrative" of Soviet successes began to surface, and only Mars beckoned weakly as a goal of the distant future.[25] Moreover, much as Kristen Haring and Christophe Lécuyer have shown in the United States and oral interviews with older technologists confirmed, computer professionals and hobbyists did not spring, *de novo*, into being alongside the personal computer revolution of the late 1970s and early 1980s. They emerged from an already well-established culture of amateur radio and electronics tinkering and maintenance and moved into computer work due to a mixture of personal interest, material availability and professional opportunity.[26]

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[24] "Here was the genie," Sherry Turkle wrote, "the workhorse that we could mount today and ride onto the new millennium." Sherry Turkle, "The Psychology of Personal Computers," in: Tom Forester, ed., *The Information Technology Revolution* (Cambridge, MA: MIT Press, 1985), 182.

[25] Scott W. Palmer, *Dictatorship of the Air: Aviation Culture and the Fate of Modern Russia* (Cambridge: Cambridge University Press, 2006), 98; Kristin Ross, *Fast Cars, Clean Bodies: Decolonization and the Reordering of French Culture* (Cambridge, MA: MIT Press, 1996) quoted in: Lewis H. Siegelbaum, *Cars for Comrades: The Life of the Soviet Automobile* (Ithaca: Cornell University Press, 2011): 24-25; the failure of the Soviet crewed lunar program played a major role in diminishing the heroic sheen of the space program, but so did private diaries and archival documents describing corruption and safety problems which surfaced with *glasnost* in the mid-1980s. Slava Gerovitch, *Soviet Space Mythologies: Public Images, Private Memories, and the Making of a Cultural Identity*, Pittsburgh, Pennsylvania: University of Pittsburgh Press, 2015: 156.

[26] Kristen Haring, *Ham Radio's Technical Culture*, Cambridge, Massachusetts: The MIT Press, 2007; Christophe Lécuyer, *Making Silicon Valley: Innovation and the Growth of High Tech, 1930-1970*, Cambridge, Massachusetts: The MIT Press, 2007; Pajas in discussion with the author.

Chapter one examines this emergent community of computer professionals over a two decade period ending in 1984. Over the course of a "long 1970s" that lasted from computer scientist Antonín Svoboda's emigration to the United States in 1964 to the government's adoption of the two Long Term Complex Electronization plans for the economy in 1984-85, the computerist community in Czechoslovakia grew at a rapid clip. Lacking any coherent industrial strategy from the government to organize the production, acquisition or implementation of computing in the economy, military and government, technologists in the mid-tier institutions engaged in an unregulated scramble for computers.

What ensued from this initial chaos by the early 1970s was the construction of a stable equilibrium that featured balanced institutional collaboration and competition, a slow but steady integration of machines and software under the framework of the Soviet-led Unified System of Electronic Computers, and new privileges and autonomy for professionalizing computerists. Rather than a focus on disruptive innovations or world-changing inventions, which are necessarily rare and atypical of ordinary life, this chapter's attention to both maintenance and adaptation within conditions of material scarcity takes part in the turn to maintenance as a shift in scholarly discussion. Reframing the historical narrative to include the labor and professionalization of the computerist community during the long 1970s, rather than simply a comparative inventory of computer production in the capitalist and state socialist blocs, "emphasizes stability and continuity across history, and thereby undermines and diminishes the 'rupture-talk' that is common in some histories of technology."[27] This has often acted to exclude or at best elide narratives focused on everyday use, local appropriation and adaptation,

[27] Andrew L. Russell and Lee Vinsel, "After Innovation, Turn to Maintenance," *Technology and Culture* 59, no. 1 (January 2018): 10.

maintenance and second-order innovation. Those narratives are the focus of this chapter, a history that focuses on tactics and not strategy in Michel de Certeau's sense.

A key insight of this work is not merely the way Czechoslovak computer technologists engaged in the tactics of what sociologist John Law refers to as "heterogeneous engineering" to create, maintain and extend the utility of computers themselves. Czech and Slovak computerists also inhabited and reappropriated formal institutions such as their workplace, socialist youth clubs and academic conferences into, in de Certeau's description: "a space in which he [the computerist] can find *ways of using* the constraining order of the place," to their individual and communal benefit.[28] How Czech and Slovak users, their communities, and their institutions scrambled for, adopted, appropriated and used computers in everyday life can offer valuable insight into how individuals respond to and overcome structural problems.

Poverty, malfunctioning markets, cultural imperialism, embargos, and a government with chaotic, misguided and perhaps actively injurious policies are not unique to Czechoslovak computing in the late twentieth century. Although the Cold War embargo that Czechoslovakia and its state socialist neighbors suffered under for decades was, for instance, the product of the now-defunct American-led and Paris-based Coordinating Committee for Multilateral Export

[28] Computers fulfill all three of John Law's criteria to be objects of heterogeneous engineering in late socialist Czechoslovakia, i.e. "the heterogeneity of the elements involved in technological problem solving," since computer technologists had to navigate a rapidly shifting world of embargos, changes in manufacturing techniques, market demand, negotiation between the use cases and needs of varying large enterprises, the military, and the research institutes; "the complexity and contingency of the ways in which these elements interrelate," which involved integrating and making use of scientific knowledge and material objects from a number of different languages and countries of origin and typically incompatible machines and software and; "the way in which solutions are forged in situations of conflict," which as this dissertation shows sometimes resulted in stable system accommodations as during the synthesis of the 1970s, and sometimes played a role in the destruction of the system altogether in favor of a new paradigm, as during the microelectronics crisis of the 1980s. John Law, "Technology and Heterogeneous Engineering: The Case of Portuguese Expansion," in Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, MA: The MIT Press, 1994: 111; Michel de Certeau, *The Practice of Everyday Life*, trans. Steven Rendall, Berkeley, California: University of California Press, 1984: 29-30.

Controls (CoCom), technicians in Iran or Cuba similarly struggle today to find spare parts or import new equipment under a U.S. blockade. It is a story likely familiar to anyone repairing TVs in a Jakarta shop or making homebrew computer games for a hacked Playstation console in a Brazilian favela. It sums up to a story of material scarcity that drives communities of technological practitioners around the world to skilled hard work in the service of the practical needs of today and a vision of a better tomorrow.

In Czechoslovakia, as elsewhere around the world during the late twentieth century, it was by no means clear from what background these skilled technological practitioners might come, how they ought to be trained, or what the shape of their profession. The subject of chapter two is, thus, the social origins and identities of computer technologists in Czechoslovakia. Borrowing from prominent SCOT (social construction of technology) thinkers like Wiebe Bijker and Trevor Pinch, I argue computing and indeed the computer itself as a technological artifact in the 1970s and 1980s was still subject to interpretive flexibility.[29] Professional boundaries had yet to harden, and virtually anyone regardless of age, education or background might find himself or herself writing and running programs or maintaining computer equipment. Furthermore, a rich native tradition of electronics tinkering and social clubs in Czechoslovakia often threw together older mentors and younger apprentices, particularly when it came to programming, which was only poorly taught in formal educational settings and often required hundreds of hours of trial-and-error work alone or in small groups to develop competence.

Of course there were other, cultural, factors that often slammed the gates of computer work shut in the face of adult workers, particularly women. As historian of computing Nathan

[29] Trevor J. Pinch and Wiebe E. Bijker, "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other," in Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, MA: The MIT Press, 1994: 27.

Ensmenger notes, the work of computer programming, even more than data processing or academic computer science, was where "the culture and practices of adolescent masculinity" such as poor diet, hygiene, obsessiveness and asociality were most firmly established.[30] To that end, chapter two considers at length the unique position women computer workers occupied in late socialist Czechoslovakia. Much as in Western countries like the United States and United Kingdom, women in Czechoslovakia disproportionately occupied lower status positions as operators (*operátorky*) of punch card data processing equipment in offices around the country. Unlike the practice in Western countries, however, where the work of Mar Hicks and Janet Abbate have concluded that professionalizing computer work in the 1960s and 1970s typically meant men pushing women out of newly high status (and highly paid) employment, in Czechoslovakia over half the country's programmers remained women into the 1980s.[31] While chapter two demonstrates that misogyny persisted even in a state socialist setting that encouraged at least formal equality between the sexes, women computerists like Božena Mannová, Alena Šolcová and Sylva Prokšová nevertheless played prominent roles in organizing and contributing to the country's professional and hobbyist computing scenes in the 1970s and 1980s.

Finally, chapter two examines the ways in which the community ethos of computer users in Czechoslovakia was shaped by their interaction with the computer while initial interest in computers typically arose from their family background and childhood interests. In science and technology studies, users are considered "highly active and agentic in processes of innovation," and therefore understanding who users are plays a significant role in determining what they want

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[30] Nathan Ensmenger, "'Beards, Sandals, and Other Signs of Rugged Individualism': Masculine Culture within the Computing Professions," *Osiris* 30, no. 1. Scientific Masculinities (2015): 55-56.

[31] "Many women operated and programmed electromechanical and, later, electronic computers because of the perception that these machines made work rote." Mar Hicks, *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing*, Cambridge: The MIT Press, 2017: 13. Janet Abbate, *Recoding Gender: Women's Changing Participation in Computing*, Cambridge, Massachusetts: The MIT Press, 2012: 71-72.

from the technologies they use and how they co-construct the symbolic meaning and everyday use of technologies like the computer in their local environment.[32] The chapter traces commonalities among community members' social origins. It argues that these shared backgrounds played a significant role in helping bind computerists together into a profession and a subculture. In turn, their community values—egalitarianism and meritocracy, unrestricted access to the machine, openness (information sharing was paramount), and the importance of tinkering, amateur craft-work and hands-on knowledge—stemmed from an older culture of engineering and technicity, particularly in radio electronics and mechanical work, and a still older culture of "golden Czech hands" (*zlaté české ruce*) that prized adaptation, clever craftsmanship and quick wittedness as supposedly national traits.[33]

Despite endemic shortages during the microelectronics crisis of the 1980s, the years preceding the Velvet Revolution in 1989 when government plans to produce or acquire through imports an adequate number of microcomputers for schools, offices and industry failed, the home computer inspired a vibrant user culture in Czechoslovakia. A personal computer symbolized modernity, a liberatory future for the technically-minded that called forth the interest and attachment of thousands of Czech and Slovak enthusiasts who anticipated the same potential as other technophiles around the world. Much as in the United States, which Martin Campbell-Kelly and William Aspray described in their survey *Computer: A History of the Information Machine*, the hobbyist computer user in 1980s' Czechoslovakia was "typically a young male

[32] Dale Rose and Stuart Blume, "Citizens as Users of Technology: An Exploratory Study of Vaccines and Vaccination," in Nelly Oudshoorn and Trevor Pinch, *How Users Matter: The Co-Construction of Users and Technologies*, Cambridge, Massachusetts: The MIT Press, 2003: 106-107.

[33] Zdeněk Svěrák and Ladislav Smoljak satirized this national stereotype beginning in 1966 by inventing the figure of Jára Cimrman, a fictional Czech inventor, author, sculptor, playwright and all-around genius who has been quietly responsible for nearly every major world-renowned work of art and technology, but is never properly credited for his contributions. Ladislav Smoljak, *Jára Cimrman ležící, spící* (Jára Cimrman lying, sleeping), Prague, Czechoslovakia, 1983.

technophile." His interest in computers usually stemmed from initial contacts made "at work or in college," which were domains of the state in socialist Czechoslovakia, but he "hungered for a computer at home for recreational use, so that he could explore its inner complexity, experiment with computer games, and hook it up to other electronic gadgets."[34] In the late twentieth century, many countries around the world struggled to enforce state policies that would foster innovation, adoption and a technically perceptive cohort of young workers to lead their societies into the future. Czechoslovak policymakers had important plans for their own cohort—as in East Germany and the Soviet Union, planners and officials knew by the mid-1980s that a flourishing IT sector, with skilled programmers and other technicians, was vital to the economic survival of socialism.[35] The tension grew rapidly in the mid-to-late 1980s between what the socialist state was capable of achieving in regards to computer production, distribution and implementation, and what it had promised a rising cohort of computer technologists with great expectations for the future.

The subject of chapters three and four, how to achieve that better tomorrow, was a perpetual question with political ramifications for technologists in Czechoslovakia and around the world since at least the late 1960s. The stable system of computing that emerged alongside a professionalizing cadre of computer workers in the long 1970s had temporarily addressed problems of material scarcity and technologist autonomy. However, the result was a widespread political indifference among the community that presumed the continuation of the same slow but steady adoption of centralized computing (mainframes, mini-computers), the impossibility of open politics, of reform, of threats to their privileged status.

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[34] Martin Campbell-Kelly and William Aspray, *Computer: A History of the Information Machine* 2nd ed., Boulder, CO: Westview Press, 2004: 211.

[35] David A. Wellman, *A Chip in the Curtain: Computer Technology in the Soviet Union*, Washington, D.C.: National Defense University Press, 1989: 147.

The lens of *political indifference* used as a category of analysis in this dissertation to examine the technologist community's approach to navigating the repression and opportunities of life in normalization-era Czechoslovakia is inspired by historian Tara Zahra's work on national indifference in nineteenth and early twentieth century East Central Europe. In particular, Zahra makes a valuable observation about the persistence of ambiguity and opportunism that resist national and political categorization schemes.[36] Chapters three and four explore why political indifference made sense to computer technologists for most of the late socialist period. These chapters refer not just to opportunism and fear of state repression, but also technologists' belief in philosopher Radovan Richta's "scientific and technological revolution" (STR) whose vision of the future (amplified in official rhetoric from 1966 onward) promised that technological change was inevitable. As examined by Czech historian Vítězslav Sommer, STR "characterized scientists and experts as new revolutionary subjects and bearers of all significant social and political changes," and asserted that powerful new technologies (especially computers) would soon deliver a reformed, efficient and humanist socialism without the need for technicians to engage in open, and personally dangerous, political dissent.[37]

This "ideology of inevitable technological change," a term derived from Matthew Wisnioski's *Engineers for Change: Competing Visions of Technology in 1960s America* (2012), tended to seduce even the most radical and conscientious technologists. It offered a way out. The system did not need to be overthrown or re-made, just better managed, de-centralized with more effective tools. Computers were the latest in a long line of instruments that seemed to offer technocratic control to engineers who might exert order over chaos, much as they had previously

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[36] "It is hardly surprising that when questioned about his national loyalties in 1948, one bilingual factory worker frankly replied, 'It is a matter of who is giving more.'" Tara Zahra, "Imagined Noncommunities: National Indifference as a Category of Analysis," *Slavic Review* 69, no. 1 (Spring 2010): 100.
[37] Vítězslav Sommer, "'Are We Still Behaving as Revolutionaries?': Radovan Richta, Theory of Revolution and Dilemmas of Reform Communism in Czechoslovakia," *Studies in East European Thought* 69, no. 1 (2017): 106.

dreamed of solving urban unrest through air-conditioning the slums.[38] This utilitarian approach, championed by Buckminster Fuller, Brand, Nelson and others, became the guiding philosophy of the hobbyist movement for personal computers worldwide in the 1970s. As the window for radical, systemic change appeared to close around the world during that decade, technologists turned their hopes to the inevitable disruption of de-centralized computing. "The creative society was seen as an inevitable outcome of the digital revolution," and so Moore's Law (bringing about that revolution through ever-faster, ever-cheaper computers) would safely substitute for political advocacy.[39]

Inevitable technological change and the better society it would determine eased the consciousness of technicians and justified their political indifference. Then as now, and there in the socialist East as here in the capitalist West, computer technologists confronted the need for powerful technological artifacts and systems to be used in a socially responsible manner. They balanced recognition of this need uncomfortably with the realities of the Cold War world and their employment in service with the military, the bureaucracy and the largest enterprises, which formed the core computer customers.[40] At the same time reformers in 1968 Czechoslovakia agitated for 'socialism with a human face,' during the Prague Spring reform movement, a growing number of Western technologists echoed economist E.F. Schumacher's call for

[38] Sean F. Johnston, "Technological Parables and Iconic Illustrations: American Technocracy and the Rhetoric of the Technological Fix," *History and Technology* 33, no. 2 (2017): 205-206.
[39] Matthew H. Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*, Cambridge: MIT Press, 2012: 145.
[40] This was especially the case in state socialist countries, where the absence of any consumer market for computers meant that even boldly worded reform plans meant to produce a new abundance of microcomputers in the mid-1980s were still aimed at the needs of the same large industrial enterprises, collective farms, research institutions and government ministries to which previous mainframe and minicomputer production had already been addressed. Paul R. Josephson, *Red Atom: Russia's Nuclear Power from Stalin to Today*, New York: W.H. Freeman, 1999: 192-193.

'technology with a human face'—problems like environmental degradation and the nuclear arms race seemed to disregard popular input while also spinning out of elites' centralized control.[41]

Over the course of the late 1960s and early 1970s, ordinary people awoke to find themselves enmeshed as never before in a world of enormous, nigh incomprehensible technological systems. Noted science fiction author Philip K. Dick captured this zeitgeist. He warned against a centralized technological future in a 1972 speech: "If, as it seems, we are in the process of becoming a totalitarian society in which the state apparatus is all-powerful, the ethics most important for the survival of the true, free, human individual would be: cheat, lie, evade, fake it, be elsewhere, forge documents, build improved electronic gadgets in your garage that'll outwit the gadgets used by the authorities."[42] Inspired by the warnings and promises of science fiction, and able to use it as a coded discourse in their own publications, socially conscious computer technologists in 1980s' Czechoslovakia who were provoked by worsening conditions of computer scarcity and tired of relying solely on the amateur production and maintenance of their own community began to agitate for reforms that would open up computer access to the people.

Chapter five examines this technologist dissatisfaction, which grew pronounced from 1987 to 1989 as the government's reform agenda of 1984-85, and decades of prior promises, failed to yield fruit. The chapter builds on the previous four chapters to advance the synthetic argument of the dissertation: the decades-long condition of material scarcity under state socialism, alongside contingent elements such as indigenous culture, global technological changes, international scientific discourse, and the political context of the Cold War world, was a significant factor in fostering the creation of a close-knit computer user community in

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[41] Wisnioski, *Engineers for Change*, 145.
[42] Philip K. Dick, "The Android and the Human," a speech delivered to the Vancouver Science Fiction convention at the University of British Columbia, February 18-19, 1972: 12.

Czechoslovakia. That community approached computer work as a craft, both in regards to initial hardware engineering, repair and modification, and software production. This approach owed both to a culture that elevated tacit knowledge and amateur tinkering as a constituent of national belonging, of "Czechness," and the reality of existing in tension and in poverty between a largely non-existent and at best informal market and a government incapable of fulfilling its promises, inadequate in its support, and increasingly distrusted by the community.

The result was a move away from political indifference. Distrust in the late 1980s ended a relationship with the state that earlier could be characterized as mutualistic, even symbiotic, in the degree to which elements of the user community and the government supported and relied upon one another. The microelectronics crisis of the 1980s, part of the larger economic crisis in the state socialist bloc of the 1980s, was when it became clear that the nature of computing—how it was used, how it was taught in schools, its role in the economy—was changing rapidly and in ways that the previous stable system of computing could not easily accommodate. Government plans failed to effectively address the crisis.

This time, unlike in the earlier computing crisis of the 1960s, the institutions of the Czechoslovak computer community were also not nimble enough to respond at the institutional level. By the 1980s production of, especially, the integrated circuits and microprocessors that CPUs were made of depended either on the possession of sophisticated, expensive and high precision semiconductor fabrication facilities or the wealth to connect to international supply chains in, e.g. the United States, Taiwan or Japan to purchase these chips for the home market. Reverse engineering had become so difficult and lengthy as to be impractical.[43]

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[43] "Reverse engineering a complex modern microprocessor has proved to be more difficult than the Soviets had originally anticipated. The silicon flakes that constitute today's computer chips contain increasingly greater numbers

In fact, the scramble for computers at the institutional level in the mid-1980s hurt overall diffusion, as it starved the small but growing consumer market of computers and led to production of hasty, low quality machines with little thought given to their implementation, education, software. Thus by the late 1980s a technicians' revolt was in the offing. This argument constitutes an intervention not only in the history of computing, but in the history of dissent as well. Recent scholarship such as Lewis Siegelbaum's *Cars for Comrades: The Life of the Soviet Automobile* (2011) and Paulina Bren and Mary Neuburger's edited volume *Communism Unwrapped: Consumption in Cold War Eastern Europe* (2012) has linked consumer dissatisfaction to revolutionary politics that brought state socialist regimes down across East Central Europe from 1989-1991.[44] Yet the result here was not linked to shortages of computers-as-consumer-commodity, since interest in the computer was not sufficiently widespread across the whole society and professionals generally enjoyed computer access of some kind.[45] What had diminished was their political indifference as a community, aggravated by acute shortages but also based on a now broken faith that the government might deliver the digital future and with it socialist abundance.

The unique, contingent and brief outcome of scarcity and the technicians' community politics emerging from it, was the lasting influence (attenuating with the introduction of a market economy in the 1990s) of a kind of technicians' syndicalism. They rejected the old system of state socialism and, at SOFSEM 1989, after drinking the hotel's entire stock of alcohol in

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of electronic components. … The task of replicating such complex microcircuitry is formidable enough when tackled in a sequence envisioned by the designer, but to copy the finished device and attempt to recover the logic of the original designer is far more difficult." Wellman, *A Chip in the Curtain*, 104.

[44] Paulina Bren, "Tuzex and the Hustler: Living It Up in Czechoslovakia," in Paulina Bren and Mary Neuburger, *Communism Unwrapped: Consumption in Cold War Eastern Europe*, Oxford: Oxford University Press, 2012: 45.

[45] As seen in man-on-the-street interviews conducted on state television at the end of the 1980s. Jan Flak, "Počítačová dilemata, II." *Počítačová dilemata*, Ostrava, Czechoslovakia: Czechoslovak Television (September 14, 1988).

celebration of radio reports that the Communist Party of Czechoslovakia had formally abdicated its legal monopoly on power, they joined together in rousing song.[46] "We are the Software Party," they declared:

> I won't join the [Communist] Party/
> That life's too bitter for me/
> I would always regret it/
> I won't be like a fence post.
>
> It's the Software Party/
> that fulfills wishes/
> All you need is the right software/
> My conscience does not bother me.[47]

The song concluded with a rallying cry: "Everyone join the party!" This technicians' syndicalism, articulated above as a "Software Party," can be best understood as community management of computing needs being met neither by government nor market forces in the late 1980s. Its characteristics—spontaneous exchange networks, tacit knowledge transmission through community education initiatives, resource pooling and material sharing, intensive and creative re-appropriation and re-imagining of the uses of older machines—better reflect and preserve the original countercultural hopes and practices of early personal computing. They have also had lasting cultural and material effects.

In the early spring of 2020, Czech communities of technological practitioners once again leaped into action. Prompted by an initially inadequate government response and market shortages, they assembled spontaneous networks of production (sewing brigades) and

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[46] Wiedermann, "XXX Years of SOFSEM."

[47] Sung to the tune of *Já do lesa nepojedu*, a traditional Czech childrens' song: "Já do strany nenastoupím/života to pro mne sůl/nikdy se tím neprohloupím/nebudu jak v plotě kůl. Jeho strana softwarová/ona přání vyplní/dodává jen správný software/svědomí mně nebrní. Necítím tu zrady rozkol/nebojím se o stranu/koupím větší množství klihu/do kupy ji dostanu. Jsou to všechno jenom klepy/že klíh není k dostání/naše strana dobře lepí/vstupte všichni do STRANY!" Emphasis original. "Hymna Softwarové strany," in Antisofsem '89, Sofsemovské texty.

distribution ("mask trees" on street corners) to achieve nearly universal social dissemination of face masks meant to safeguard against the global SARS-COV-2 pandemic.[48] Although chapter five addresses the limits and frustrations of a community forced into constant reliance on amateur miracles, an inadvertent legacy of the state socialist period and the economic disruption of the 1990s has been a technologically resilient society. Finally, as the epilogue addresses, studying resilient communities of computer technologists in Czechoslovakia who articulated values of openness, egalitarianism, and community management of computing needs offers insights into navigating our present day, where computers are ubiquitous but moving back toward centralized and autocratic government and corporate controls. Looking back at networked computers as a community resource managed by the community itself constitutes an alternate modernity of computing—a different vision of tomorrow that holds much promise in a new era of surveillance capitalism.

[48] Ian Willoughby, "Strict measures—including compulsory face masks—help Czechs get grip on COVID-19," *New Atlanticist*, The Atlantic Council (April 6, 2020). Available from: https://www.atlanticcouncil.org/blogs/new-atlanticist/strict-measures-including-compulsory-face-masks-help-czechs-get-grip-on-covid-19/; The nationwide spontaneous effort was led by prominent women who raised awareness of the campaign, including popular Czech singer Lucie Bílá and former first lady Dagmar Havlová. Blanka Kubíková, "Lucie Bílá je znovu švadlenkou. Tipnete, kolik dokáže ušít za noc roušek?" *Seznam Zprávy* (March 17, 2020). Available from: https://www.seznamzpravy.cz/clanek/lucie-bila-je-znovu-svadlenkou-tipnete-kolik-dokaze-usit-za-noc-rousek-93690.

Chapter 1
Little Czechs, Big Iron:
In Search of the Stable System, 1964-1984

One day in the early fall of 1983, an anonymous letter to the editor crossed the desk of Vladimír Čechlovský, a reporter at *Rudé právo,* the Czechoslovak Communist party's official newspaper. It was a complaint. Of course, anonymous letters typically were, but it was the unusual subject matter that drew Čechlovský's attention and which quickly merited a detailed response on page three, just inside the issue.

The letter writer, likely an enterprise manager in Kolín, began by complaining that, for twenty years officials and experts had promised the public that installing computers in offices and on assembly lines would transform the economy. These machines, it was said, would iron out inefficiencies in central planning and distribution, eliminate drudgery and deliver prosperity. Yet, they wrote, "the effects achieved seem to me very small in relation to the technical equipment and number of people who operate computers. I see it for example in regard to the reduction of the labor force. Many promises have been made in this respect and what is the reality? The administrative machinery as well as the number of technical-economic workers have actually further increased in our enterprise."[49] They closed on an ominous note: "Have we not overestimated the possibilities of computers?"[50]

The letter was more subversive than it might appear, and only an excerpt of it was included in Čechlovský's response. Since the mid-1960s, one of the Communist party's default answers to critics of inefficiencies in the command economy was that in the near future more

[49] Vladimír Čechlovský, "Využít předností výpočetní techniky" (Take Advantage of Computer Technology), *Rudé právo* (September 1, 1983): 3.
[50] Ibid.

powerful computers would rationalize planning, production and distribution. This letter writer reflected a dangerous anxiety—that perhaps improving technology would not solve all the system's problems after all. That perhaps more fundamental structural changes might be necessary.

Čechlovský responded at length, forcefully attacking not just the premise of the letter writer's question—"Have we not overestimated the possibilities of computers?"—but levying *ad hominem* attacks against the writer as well, given that they were most likely an enterprise manager. The fault lay not with computers, or with the ideology behind their use as centralized inventory control and data processing machines, but "[with] the fact that appropriate organizational and technical conditions have not yet been created for their effective use," any additional "shortcomings" should be blamed on "management personnel [who] bear the primary responsibility."[51] Čechlovský concluded his rebuttal, noting "despite our more than 20 years' experience with the use of computers in the national economy, we still are in the initial, extensive stage of their use, with all of the shortcomings which in the eyes of the public reduce their tremendous significance. It would be, however, more correct to rectify the mistakes rather than to blame the computers."[52] Čechlovský's confidence in the computer as salvatory key to the country's future economic well-being reveals a mindset common among state planning officials of the time.

Czechoslovakia had an especially conservative political climate following the suppression of the reform movement within the Communist party in 1968. This included extensive purges of the party membership, which discouraged intra-party criticism and high-level

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[51] Ibid.
[52] Ibid.

debate about the future of computing in the country to a degree unusual in neighboring state socialist countries like Poland and Hungary.[53] However, the middle manager's enterprise-level view of a troubling gap between what computers might be best suited for, how they were actually used and the excessive expectations placed on them as economic miracle workers reflects increasing disgruntlement among the white-collar cadres of contemporary Czech and Slovak technicians and managers.

It was the middle manager, not the politically-connected Čechlovský, who as it turned out had a better sense of the burgeoning crisis. This was reflected almost precisely a year later, in the so-called "Long-Term Complex Program of Electronization of the Czechoslovak National Economy," promulgated by the Communist party's Central Committee in September 1984, aimed at using computers to automate industrial production and management. New attention would be paid to on-the-job training and to computerized inventory management that would diminish or streamline administrative tasks. This was followed rapidly by the November 1985 "Long-Term Complex Program of Electronization in Training and Education" which provided funding to increase the production of domestic micro-computers, distribute them to schools and train Czech and Slovak educators in their programming and use.[54]

Government funds in the mid-1980s began to flow freely to youth groups, magazines, television programs and programming competitions. Significantly, these reforms marked an abrupt departure from previous policies that had favored the paradigm of centralized mainframe and mini-computing as part of CMEA-wide efforts, occurred without lobbying or major input from the country's computer experts and preceded by at least two, sometimes three, years the

[53] Gruska in discussion with the author.
[54] Švelch, *Gaming the Iron Curtain*, 17.

laggardly economic reforms of Czechoslovak *přestavba* (1987) which mimicked Gorbachev's earlier (1985) Soviet *perestroika* efforts.[55] Officials in the Central Committee and its State Planning Commission were too deeply concerned to wait any longer: Computers came first.

Computer panic was a new phenomenon in the mid-1980s, the government's defensive response to changes in telecommunications and microelectronics that overturned the long-established paradigm of technological change in socialist states. As this chapter will show, the key stakeholders in Czechoslovak computing over the previous two decades, from 1964 to 1984, had arrived at a stable consensus. This vision of the future embraced centralized mainframe and mini-computing.[56] Government policymakers struck a social bargain with a crucial layer of technical and managerial professionals to deliver a computerized future. Their discourse was filled with the rhetoric of Czech philosopher Radovan Richta's "scientific and technological revolution" tempered by the realities of a command economy in a small country with limited hard currency reserves.[57] The stable system that resulted was remarkably durable and arguably

[55] Gorbachev's reforms "were not taken in consideration seriously" in Czechoslovakia. "Contrary to Hungary and Poland, Czechoslovak leadership did not start with reforms independently" and only with two years of external Soviet pressure did the leadership of the Czechoslovak Community Party grudgingly agree to the announcement of "36 general principles for reconstruction of the economic system," in *Rudé právo* on January 9, 1987. Martin Štefek, "The Scope and Limits of Czechoslovak Perestroika: The Case of [the] Party's Programme," *Revue des Sciences Politiques* 43, (2014): 25.

[56] The mini-computer demands some definition from its bulkier, older cousin, the mainframe. It was a different and smaller machine, but the mini-computer also worked somewhat differently—in simple terms, it substituted more complex instruction codes on fast, new and inexpensive transistors to make up for shorter 16-bit "words" addressed to fewer registers in the central processor compared to a typical mainframe. Despite this, we can speak of mainframe and mini-computing existing within the same computer paradigm (unlike micro-computing later), as the mini "was not a direct competitor to mainframes or to the culture of using mainframes." Paul E. Ceruzzi, *A History of Modern Computing*, Cambridge: The MIT Press, 2003: 124-125.

[57] The phrase "scientific-technical revolution" itself seems to have originated in the Soviet Union with Nikolai Bulganin in a July 1955 speech at a Central Committee plenary session, though the ideas behind it have older Marxist roots in John D. Bernal's 1954 book *Science in History*. Stefan Guth, "One Future Only: The Soviet Union in the Age of the Scientific-Technical Revolution," *Journal of Modern European History* 13, no. 3, Politics and Time from the 1960s to the 1980s (2015): 356-357. For analysis on Richta's theory of STR and reform communism, see: Vítězslav Sommer, "Scientists of the World, Unite! Radovan Richta's Theory of Scientific and Technological Revolution," In *Science Studies during the Cold War and Beyond*, New York: Palgrave Macmillan, 2016: 177-204; Vítězslav Sommer, ""Are We Still Behaving as Revolutionaries?": Radovan Richta, Theory of Revolution and Dilemmas of Reform Communism in Czechoslovakia," *Studies in East European Thought* 69, no. 1 (2017): 93-110

the prime of Czechoslovak computing. It protected and privileged technological cadres, guaranteed unspectacular but steady growth in computing, and carved out an important position within the socialist east's high-tech supply chain while maintaining access to the capitalist west's expertise and advanced machines.

This chapter re-intreprets Czechoslovakia's participation in CMEA's (Council for Mutual Economic Assistance) Unified System of Electronic Computers in the light of growth and change over time, rather than stagnation or technological failure. Historians of technology have typically viewed the creation of the unified system as a serious mistake which stifled native innovation and locked the Soviet Union and its allied states in East Central Europe into a permanent dependency on Western computers, particularly from IBM and particularly in the realm of semiconductor fabrication.[58] This would prove, especially in the 1980s, to be an Achilles' heel for CMEA industry with the ongoing miniaturization and correspondingly intricate work required to produce integrated circuits for microelectronics. However, this chapter newly assesses the unified system as an example of a technological network in which partial participation brought both risks and benefits to the member country.[59] The Soviet decision to tie the design of the Unified System computers to IBM's System 360 mainframes has often been viewed as a critical mistake that trapped the country (and by extension its satellite states in CMEA) into a relationship of technological backwardness.[60] Ultimately the unified system failed

[58] Norman C. Davis and S.E. Goodman, "The Soviet Bloc's Unified System of Computers," *ACM Computing Surveys* 10, no. 2 (1978): 111.
[59] CMEA, often also referred to in publications as 'Comecon' was the Soviet-led chief multilateral organization for international economic exchange between state socialist countries in East Central Europe from 1949 to its dissolution in 1991—it also included Cuba, Mongolia and Vietnam.
[60] Wellman, *A Chip in the Curtain*, 98, 101-102; Francis Spufford, *Red Plenty*, Minneapolis: Graywolf Press, 2010: 329-340; JSEP/SMEP machines were "slow" and "unreliable" compared to the Western counterparts, like the DEC PDP-11 and VAX machines they were designed after. RNDr. Miroslav Bartošek, CSc. (Department Head – Cybersecurity and Data Management Division, Masaryk University), in discussion with the author. March 29th, 2018.

to follow through on its ambition to integrate CMEA, and to integrate computers into CMEA. To do so would have meant taking advantage of the entire bloc's technical expertise, diversified labor potential and economies of scale in the service of computer production, allocation and related services. Too, it would have completely modernized the bloc's economies, in the sense of making them more competitive with Western countries like the United States, by integrating computers into the bureaucracy for efficient data processing and planning needs, or into industry as automated management and control systems. That the unified system did not accomplish these lofty goals lends fuel to technology historians' assessment of the system's demerits.

However, participation in the Unified System is an important element that set Czechoslovakia apart from many other modernizing economies around the world. The Unified System addressed a then-serious problem—Czechoslovakia was impractically small to sustain autarky in computing—and granted Czechoslovaks comparatively enhanced access to outside expertise, (limited) economies of scale in manufacturing, a specialized division of labor and privileged status as part of a global "second standard" of computing systems marketed to socialist and non-aligned countries.[61] The Unified System in the late 1960s offered a path to technologically efficient socialist abundance.

That this future never came to pass should not consign to oblivion the work done in its service. Failure was not inevitable but the consequence of a number of contingent cultural, political, economic and ideological choices. Understanding that work—the enormous costs sunk into this system by numerous stakeholders in computing in Czechoslovakia and across CMEA, as well as the real achievements and benefits of the Unified System—offers an in-depth

[61] One contemporary assessment of the Unified System in 1978 also reflected on its overall strength compared to previously disparate efforts by CMEA member countries. "In summary, the Unified System provides the CEMA countries with unprecedented quantities of reasonably good hardware." Davis and Goodman, "The Soviet Bloc's Unified System of Computers," 111.

perspective on the crisis of computing in the 1980s. What Czech media studies scholar Jaroslav Švelch calls a “clash of teleologies” in that decade occurred, ironically, not because of the failures of the Unified System but precisely because of the ways in which that system succeeded in creating stability and opportunities for its numerous stakeholders. It was not just shortsighted and technologically illiterate apparatchiks who resisted the introduction of microcomputers in the 1980s. By then an entire profession of computer workers had grown up over the course of two decades who understood how to live and work within an existing political and technological system that prioritized stability and short-term horizons.

In order to better discuss the ways in which the layer of research institutes, large industrial enterprises, universities and professional associations mediated, accommodated, frustrated and resisted the commands of government officials and the demands of end users, this chapter borrows two terms of art, one from biology and one from cybernetics. The first, *mesocosm*, refers to mid-sized ecologies that contain multiply-interacting trophic organisms. That is, entities that feed off of and rely upon one another, not dissimilarly to how research universities, government ministries and industry behaved regarding computing.

The second term, *heterarchy*, originates with cybernetician Warren S. McCulloch and describes a scenario in which three or more factors are capable each of inhibiting or dominating any one of the others, such that a heterarchical system, unlike a hierarchy, tends toward self-sustaining balance over time. This chapter argues that over the course of “the long 1970s” in Czechoslovak computing, the system that developed at the mesocosmic level of stakeholder institutions such as universities, government research institutes and large state enterprises became a complex, stable heterarchy the success of which ultimately made it insufficiently agile or responsive to rapid technological change.[62] This is crucial to understanding how and why the microelectronics crisis of the 1980s unfolded the way it did in Czechoslovakia.

Because the country lacked a functioning open market and a wealthy population, there was no space for hobbyists to perform the bottom-up diffusion or adoption of computing that characterized the early spread of personal computers in the United States and other Western economies. Nor was there a competently executed or well-funded strategy from the federal government to produce and distribute computers to schools, enterprises and ministries. Instead, in the 1980s the mid-tier institutions and the computer workers within them, accustomed to a much different, slower and more stable system of computing, would once again be called on to produce “amateur miracles” that would never be sufficient to meet skyrocketing demand for machines, software, peripherals and training.

In order to undertake a thorough and useful examination of the long 1970s and the stable system that dominated it, this chapter is organized chronologically. A consideration of the worldwide context of mainframe and mini-computing, along with Czechoslovakia’s relative position within this system and its own domestic computing efforts beginning in 1964 is followed by a definition and discussion of accession to the Soviet-led Unified System of Electronic Computers, its rationale, organization in CMEA and within Czechoslovakia, and the peak equilibrium of the stable system in 1974. The chapter concludes with an assessment of the Unified System from 1974 to 1984—its impact on the Czechoslovak economy and national life, its lasting influence on the generation of computer technologists that contributed to and worked within it, and its inadvertently causal role in the crisis of computing that arrived in the 1980s.

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[62] Eugene P. Odum, “The Mesocosm,” *BioScience* 34, no. 9 (October 1984): 558-562; Warren S. McCulloch, *Embodiments of Mind*, Cambridge: The MIT Press, 1965: 219-220. Švelch, *Gaming the Iron Curtain*, 29-31.

Na Prahu v Praze?
The Scramble for Stability, 1964-1974

While 1968 was the tipping point for Czechoslovak politics, it was in 1964 that the fate of Czechoslovak computing hung perilously in the balance. Tired of endless political maneuvering, with his pioneering SAPO computer damaged beyond repair in a 1960 fire, and removed from his position as director of the Research Institute for Mathematical Machines (VÚMS) in Prague, Antonín Svoboda emigrated to the United States.[63] Dozens of his best students followed. It was a move that crippled hardware invention in Czechoslovakia's fledgling computer industry and part of a worrisome continent-wide trend—the British Royal Society coined the term "brain drain" to describe the mass emigration of European scientists to North America the previous year.[64] Decades later, his friend Jiří Malek reminisced on the seismic departure: "[When] professor Svoboda—who I knew personally—he left the country and he essentially designed the first family of IBM computers. So, judging from that, we were not that much behind, if a professor of computers from [the] Czech Republic could come here [to America] and start a century of revolution in modern computers."[65]

Some directionless years followed Svoboda's 1964 emigration and inertia appears to have been the most powerful force in Czechoslovak computing, at least where hardware development and production are concerned. Not until 1969 did the country negotiate membership in the Soviet-led Unified System of Electronic Computers (JSEP in Czechoslovakia,

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[63] Durnová, "Sovietization of Czechoslovak Computing," 28. In a country without access to reliable vacuum tubes in the 1950s, Svobodá was able to construct the world's first fault-tolerant, five-register computer based on electromechanical relays instead. It was "a triplet machine with three arithmetic units which after every operation (made simultaneously) 'voted' and the majority vote was used as the answer." Ivo Babuška, "Comments on the Development of Computational Mathematics in Czechoslovakia and in the USSR," a lecture delivered at the ACM Conference on the History of Scientific and Numeric Computations, May 13-15, 1987 in Princeton, NJ: 2.

[64] Richard C. Oldfield, J.A. Simmons, et al., "The Emigration of Scientists from the United Kingdom: Report of a Committee Appointed by the Royal Society," *Minerva* 1, no. 3 (Spring 1963): 358-380.

[65] National Czech & Slovak Museum & Library, "George Malek," *NCSML Digital Library*, June 25, 2012. Available from: https://ncsml.omeka.net/items/show/4058. Accessed February 23, 2017.

but typically referred to as 'RYAD' in the USSR). In this five year period of technological uncertainty, the Central Committee of the Communist party in Czechoslovakia failed to promulgate an overall strategy for the production, distribution, adoption and use of computers in the country.

When Zdeněk Král, a member of the State Planning Commission (*Státní plánovací komise* or SPK), was interviewed by the editors of *Amatérské radio* in November 1966 about the future of the country's electronics industry, he offered only two certainties. First, in a notable reversal from Svobodá's push in the 1950s, Král impatiently asserted "As I have already said, electronics in its [present] structure represents a wide range of different types of products, which cannot be secured without an international division of labor."[66] Czechoslovakia no longer expected to develop its electronics industry without international assistance and cooperation, which in 1966 meant continued purchasing of computers from the West (since Soviet production of computers at that time was not in sufficient quantity to allow exports to its CMEA partners), while in a preview of its later role in the Unified System of Computing, CMEA cooperation had already begun in radio electronics.[67]

Second, the State Planning Commission, and by extension the Central Committee, would continue to allow free rein at the mesocosmic level of the research institutions, large manufacturing enterprises and universities. In bureaucratic language, Král referred to: "New forms of management and planning … [which] are a prerequisite for a successful solution to

[66] "Jak jsem již řekl, představuje elektronika ve své struktuře široký sortiment různých druhů výrobků, jejichž zabezpečení není možné bez mezinárodní dělby práce." "Náš interview s prácovníkem Státní plánovací komise Zdeňkem Králem" (Our Interview with State Planning Commission worker Zdeněk Král), *Amatérské radio* 15, no. 11 (November 1966): 2.
[67] Ibid.

these problems [of developing an electronics industry, including computing]."[68] But this shifted all responsibility for industrial strategy away from the highest levels of government, which two years after Svobodá's departure remained uncertain about the future of computers in the country.

Nearly twenty years later, on the edge of the microcomputer crisis Král (still a member of the State Planning Commission) continued to insist that what the industry needed was more rapid technological acceleration and a coherent top-down plan to force implementation on recalcitrant enterprise managers and workers. "This unsatisfactory situation," he complained, referring to the microcomputer crisis of the mid-1980s "is the result in part of what has been a simplistic approach to electronics applications in the Czechoslovak national economy. Both individual projects for the electronization of specific sectors as well as a nationwide program of electronization that defines its strategic objectives, efficiency and the means of assurance have been lacking."[69] This, then, was a pattern of the middle 1960s re-appearing some two decades later: A crisis of technological uncertainty and the same ironic lack of top-down control and planning in a state socialist country that Benjamin Peters has identified as a hallmark of the abortive Soviet efforts to construct a computer network to rival ARPAnet, the American government's effort to manage scarce computer resources in the late 1960s by linking together computers at large research universities.[70]

The reason Král and others, from the State Planning Commission down to the individual large enterprises such as Tesla, ZPA, Aritma and Zbrojovka Brno, continued to believe so strongly in centralized computing as the solution to the crisis, at least as an ideal, was not purely

[68] "Nové formy řízení a plánování spolu s vytvořením generálního ředitelství Tesla dávají předpoklad ke zdárnému řešení těchto problému." Ibid.
[69] Jaromír Liška and Zdeněk Král, "Některé aspekty elektronizace československé národní ekonomiky" (Some Aspects of the Electronization of the Czechoslovak National Economy), *Plánované hospodářství* no. 6 (1984): 60-67.
[70] Peters, *How Not to Network a Nation*, 193.

the ideological affinity shared between technological and political visions of the future. It had worked once before. Czechoslovakia had, after all, faced the crisis in its computer industry in the mid-1960s by embracing the model of centralized computing, if not in the sense of a coherent top-down set of government policies, at least in increased coordination between mesocosmic institutions and within the CMEA unified system framework. Policymakers, managers and technologists had accepted a slow but steady pace of production and a seemingly permanent lock-step lag in the most advanced hardware as the price of a system that was realistic, "good enough" to provide employment, prestige, and diversion for thousands of computer technologists without depleting hard currency that could be used to import Western consumer goods for the broader public.[71]

The ideology of scientific and technological revolution in 1966 seemed to offer a solution tailor-made for the command economy, one in which centralized computing would streamline industrial production and government planning. As Miron Rezun observed "The mainframe computer, institutionally controlled—be it for defense, the secret service, or economic planning—was an ideologically legitimate piece of hardware. It fit into the inner institutional framework and hardly extended beyond that to the public at large."[72] However, by 1984 it was growing apparent that practical failures in production and distribution had led to a society of too few computers, employed too ineffectively, to achieve the utopian goals of socialist computing

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[71] "I remember quite well the enthusiasm of physicists in Czechoslovakia when the decision concerned RYAD was announced early in 1970. They believed that the production of COMECON's own modern computers would solve the difficulties with up-dating their computing systems in the future, since it was increasingly difficult in the seventies to count on possibilities of purchasing modern computers from the West." František A. Janouch, "Computers and Scientific Research in CMEA Countries," in Craig Sinclair, ed., *The Status of Civil Science in Eastern Europe*, Proceedings of the Symposium on Science in Eastern Europe, NATO Headquarters, Brussels, Belgium, September 28-30, 1988, Dordrecht: Kluwer Academic Publishers, 1989: 177.

[72] Miron Rezun, *Science, Technology, and Ecopolitics in the USSR*, Westport, Connecticut: Praeger, 1996: 64.

articulated in the reformist arguments of Richta and other Czech and Slovak intellectuals in the seminal 1966 essay collection *Civilizace na rozcestí* (Civilization at the Crossroads).

As historian of science Elena Aronova argues, the comprehensive, even radical reform plans advocated by Richta—which sought to engineer new, more egalitarian social and political relations alongside increased use of and democratized access to computers—were defanged by more conservative authorities following the Soviet invasion of Czechoslovakia in August 1968. Although Richta's rhetoric lived on in official pronouncements, there was no overhaul of the Czechoslovak economy, no rapid shift to efficient computer planning.[73] Instead, much as in those first five years of the stable system (1964-1969) before joining the Unified System of Electronic Computers, Czechs and Slovaks simply made do. They met their needs by sourcing computers, programs, peripherals and education from wherever possible. The result was that they ended up as partial participants in at least three computing networks, broadly construed—their own, the Soviet Union's and the West's.

In reality, even this tripartite scheme is a potentially misleading representation, as during the 1960s identifiably separate national computing networks existed in the Soviet Union, France, Denmark, West Germany, Italy, the United Kingdom, the United States, Poland and East Germany.[74] These national computer efforts in Western Europe, however, were already deeply interwoven with American companies. For example, French computers in the 1960s were built

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[73] Elena Aronova, "The Politics and Contexts of Soviet Science Studies (*Naukovedenie*): Soviet Philosophy of Science at the Crossroads," *Studies in East European Thought* 63, no. 3 (2011): 185-186.

[74] By 1961 sixteen separate European countries, including Czechoslovakia, had constructed their own digital computers, and seven produced them commercially (i.e. not simply a prototype or a handful of machines). Nelson M. Blachman, "The State of Digital Computer Technology in Europe," *Communications of the ACM* 4, no. 6 (1961): 256-265. These national computer networks, and the champion companies that often led them, began to weaken and break down in the face of IBM's market dominance (more than 60 percent of European computing) as early as 1964. Elisabetta Mori, "Coping with the 'American Giants': Mergers, Relationships and Attempted Partnerships in the European Computer Industry in the Early Sixties," a presentation delivered at the Fourth International Conference on the History and Philosophy of Computing in Brno, Czech Republic, October 5, 2017.

with a number of U.S. components or in collaboration with companies like RCA, Burroughs and General Electric, so that it would be deceptive to treat them as truly separate entities. For simplicity's sake, this chapter will often refer to them under the umbrella term "Western computers" to help distinguish from Soviet- and Czechoslovak-developed computing networks though these, too, it must be said, hardly existed in a vacuum free of Western influence and materials. In any case, Czechoslovakia dabbled in them all. František Janouch, a Soviet-trained nuclear physicist and founder of the Charter 77 Foundation, recalled "it was mainly during the sixties that the scientists in Czechoslovakia persuaded the government to provide hard currencies for the purchase of IBM, PDP, CDC, Hewlett-Packard, Danish Gier, West-German ZUSE [computers] etc." Even Král's State Planning Commission resorted to bulk purchases of IBM computers to supplement its data processing work in this period.[75]

One popular British vendor was Elliott Brothers, well-known for their small, mid-speed digital computer the Elliott 803. At nearly a million dollars a machine (and up) in today's currency, they sold at least eight mainframes officially (seven of them 803s) to Czechoslovak customers between September 1960 and 1966. Customers included automotive manufacturer Škoda, Kancelářské stroje (the Office Machines concern, often an all-purpose buyer for smaller Czech enterprises), the chemical industry and Slovnaft (an oil refinery in Slovakia). Before English Electric swallowed it up in a 1967 merger, Elliott sold one of its last few computers, the Elliott 4130, to the Institute of Automation and Computing Techniques in Prague, where artificial intelligence expert and brother to the future Czechoslovak president Ivan M. Havel worked with it during his employment as a researcher there from 1966 to 1969.[76]

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[75] Janouch, "Computers and Scientific Research in CMEA Countries," 176-177.
[76] "Appendix 8: Elliott Digital Computer Deliveries and Costs," in Simon Lavington, *Moving Targets: Elliott-Automation and the Dawn of the Computer Age in Britain, 1947-67*, New York: Springer Science & Business

Ideological sympathies might incline the government to purchase from the Soviets, but in the mid-1960s the USSR was in poor position to export computers even to its allies, given its struggles with producing them at volume. With no central strategy from on high, particular research institutions, universities and government ministries had to meet their growing data processing, control and automation needs somehow. The first computer in Czechoslovakia's Nuclear Research Institute for example, in c. 1962-63, was a Danish GIER (*Geodætisk Institut Elektronisk Regnemaskine*) mainframe. According to Petr Jan Pajas, a nuclear physicist who worked on the GIER during the mid-1960s, the acquisition was negotiated simply between peers, the Czechoslovak Academy of Sciences and the Danish Academy for Technical Science, whose company Regnecentralen had built the GIER: "At that time it was possible to buy [directly] of course. They were allowed to buy something from abroad. But the technology was equivalent to what they could afford," and the GIER was a significant purchase, so the Nuclear Research Institute continued to use the Danish mainframe throughout the 1960s.[77]

Such peer-to-peer direct imports were a common means of computer acquisition, as was barter—Poland reportedly offered a million eggs to a British company for process control instruments.[78] Czechs and Slovaks employed a variety of tactics to obtain the computers they wanted. They also did so by batch-manufacturing small volumes of machines based on in-house designs and those borrowed from Svobodá's earlier blueprints, manufacturing under license with

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Media, 2011: 615-630; Doc. Ing. Ivan M. Havel, CSc., Ph.D., (Docent – Faculty of Mathematics and Physics, Charles University; Director – Center for Theoretical Studies), in discussion with the author. June 6, 2018.

[77] Pajas in discussion with the author; L. Trlifaj, "Problems of the Development of Nuclear Physics in Small Countries (as Exemplified by Czechoslovakia)," *Future of Nuclear Structure Studies: Proceedings of a Panel on the Future of Nuclear Structure Studies Held in Dubna, 1-3 July 1968* 220 (1969): 136; Janis Bubenko, John Impagliazzo and Arne Sølvberg, eds., *History of Nordic Computing: IFIP WG9. 7 First Working Conference on the History of Nordic Computing (HiNC1), June 16-18, 2003, Trondheim, Norway*. Vol. 174, Springer Science & Business Media, 2005: 186.

[78] Lewis H. Young, "Electronics in East Europe," *Electronics* 39, no. 16, (August 8, 1966). New York: McGraw-Hill, 157.

foreign companies, and finally by freely bartering their way to a bewildering mix of incompatible hardware, usually striking deals at the major Central European trade and engineering fairs in Leipzig, Brno and Hannover.

As sites of both spectacle and commercial exchange, these trade fairs and exhibitions were a crucial entry point for Czechs and Slovaks who wished to participate in the Western computer network. At a cursory glance, they functioned simply as marts for customers behind the Iron Curtain to spend precious hard currency on computers, peripherals and software developed by Western companies.[79] This did not always take place in plain sight, but had more of the character of exploiting a loophole. It was an open secret that numerous Western companies found trade fairs the perfect opportunity to circumvent the U.S.-led, Paris-based Coordinating Committee on Multilateral Export Controls embargo on selling powerful computer technology to their state socialist enemies. "Elliott-Automation," for instance, "had a presence at various trade exhibitions behind the Iron Curtain. At the conclusion of many of these exhibitions, equipment was 'sold' off the stand. This was standard practice for several British companies, being a mutually beneficial way of circumventing bureaucracy."[80] While it is difficult to assess what proportion of Western computers brought into the Czechoslovak computing ambit had their origins in such under-the-table deals, this sort of informal acquisition deserves remark as it identifies one important, long-standing route for technological diffusion. The Iron Curtain was semi-permeable throughout the Cold War, but ideas typically flowed more easily through its

[79] "Exhibitions and expos offered, at least partially, a field for independent business initiative and contributed to overcoming the Iron Curtain … The trade exchange, and to a lesser extent also technological co-operation with neutral states, were to a degree visible, for instance, in machine engineering …" Ľudovít Hallon and Miroslav Londák, "Facilities, Forms and Areas of Economic Activities of Firms in Neutral and Socialist Countries during the Cold War: The Slovak Case," in Gertrude Enderle-Burcel, Piotr Franaszek, et al., eds., *Gaps in the Iron Curtain: Economic Relations between Neutral and Socialist Countries in Cold War Europe*, Kraków: Wydawnictwo Uniwersytetu Jagiellońsiego, 2009: 234.
[80] "Appendix 8: Elliott Digital Computer Deliveries and Costs," 620.

membranes than hardware.[81] This accords with the broader argument advanced by historian of East Central Europe György Péteri, who described the barriers between East and West as a "Nylon Curtain" amenable to two-way exchange. "It was not only transparent," Péteri notes, "but it also yielded to strong osmotic tendencies that were globalizing knowledge across the systemic divide about culture, goods, and services."[82] The computing swaps, bargains and under-the-table deals that took place at these fairs—not just machines, but also manuals, software, ideas and personal connections—were nodes in a global web of intellectual and material exchange.

Trade fairs also served as a showcase, and a more limited market, for the achievements of state socialist societies—model computers and other engineering and scientific products that might never reach a significant number of customers nevertheless proved that Czechoslovakia's scientists, engineers and programmers could keep pace with their colleagues around the world; that they too were talented, innovative and up-to-date. Fairs were an important venue for measuring the competition and annually reassessing how modern (in computing terms) was one's society. In an August 1966 issue of *Electronics*, Lewis H. Young, the former editor-in-chief of *Business Week*, reported: "Experts on Czechoslovakia are now saying that the main purpose of the International Computer Fair held in Prague in May may have been to show Czech engineers what electronic computers could do and how they operate."[83] Despite the inventiveness of Svobodá's Czech-made machines (his triple-register SAPO computer, built in 1957, was the first fault-tolerant machine in the world which could continue operating, albeit at reduced capacity, even if one or more components broke down) his work had not translated into a thriving

[81] As Durnová notes: "the Iron Curtain's transparency differentiated among artifacts and ideas." Helena Durnová and Petri Paju, "Computing Close to the Iron Curtain: Inter/national Computing Practices in Czechoslovakia and Finland, 1945-1970," *Comparative Technology Transfer and Society* 7, no. 3 (December 2009): 316.
[82] György Péteri, "Nylon Curtain—Transnational and Transsytemic Tendencies In the Cultural Life of State Socialist Russia and East Central Europe," *Slavonica* 10, no. 2 (2004): 115.
[83] Young, "Electronics in East Europe," 157.

domestic industry. Thus, many Czechs and Slovaks in the mid-1960s would have looked west for the latest technological advances, rather than closer to home.

Yet these spectacles were not purely a matter of East looking West. Young observed in the same issue "some Czechoslovakian instruments [on display] are admired in the West, though an Englishman who sells them in the United Kingdom described them as '… well engineered though the styling's a bit stodgy.'"[84] Observing modernity in technical competence (or failing that, in style) was mutual, like looking through a screen while being conscious of one's own reflection. It had to be, since any comparison demands one become both the looker and the looked-at. An 8mm film from the 1966 engineering fair in Brno demonstrates the priorities of this kind of split gaze at the products of East and West: The camera's operator lingers on well-dressed fairgoers examining instrument control panels from Messer Griesheim, an industrial gas and welding firm from West Germany; bulky drill presses; shining aircraft; Mercedes automobiles; enormous construction cranes towering over the grounds; the soaring architecture of the GDR pavilion; and the legendary 1962 ČKD Tatra T3 electric trams, the workhorse of Czech metropolitan public transit.[85] The significance of these artifacts lay in their token representation of modernity itself, as technologies emblematic of speed, size, power, novelty and control of nature. Importantly, Czechoslovakia was a contributor to these displays, with its new electric trams, and not just a middle ground between socialist east and capitalist west. Yet there is no evidence, in 1966, of Czechoslovak computers on display.

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[84] Ibid.

[85] "VELETRH BRNO 1966," Strojírenský veletrh (Engineering fair) Brno 1966, YouTube video, digitalization of an 8mm film original, 3:51, posted by "archivservis," July 20, 2014, https://www.youtube.com/watch?v=einzGNKY0n8.

Attaining Electronics' Steady State: Czech Analogs, Hybrids and Mainframes

In part, that was because there simply were not many truly digital all-electronic Czech computers to show off to foreign visitors and the country's citizens. Most of the in-house, domestically designed computers based on the earlier work of Svoboda or his students at VÚMS blurred the definitional lines of computing in retrospect, since they constituted a family of analog and hybrid analog/digital computers. This was an advantageous adaptation to the country's pre-war strength in producing precision machinery and electromechanical calculators.[86] Unfortunately, while this was a tactic that helped to address the immediate needs of enterprises, government and research facilities, these machines were not the industry's state-of-the-art at a global level.

At Aritma-Vokovice, which had historically specialized in producing mechanical punch-card calculators but had partially converted to computer production, 220 digital electronic computers (the DP-100 series, used primarily for accounting and assessing payroll) designed in collaboration with the Research Institute of Mathematical Machines (VÚMS) in Prague, were produced between 1962 and 1967.[87] Workers like Božená Mannová, then a young woman freshly graduated from the Czech Technical University in 1963, manually assembled, maintained and programmed them:

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[86] One example of this adaptive work is Svobodá's first machine, SAPO, which was an electromechanical computer that made up for its slower, relay-based construction not only through its novel fault tolerance in performing complex calculations, but because it was designed to compensate by running, error-free and with no routine maintenance, over long periods of time. Blachman, "The State of Digital Computer Technology in Europe," 258.

[87] A.Y. Nitusov, "Computer Development in the Socialist Countries: Members of the Council for Mutual Economic Assistance (CMEA)," in John Impagliazzo and Eduard Proydakov, eds., *Perspectives on Soviet and Russian Computing: First IFIP WG 9.7 Conference,* SoRuCom 2006, Petrozavodsk, Russia, (July 3-7, 2006), Revised Selected Papers, Vol. 357, Springer Science & Business Media, 2011: 213.

> This DP-100, it was … a computer; it was more a sorting machine. Anyway, there were things, there were the accumulators, there was everything as in a normal computer and in fact … the architecture of the computer was … almost the same as the von Neumann design. It's a little different, but the basic idea was the same. And I learned a lot because when I was in the hardware group, it meant we had to repair the computer and prepare to be ready to work; when we made an instruction it was machine code, and when we made instructions [successfully] that the computer print out a circle, well … it was [a] celebration for one week![88]

Although these analog and hybrid digital/analog computers were often considered one or more steps removed from "true" digital all-electronic computers—as Mannová pointed out, they had to be painstakingly programmed in machine code, not in a higher-level language like ALGOL 60—they filled many of the same needs for data processing, inventory control, payroll accounting, control systems and precision measuring tools as their cousins. Nevertheless, Mannová's hesitation in describing the DP-100 as a true computer reveals the reason analog and analog/hybrid machines have largely slipped through the cracks of a historical narrative divided in attention between the country's first computers in the 1950s and its more prominent contributions to the Unified System of Electronic Computers in the 1970s.[89]

Analog and hybrid analog/digital computers are worth our attention. They were a unique strength of the country's engineers and programmers, they often resembled the crafted artifacts of a cottage industry more than mass-manufactured products (a common feature in an infant technology), and they represented a kind of adaptive modernization common to many peripheral

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[88] Ing. Božena Mannová, Ph.D., (Professor – Department of Computer Science, Czech Technical University), in discussion with the author. December 6, 2017. By "von Neumann design" Mannová is referring to the DP-100's ability to store a program in memory. Ceruzzi, *A History of Modern Computing*, 20-22.

[89] While scholars such as Jaroslav Folta and Petr Kovář have written comprehensive treatments of the history of Czechoslovak computing in Czech, the most prominent and accessible English-language scholarship has been undertaken by Helena Durnová, whose work primarily focuses on Svoboda and the events leading up to 1964, and Jaroslav Švelch, whose media studies scholarship (though with a keen historical eye) is oriented toward games and the 1980s. The 1970s in Czechoslovak computing remains under-addressed in English-language scholarship. Jaroslav Folta, *Studie o Technice v Českých Zemích (Study on Technology in the Czech Lands), 1945-1992*, Prague: Encyklopedický dům, 2003; Petr Kovář, "Historie výpočetní techniky v Československu" (History of Computer Technology in Czechoslovakia), Master's thesis, Charles University in Prague, 2005.

or developing countries.[90] Analog and hybrid machines were the building blocks of Czechoslovak computing in the mid-to-late 1960s. They served as the foundation of the stable system of computing that would eventually marry native Czechoslovak traditions of craft work, tinkering and adaptive heterogenous engineering with the country's historical strength in electromechanical relay, calculator and data processing machine manufacturing.

This form of technological diffusion in computing, more akin to local appropriation, was the dominant model around the world. Most nations were unwilling or unable to supply all their needs by purchasing the latest technology from, for instance, IBM or British ICL. Thus this first generation of computer technologists in countries such as the USSR, Czechoslovakia, Brazil and others often gained experience in hardware engineering in a cottage industry, incorporating expertise and components from outside their country into a "national" computer industry. In Brazil, the first computer was built in the early 1960s in a lab headed by a German refugee with expertise lent by the Israeli Weizman Institute; the Soviet MESM (*Малая Электронно-Счетная Машина*) relied on "wartime-appropriated German electronic parts for the computer-copper-oxide rectifiers and reliable pentodes" alongside "wide rolls of German army teletype paper for data I/O that produced one printed number per line."[91] This offers a markedly different kind of transnational lens through which to understand the global history of computing, not just

[90] Significantly, while such kinds of adaptive modernization often include or require local, appropriative acts that constitute a form of innovation, they usually fall outside the scope of a historiography of technology that, as Edgerton has rightly noted, is traditionally focused to an excess on invention and innovation that leads to profitable commercial success. David Edgerton, "From Innovation to Use: Ten Eclectic Theses on the Historiography of Technology," *History and Technology* 16, no. 2 (1999): 112-115.

[91] Erick D. Langer, "Generations of Scientists and Engineers: Origins of the Computer Industry in Brazil," *Latin American Research Review* 24, no. 2 (1989): 97; Anne Fitzpatrick, Simon Berkovich and Tatiana Kazokova, "MESM and the Beginning of the Computer Era in the Soviet Union," *IEEE Annals of the History of Computing* 28, no. 3 (2006): 11.

as the adoption of a technology by wealthy countries with unrestricted access to service vendors like IBM, a successful model of diffusion James W. Cortada has noted.[92]

Rather, just as hybrid analog/digital computers were neither one thing nor another completely, but fulfilled many of the same roles as all-electronic digital computers did in the West, historians can profit from studying these unconventional adoption patterns in computing which resulted from conditions of scarcity coupled with native ingenuity and bricolage. In Poland, for example, technicians scrambled to assemble the country's first electronic computer from a model of IBM's architecture, but found they could only do so with Polish magnetic drum memory, Soviet elementary electronic cells taken from the BESM-6 computer, and by cannibalizing parts from EMAL, an earlier failed project. Projects such as these resist binary categorization of success/failure, innovative/derivative and national/international and thereby complicate triumphalist and Western-centric narratives of the computer's invention, development, diffusion and adoption.[93] They are, rather, in the words of Ksenia Tatarchenko "a scrounger's triumph over scarcity during a difficult economic recovery."[94] In Czechoslovakia, this was a time (1964-69) when the country could neither afford to import computers from the West nor rely on sufficient deliveries from the USSR. Its own computers sealed the breach.

Although the Aritma DP-100 never entered mass production, one hybrid computer that saw widespread implementation in Czechoslovakia was the ADT (Analog Digital Technology) line. Jaroslav Studenka, in the early 1970s lead engineer at INORGA Brno, pointed out that in some ways these hybrid machines were, a decade later, both the last legacy of Svobodá's talents

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[92] Cortada, "How New Technologies Spread," 240-241.
[93] Leon Łukaszewicz, "On the Beginnings of Computer Development in Poland," *Annals of the History of Computing* 12, no. 2 (1990): 106.
[94] Tatarchenko, "'The Computer Does Not Believe in Tears'," 715.

and a unique testament to what computer scientists N.C. Davis and S.E. Goodman referred to as Czechoslovakia's out-size role in socialist bloc computer innovation:

> This line of ADT … we did these small computers, little computers. The minicomputers and these hybrids between digital and analog computing. And in that time, in these central and east European countries, we were the only ones. Nobody else – maybe, I don't know if in Russia there was something – but not serially produced. In our country, in Prague here, was normal, serial production of both parts of [the] hybrid computer ADT 7000: digital computer, ADT 4000 at ZPA, and analog hybrid computers, ADT 3000, at Aritma, and together the system was named ADT 7000. Analog and hybrid parts, so this coupled unit, or interface unit, between [the] analog part and [the] digital computer.[95]

Studenka and his colleagues were responsible for coupling the hardware of the ADT 3000 and ADT 4000 computers, a craft that only a few workers in Czechoslovakia were certified to undertake at the time. ZPA Čakovice and later ZPA Trutnov manufactured over a thousand ADT line mini-computers, both digital ADT 4000 and analog ADT 3000 machines, beginning in 1973.[96]

The ADT line of mini-computers lets us trace the contours of the computing network in Czechoslovakia, including labor, distribution and use. According to Miroslav Kepka, at the time an army colonel posted to VÚMS as liaison officer with the military, research and design for the ADT series began as an all-Prague affair.[97] VÚMS took the lead in the initial research, with the

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[95] Ing. Jaroslav Studenka, (Lead Engineer at INORGA Brno – ADT Digital/Analog Hybrid Computer Hardware Design), in discussion with the author. April 3, 2018. Emphasis original; the computer industry in Czechoslovakia (as well as the GDR) was "much smaller than that of the USSR, but in some ways they were more sophisticated. There had been more contact with the Western computer community and this experience would prove to be a valuable asset for the Ryad project. The CEMA partners also had more advanced capabilities in some aspects of peripheral technology and software development." This gave the Czechs a strong bargaining position within the unified system, and they were able to continue development on their own line of computers from before accession, notably the EC 1021 based on the previous Czech-developed ZPA 6000/20. Davis and Goodman, "The Soviet Bloc's Unified System of Computers," 100-102.

[96] Miroslav Kepka, "Zkušenosti se zavedením systémů ADT a příklady jejich zajímavých aplikací v praxi" (Experience with the Introduction of ADT Systems and Examples of Their Interesting Applications in Practice) *Výběr informací z organizační a výpočetní techniky* no. 2 (1983): 189-195.

[97] Kepka is identified as an army colonel in: Petr Golan, "1951-1956 / Základy československých analogových počítačů" (1951-1956 / Fundamentals of Czechoslovak analog computers), Historie programování a VT u nás.

analog half farmed out to Aritma given its traditional strength in analog computers such as the DP-100. After the first few prototypes were tested, mass production was moved north across the city to ZPA Čakovice, near the military airfield in Letňany. Yet another institution, VÚAP (*Výzkumný ústav automatizačních prostředků*) the Research Institute for Automation Systems located in the Karlín district of Prague, was responsible for developing peripherals, input/output devices and basic application software in order to integrate the ADT into its new working environments. On a case-by-case basis, depending on the different needs of enterprise, industrial and military clients, both VÚMS and Studenka's INORGA office at the Brno Technical University were called on to write additional application software or couple the ADT 4000 and ADT 3000 into the more flexible ADT 7000 hybrid analog/digital computer.

Modeled after and compatible with the popular mid-1960s Hewlett-Packard 2116 line of mini-computers, the ADT mini-computer line was, by 1973-74 when it began to be installed on a wide basis, a natively engineered, manufactured and programmed solution to both the national shortage of computers and dependence on Soviet and Western imports.[98] ADT computers were installed first in the control room of the Tušimice coal-fired power plant in northern Bohemia, but also later around the country— in a cement plant in Čížkovice, the Vřesová gasworks, hydroelectric power plants and as a control system in the famous Vítkovice Iron and Steel Works in Ostrava.[99]

The series was partially rooted in the original line of ANALOGON and MEDA analog computers developed at the Military Technical Institute in Prague during the mid-1950s with input from American engineers Joel Barr and Alfred Sarant, members of the Rosenberg atomic

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Technické Muzeum v Brně. Available from: http://prog-story.technicalmuseum.cz/index.php/b-pocitace-a-dalsi-technika/analogove-a-hybridni-pocitace/3997-1951-1956-zaklady-ceskoslovenskych-analogovych-pocitacu.

[98] Studenka in discussion with the author.

[99] Kepka, "Zkušenosti se zavedením systémů ADT," 189-195.

spy ring who had fled the United States for initial exile in Czechoslovakia.[100] They would later help found the Soviet 'Silicon Valley' at Zelenograd, outside Moscow. ADT's digital design heritage also stretched back to the late 1950s and early 1960s at VÚMS, where Svobodá's group had begun work on the EPOS-1 and, later, EPOS-2 transistor-based all-electronic digital computer as successors to SAPO.[101] Our attention is drawn to the DP-100 and ADT machines because of what they represent: A tradition of native computer manufacturing, programming and use in Czechoslovakia. The machines link Czechoslovakia to a wider global story of emerging countries that struggled to enrich and empower themselves by acquiring the *realia* of modernity.

Simultaneously, the fact that Czechs and Slovaks already possessed electromechanical engineering's pre-war craft traditions, industrial plant and equipment meant they were able to play to established strengths and retain a degree of independence throughout the long 1970s. As a true "second world" member Czechoslovakia retained a greater degree of technological autonomy than many other peripheral countries, such as India, which were leashed ever more tightly to IBM and the United States. Indian elites in the 1960s attempted Cold War non-alignment in computing, but without a strong base of mechanical and electronics engineering were hardware dependent on other countries. While this did lead to second-order innovation, e.g. in software, of the kind David Edgerton has encouraged scholars to seek out, it also led to human

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[100] Golan, "Základy československých analogových počítačů," Technické Muzeum v Brně. For more on Barr and Sarant's role in international technological transfer during the Cold War, see: Steven T. Usdin, *Engineering Communism: How Two Americans Spied for Stalin and Founded the Soviet Silicon Valley*, New Haven: Yale University Press, 2008.

[101] "Jedním z důvodů pro rozhodnutí neopravovat počítač byly prácena počítači EPOS 1 (Elektronkový POčítač Střední). Projekt EPOS 1 byl dokončen v roce 1960 podvedením A.Svobody, Jana Oblonského a Zdeňka Korvase [at VÚMS in Prague]. Počítač byl později vyráběn v ZPA (Závody průmyslové automatizace) pod názvem ZPA 600. Následoval vylepšený model EPOS 2, dokončený v roce 1962, a MSP (Malý Samočinný Počítač)." Helena Durnová, "Antonín Svoboda (1907-1980)—průkopník výpočetní techniky v Československu" (Antonín Svoboda 1907-1980—Pioneer of computer technology in Czechoslovakia), *Pokroky matematiky, fyziky a astronomie* 52, no. 4 (2007): 327.

capital flight.[102] "Of the nineteen original [Indian] graduates in computer science from 1983," Ross Bassett noted in a 2009 article "an alumni website accessible in 2007 yielded information regarding the careers of seventeen. One graduate had passed away; of the remaining sixteen, fourteen lived in the United States, one in the Czech Republic, and the last in India."[103] By 1974 some 65 percent of India's computers came from one company, IBM.[104] State socialist countries' restrictions on emigration for their computer scientists, programmers and hardware engineers, on the other hand, acted as a form of human capital control that stanched this kind of brain drain at the source. With import-substitution of computers never realistic and a flood of funding into the country from the West compared to a trickle from the USSR, Indian computing became an auxiliary of the USA, an enduring pattern.

Before moving to a consideration of accession to JSEP in 1969, only two additional prominent examples of domestically produced computer hardware demand our attention. These were the last major exponents of what Marcela Efmertová and Petr Golan have referred to as the "Czechoslovak Computer School," which as this chapter describes, briefly flourished in the first half of the stable system years until the first JSEP computers began to supplant older Czech and imported machines around 1974. Beginning with a prototype in 1965, Svoboda's EPOS-2 (*Elektronický Počítač Střední*) was, like its experimental predecessor EPOS-1 an all-electronic computer, but a true second-generation computer taking advantage of transistor-based logic

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[102] According to Bassett, "the problem of producing up-to-date software for out-of-date hardware proved a spur to innovation. In 1970, IIT Kanpur undergraduates produced the first compiler written in India, which incorporated features implemented on newer versions of FORTRAN written for more recent hardware not available in Kanpur." Bassett, "Aligning India in the Cold War Era," 794. What I refer to as 'second-order innovation' is the re-use and adaptation of existing technologies and systems in ways unanticipated by the original designers or manufacturers, following Edgerton's directive to "reach down the food chain, to the amateur specialists on plows, tractors, airplanes, rickshaws, aircraft, small arms, and electric toasters." David Edgerton, "Innovation, Technology, or History: What is the Historiography of Technology About?" *Technology and Culture* 51, no. 3 (2010): 698.
[103] Bassett, "Aligning India in the Cold War Era," 807.
[104] Ibid, 800.

circuits rather than vacuum tubes. A pioneer of fail-safe circuits, the EPOS-2 entered serial production at ZPA Čakovice as the mid-size mainframe ZPA-600 computer, iterated later as the smaller ZPA-601.[105] The computer was thus the first digital all-electronic Czech computer to move beyond prototype into mass production, as its 1965 birth coincided with the government's simultaneous founding of ZPA (*Závody přístrojů a automatizace*) the consortium responsible for manufacturing and distribution of computers, laboratory instruments and office machines.[106]

Prior to the installation of JSEP computers at scale in the mid-1970s, the older ZPA-600, 601 and a few of the newer ZPA 6000/20 machines had been put to work in a range of scientific and industrial activities, from analyzing Soviet samples of lunar dust to wood transport control systems in Czech lumber mills.[107] In fact even after 1974, when JSEP machines assumed a prominent position in the sphere of Czechoslovak computing, the Czech heritage (EPOS-2) of the ZPA mainframe series lingered on: The ZPA 6000/20 was renamed EC 1021, the primary Czech contribution to the Unified System, but "retaining its special control instructions which prevented full compatibility with other RYAD models."[108] A decade after his emigration, Svobodá's legacy was still at least a minor force to contend with. Little Czechs were disrupting the operations of Big Iron—a nickname for mainframes, a stand-in for centralized computing, but also an appropriate metonym for an entire system of political domination that issued forth from the barrels of Soviet tanks.

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[105] Petr Golan, Marcela Efmertová and Tomáš Konečný, "Czechoslovak Computer School," *Academia.edu.*
[106] Durnová and Paju, "Computing Close to the Iron Curtain," 312.
[107] T. Zemčík and K. Raclavskí, "Moessbauer Measurements of the Soviet Luna-16 and Luna-20 Samples," *Le Journal de Physique Colloques* 35, no. C6 (1974): 549; A. Kastner and O. Slama, "Fundamental Variant of a Program of Wood Transport Control by the ZPA 600 Computer [of Czechoslovak origin]," *Lesnictvi-UVTIZ* (1979).
[108] Marilyn Rurak, "The American Computer Industry in its International Competitive Environment," a report prepared for the U.S. Department of Commerce, Washington: U.S. Government Printing Office, 1976: 58.

A more complicated example of the native "Czechoslovak school" of computer engineering and production is the Tesla 200. Built in Pardubice, it was a licensed copy of the French Bull-GE Gamma 140/145 from 1966, a mid-range French prototype that, after some initial problems with its tape drives, General Electric decided to kill off in favor of a more 'reliable' version from its American branch.[109] Tesla bought the license for a song, fixed the tape drive problem, pentupled production compared to the Angers facility, and promptly began exporting the French-developed, Czechoslovak-improved computer to the Soviet Union.[110] This was consistent with Czechoslovakia's position, one it typically shared with the GDR, as "suppliers of the socialist bloc's cutting-edge and thus high profit technologies," according to Victor Petrov, who studied the history of CMEA's computer production efforts.[111] The Tesla 200 entered production in Czechoslovakia in 1968 just prior to the Soviet invasion of the country in August which, ironically, interrupted the first scheduled delivery of the Tesla 200 mainframes to the USSR.[112]

An expensive mainframe computer, its production run nevertheless totaled more than one hundred units. The Tesla 200 found use in research institutions and universities, where it formed the backbone of the country's scientific apparatus. As a brief survey of the available literature demonstrates, Czech and Slovak scientists used the reliable mainframe to perform calculations for published work in dozens of different scholarly journals, in fields including chemistry,

[109] Andrew Targowski, *The History, Present State, and Future of Information Technology*, Informing Science, 2016: 94-95.
[110] Pierre Mounier-Kuhn, "From General Electric to Bull: A Case of Managerial Knowledge Transfer (1956-1970)," La Circulation de l'Information et des Conaissances, *Entreprises et Histoire* 75 (June 2014): 54.
[111] Petrov, "A Cyber-Socialism at Home and Abroad," 56.
[112] Jaroslav Vlček, *Výpočetní technika v zemích RVHP: Československá socialistická republika* (*Computing technology in CMEA countries: Czechoslovak Socialist Republic*), Praha: Státní nakladatelství technické literatury, 1975: 18; Frank Dittmann, "The Beginning of Network Technology in COMECON," delivered at ICOHTEC Symposium: "Computer Networks, the Internet and the Netizens: Their Impact on Science and Society," in Beijing, July 24-30, 2005: 6.

computer science, history, biology and even apiculture.[113] The Tesla 200 was also capable of changing the course of technologists' lives more directly.

As a teenager Jiří Zlatuška, later in life a member of SOFSEM and founder of Masaryk University's Faculty of Informatics, hungered for access to the Tesla 200 mainframe housed at Brno's nearby Technical University. With three like-minded friends, he submitted an application to the university to be recognized officially as a "club of programmers" permitted to work with the computer:

> Plus one of the part-time astronomers at the observatory, with whom I would have extensive discussions during the evenings, worked as a programmer for real-time systems for controlling of air traffic; incidentally at the same time with the computer, Tesla 200, which was here at the technical university. And he provided me some technical specifications needed for really low-level Assembler language programming, programming channel programs for peripheries and, actually, I did make some modifications of the operating system at that time. ... And around that time I also took part … in a competition that's called SVOČ [*Studentské Vědecké Odborné Činnosti*], the Student Scientific Technical Work ... So I won it in comparison with their [collegiate] students of computer science![114]

Winning the student competition at such a young age duly impressed the right people at the electrotechnical faculty, who offered Zlatuška a research assistantship in the department of thermal mechanics. Zlatuška used his enhanced access to the Tesla 200 to dive deeper into the world of programming. Reflecting on the central role it played in kicking off his career, Zlatuška

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[113] Petr Voznica, Josef Havel and Lumír Sommer, "The Reactions of Gallium, Indium and Thallium with 2-(2-pyridylazo)-1-naphthol-4-sulphonic acid and Their Spectrophotometric Determination," *Collection of Czechoslovak Chemical Communications* 45, no. 1 (1980): 54-79; Michal Servit and Jan Schmidt, "Experiments with Routing on Printed Circuit Boards," *Computer-Aided Design* 12, no. 5 (1980): 231-234; J. Tauer and Jaroslav Purš, "New Methods and Techniques of Research into Economic History in Czechoslovakia," *Quantum Information* 10 (1979): 1-9; M. Repčák, B. Šmajda, et al., "Diurnal Rhythms of Certain Sesquiterpenes in Wild Camomile (Matricaria chamomilla L.)," *Biologia Plantarum* 22, no. 6 (1980): 420-427; O. Benada, V. Drobnikova, et al., "Plasmid DNA in Bacillus larvae," *Journal of Apicultural Research* 27, no. 1 (1988): 35-39.

[114] Prof. RNDr. Jiří Zlatuška, CSc., (Dean – Faculty of Informatics, Masaryk University), in discussion with the author. March 28, 2018.

later reflected that the "Tesla [200], as far as that, was our club."[115] Computers often had intimate, personal effects disproportionate to their limited availability in 1970s' Czechoslovakia.

Safeguarding Stability: The Emergence of Computer Professionals and the 'Clash of Teleologies,' 1974-84

The first half of the "stable system" of computing in Czechoslovakia, from 1964 to 1974, was characterized by steady if chaotic and largely undirected growth. While only 56 computer systems were in use around the country in 1965, according to Durnová there were 883 computers by the middle of 1973.[116] An earlier Ministry of Transportation report, in 1972, contains slightly different numbers: 331 (digital, all-electronic) installed computers nationwide, as well as 150 minicomputers, 184 punched card computers and 1,418 punch card systems; a 27 percent increase in computers overall from 1971. Moreover, these were almost entirely the result of the domestic computing industry that had formed during the period 1964-74—669 of these were manufactured by Tesla or ZPA; 69 Minsk computers from the USSR and 55 ODRA computers from Poland constituted the bulk of CMEA countries' contribution prior to the Unified System's emergence; and only 67 computers originated in the West.[117] The difference in records may be due, as stated earlier, to disagreements between officials in how to count analog, hybrid analog/digital and punched card systems compared to "true" digital all-electronic machines.

In any case, what is clear is that the installed base of computers in the country was growing, not stagnant. A 1978 report in Polish *Przegląd Mechaniczny* recorded "more than 900" digital all-electronic computers in Czechoslovakia. According to Michael Homberg's

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[115] Zlatuška in discussion with the author.
[116] Durnová and Paju, "Computing Close to the Iron Curtain," 317.
[117] The breakdown of capitalist computers in Czechoslovakia in 1972: "IBM (17 units), UNIVAC (14 units), CDC (4 units), Leo (3 units), ITC (13 units), Siemens (7 units), and Datasaab (9 units)." "Využití výpočetní techniky v Československu v roce 1972" (Use of Computer Technology in Czechoslovakia in 1972), Ministerstvo dopravy České socialistické republiky, Prague, 1972: 1-2.

comparative work on the GDR and West Germany, the GDR "counted around 680 computer systems" in May 1978 placing slightly behind its smaller but similarly well-developed Czechoslovak neighbor, but far behind West Germany's 17,300 installed computers.[118] A quarter of the listed Czechoslovak computers were part of the Unified System, which had begun to be installed only five years prior, in 1973—almost triple the 1972 installation base. A 1980 report in Hungarian *Számítástechnika*, likely more accurate, claims that by "the end of 1978 Czechoslovakia recorded 1,194 digital computers," which it assessed separately from punch card data processing machines, process control computers, hybrid digital/analog computers, analog machines, mini-computers and thousands of "other punch card machines."[119] However, we can also assess the emerging cadre of computer professionals in terms other than the proliferation of the machines around which their working lives revolved.

Growth in computing during the stable system of the long 1970s is reflected not merely in the number of available computers, but also in the enrollment of students in technical fields closely aligned with computing (such as mathematics and mechanical engineering), the budgets for research and development in the institutes of the Czechoslovak Academy of Sciences, and the organization of domestic manufacturing of machines, components and peripherals under the ZPA combine. Thus, by 1974 the swelling ranks of computer professionals in Czechoslovakia lived and worked within a relatively mature computing system compared to the chaos of the mid-1960s, stabilized in broad terms by three 'legs' at the mesocosmic interface between the federal

[118] Michael Homberg, "Who is Leading Innovation? German Computer Policies, the 'American Challenge' and the Technological Race of the 1960s and 1970s," *Media in Action* 1, (2017): 105.

[119] "1000 komputerów w Czechosłowacji" (1000 Computers in Czechoslovakia), *Przegląd Mechaniczny* 37, no. 11 (1978): 2; "A számítógépes technológia helyzete Csehszlovákiában" (The Status of Computer Technology in Czechoslovakia), *Számítástechnika* (March 1980): 9.

government (the Central Committee and State Planning Commission) and individual Czech and Slovak computer technologists.[120]

Those three legs of the system were the universities, the research institutes of the Czechslovak Academy of Sciences, and the ZPA trust enterprises. The faculties of mathematics and electrical/mechanical engineering trained hardware engineers, mathematicians and software programmers; these computer technologists typically found employment in the research institutes (theoretical, design and software work) or one of the ZPA subsidiaries such as Tesla, Aritma or Datasystém (hardware engineering, manufacturing, maintenance); the ZPA trust supplied the necessary machines for the universities, research institutes, military and large enterprises, supplemented by computer imports from CMEA countries or the West when possible. Although the purges following the end of the Prague Spring reform movement in 1968-69 affected individual computer technologists such as Pajas, who was forced out of the more prestigious Nuclear Research Institute into the Ministry of Transport, in general the emerging cadre of young computer professionals was not targeted for harassment by the Communist party due to their valuable skills and the politically neutral quality of their technical work.[121]

Indeed, as Alexei Yurchak observes in his work on late socialism *Everything Was Forever, Until It Was No More*, the 1970s *vnye* (the condition or feeling of simultaneous outsider and insiderness of a generational milieu of, especially, young professionals) in the Soviet Union derived from these individuals' roles, interlocked and mutually embedded in the systems of political, economic and social power in which they no longer believed nor trusted. This included

[120] "Students of technical subjects were the second-fastest growing group after students of economics. Their number almost doubled between 1961 and 1981, to about 85,000, whereas humanities only grew by one-third, to 69,000." Švelch, *Gaming the Iron Curtain*, 18-19.
[121] Švelch, *Gaming the Iron* Curtain, 5; Pajas in discussion with the author.

the emerging cadre of computer professionals in Czechoslovakia.[122] To be a technician in late socialism was to be, almost inevitably, an employee of the state in some capacity or another—an occasionally dangerous position that would also have been familiar to engineers and technicians decades earlier under Stalin's rule in the USSR.[123] An example of the prevailing conservative temperament and political apathy from the generation of the 1970s can be seen in the case of Vladimír Vaněk, who struggled to find work during the lustration of ex-Communists following the Velvet Revolution:

> Then I worked for some time for a Dutch-American computer firm. My boss, a guy about ten years my junior, took me on even though I had some issues in my past. That was in 1991; life was still pretty wild, and it was definitely not an advantage in job hunting to be a former policeman. But this guy was good to me, because when I told him straight out that I had worked for the police at the surveillance division for sixteen years, he just said: 'Do you know how to operate a computer, or can you learn it?' And so I say, 'Sure thing, I'd like that.' And he says, 'That's what matters to me.' End of story. He didn't say another word about it, something I appreciated a lot at that time.[124]

Born in 1951, Vaněk entered life as a computer professional in the early 1970s, employed with the Ministry of Interior's secret police (StB) technical division since 1973. Upon first glance, this attitude of apolitical professionalism does not distinguish the "little Czech person" in the computing professions from the man or woman on the street.

The obvious question then is whether computer technologists deserve to be categorized differently from their fellow little Czechs, engaging in private citizenship under late socialism, or

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[122] "Susan Gal and Gail Kligman provided a crucial critique of many binary divisions that dominate the studies of state socialism, arguing that in these societies '[r]ather than any clear-cut 'us' versus 'them' or 'private' versus 'public,' there was a ubiquitous self-embedding or interweaving of these categories.'" Alexei Yurchak, *Everything Was Forever, until It Was No More: The Last Soviet Generation*, Princeton: Princeton University Press, 2006: 7.
[123] "But even sticking closely to their assigned technical tasks did not guarantee that engineers would avoid political trouble, since their ability to increase output was constantly being judged. A failure to meet quotas could become a 'political' mistake in the eyes of the leaders of the local Communist Party organizations." Loren Graham, *The Ghost of the Executed Engineer: Technology and the Fall of the Soviet Union*, Russian Research Center Studies (87), Cambridge, Massachusetts: Harvard University Press, 1993: 67-68.
[124] Miroslav Vaněk and Pavel Mücke, *Velvet Revolutions: An Oral History of Czech Society*, Oxford: Oxford University Press, 2016: 84-85.

even from engineers in the West, who often worked hand-in-glove with state authority on, for example, military contracts during the Cold War.[125] Bren has observed that late socialist citizens "decided that consumer goods would be the most pleasurable means of identity formation. The result was a socialist East that differed quantitatively but not qualitatively from the capitalist West."[126] The computer, in this view, was potentially just another scarce consumer good in late socialist Czechoslovakia, and computer professionals meaningfully indistinguishable from their friends and neighbors. Were computers a meaningfully distinct category of consumer good under late socialism? Differential access to the artifact, and its attribution, is the answer.

There was a qualitative separation between Czech and Slovak technologists and their Western compatriots because, in the Czechoslovak case, scarce access to the computer defined their working lives. Computers were not market distributed and required heterogeneous, cooperative activity. Thus a different kind of technician identity took root under state socialist conditions, one durably anchored in the values of informal acquisition and distribution, peer collaboration and tinkering/maintenance. Technicians' professional lives occurred in an interlinked mesocosm full of socialist spaces in the classic sense. That is, the mesocosm offered sites for the ongoing negotiation that, in historian David Crowley and Susan Reid's description "went on between State and people in the ascription of meanings to particular spaces, as well as to the resilience of counter-hegemonic practices, representations and memories."[127] Computer work constituted employment, but also a space for tinkering and invention, a site for social

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[125] In the period 1964-74, according to Wisnioski: "Private industry and utilities employed 71 percent of the nation's engineers, while 15 percent worked for government agencies. However, when government contracts were considered, 40 to 45 percent of American engineers were either directly or indirectly in the government's employ." Wisnioski, *Engineers for Change*, 42.

[126] Paulina Bren, *The Greengrocer and His TV: The Culture of Communism after the 1968 Prague Spring*, Ithaca: Cornell University Press, 2010: 190.

[127] David Crowley and Susan Reid, eds., *Socialist Spaces: Sites of Everyday Life in the Eastern Bloc*, New York: Berg Publishers, 2002: 12-13.

networks of friends and colleagues to organize, a source of identity and shared values, and a shelter from politics. The mid-tier institutions that housed such computer work comprised multiple overlapping sites of negotiation, accommodation and consent between the central government and the research institutes, universities and large industrial concerns. Finally, computers themselves never developed into a consumer good in the ordinary sense, where shortage might be felt keenly by the public, prior to the 1989 revolution. They are incomparable to blue jeans or stereos since the transformative possibility of the computer, for all of society, was enormous—the only technologies rivaling computers in the 20th century imagination were the automobile, the airplane and the atom bomb.

Technicians in the socialist east were also simultaneously partially entangled in different computer networks, which placed unusual demands on their cadre. In the West, according to historian of computing Nathan Ensmenger, software development was far more fraught and subject to negotiation between designers, application engineers and end users than hardware. A distinguishing feature of Czechoslovak computing was that hardware itself was equally problematic, subject to negotiation and delays in its acquisition and implementation. Design, manufacturing, installation and maintenance of so many different kinds of incompatible computers were attributable to a lack of national strategy which allowed institutions to fend for themselves in the scramble for computers.[128] This had created, certainly by the middle 1970s, a complex, masterless system that provided technicians employment and privileges but was frustratingly opaque for top government officials and end users alike. “As the sociologist John Law has suggested,” Ensmenger wrote “the 'heterogeneous engineering' required to assemble

[128] This is in contrast to more organized procurement efforts and national computerization strategies in, e.g. France’s successful Minitel program of the early 1980s which “began as a top-down, State-run project with the ambitious goal of outfitting the whole of France with a cutting-edge digital telecommunications system in less than a decade.” Mailland and Driscoll, *Minitel*, 146.

such complex systems blurs the boundaries between the technological and organizational, and typically creates a process fraught with conflict, negotiation, disputes over professional authority, and the conflation of social, political, and technological agendas."[129] This additional complexity caused no end of problems with computers.

However it also granted systemic power to computer professionals, who ran the mid-tier institutions and formed a tight-knit cadre most visible in festivals and conferences such as SOFSEM and MFCS. Both conferences were organized by Slovak computer scientist Jozef Gruska in the 1970s as the ranks of technologists expanded and they developed a sense of common cause.[130] The Central Committee responded to this opaque and resistant mesocosm by continuing STR rhetoric, adjusting quotas for computer production upward in the sixth (1976) and seventh (1981) five year plans, reorganizing the ZPA trust and creating a federal ministry directly responsible for electronics production.[131]

Although the rhetoric of the scientific-technical revolution remained relatively stable throughout the long 1970s, as did the general computing paradigm, major organizational reforms and institutional and personnel changes continued during this period—no one was sitting still, and the computing scene should not be defined as stagnant. Indeed, dating from the country's accession to CMEA's Inter-Governmental Commission for Computer Technology in 1969, the Central Committee and the State Planning Commission took a more direct interest in the

[129] Nathan Ensmenger, *The Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise*, History of Computing, Cambridge, MA: The MIT Press, 2010: 7-8.
[130] See, e.g. Andrei Ershov on the outlook of programmers as an underappreciated, somewhat aggrieved technical elite in the 1970s: "To be a good programmer today is as much a privilege as it was to be a literate man in the sixteenth century. This privilege leads the programmer to expect recognition and respect on the part of society. Unfortunately, such recognition is not always realized." Andrei Ershov, "Aesthetics and the Human Factor in Programming," speech delivered at Spring Joint Computer Conference, (May 1972), republished in: *Jurimetrics Journal* 13, no. 3 (Spring 1973): 146.
[131] Vladimír Vokálek, "Uživatelé stále zanedbávají efektivitu—další kroky k elektronizaci československé národní ekonomiky" (Users Still Neglect Effectiveness—Further Steps Toward Electronization of Czechoslovak National Economy), *Hospodářské noviny* (July 29, 1983): 1.

progress of the country's computing industry. While the mid-tier institutions continued to play the dominant role in everyday decision-making, they were now subject to top-level organizational shuffles and responsive, at least to a limited degree, to the long-term goals set forth for the electronics industry in the country's five year plans.

In the winter of 1973, J. Trajbold, then the director of the office machines enterprise KNSP (*Kancelářské stroje národní průmysl*) and one of the most influential voices within the hierarchy of the ZPA trust, referenced the major organizational arrangement necessary for JSEP to be fully implemented by January 1, 1972—with each organization delegated particular tasks. These included "substantial organizational changes which were as far reaching as, for instance, shifting the output of an enterprise to another assortment. We actually had to cope with the same problem because in this country too, qualified personnel from other fields of computer technology had to take up and master JSEP technology with the greatest possible dispatch."[132] Later, in 1979, the State Planning Commission deemed the ZPA trust insufficiently productive and some of its production responsibilities shifted to a new combine, ZÁVT, which was tasked with coordinating production of mini-computers (based on the DEC PDP/11 and, later, VAX series). Toward the end of the year the Central Committee created a new arm of government, the Federal Electrotechnical Ministry, with Milan Kubát at its head to coordinate government policy, research activity and industrial response.[133]

The heterarchy of state computing institutions (Tesla, ZPA, VÚMS, NOTO, INORGA) also matured, largely unaffected by the Prague Spring and resulting crackdown since technicians

[132] J. Trajbold, "Na prahu představení prvních počítačů JSEP v Československu" (On the Threshold of Introducing the First JSEP Computers in Czechoslovakia), *Strojírenství* no. 4, 1973: 193-194.
[133] "Nová organizace konsolidované počítačové výroby zobrazuje produkty" (New Consolidated Computer Production Organization Displays Products) *Technický tydenník* no. 36, 1979: 6; Ing. Vladimír Hrbek, CSc., "Cíle produkce elektronického průmyslu, organizace v sedmém pětiletém plánu" (Electronic Industry Production Goals, Organization in Seventh Five-Year Plan), *Slaboproudý obzor* (October 1980): 469-471.

were seen as apolitical. Thus, while individual computer scientists, programmers or mathematicians might denigrate the country's computing situation, as a bloc they were a potent political force for inaction. As Dolores Augustine points out in the case of the GDR, this milieu or *vnye* of computer technologists in the 1970s were generally not individualist ideologues, but organization men and women: "East German IT specialists were not loners beginning their careers building computers in a garage, as the iconic success stories of IT entrepreneurs in the United States were. Rather, they were formally trained specialists who went to work in rigidly hierarchical bureaucracies."[134]

Move Slowly and Fix Things:
Cultural Caution, Private Citizenship and Personal Privilege

After the political turmoil during the 1968 Prague Spring reform movement and the subsequent invasion of Warsaw Pact troops, Czech and Slovak computer professionals in the 1970s understood to cherish, like most of their countrymen, a quiet life with their family and private pursuits. Their own interests and limitations (e.g. maintenance vs. installation, obtaining or writing software, carving out free time at work to tinker), as well as conflicts between uncoordinated state policies and directives, meant a measured pace of computing adoption was broadly agreeable. Peters refers to "the binary that was internal to the Soviet economic system. Hidden, informal, and often vicious administrative networks prevented public, formal, and

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[134] Dolores L. Augustine, *Red Prometheus: Engineering and Dictatorship in East Germany, 1945-1990 (Transformations)*, Cambridge: MIT Press, 2007: 268.

potentially virtuous computer networks from taking the Soviet Union online."[135] A more generous interpretation of this phenomenon exists, however.

This heterarchy of mid-tier institutions, capable of inhibiting one another, large enough to negotiate for funding and privileges such as foreign travel directly with state planners, certainly frustrated the rapid progress of computerization in Czechoslovakia. Yet these institutions—inside the Czechoslovak Academy of Sciences, the universities' mathematics faculties, the industrial trusts—behaved like scaffolding or a trellis, structuring the emerging community without constraining their personal autonomy, creative freedom or intellectual exchange. On the contrary, they experienced more personal autonomy and privileges from 1974-84, as Josef Hejsek, deputy chairman of the State Planning Commission, recognized in 1980: "The transition to the new methods of research has changed the demands on workers in the technological research base in terms of the development of the creative abilities of individuals and collectives. The primary task on all levels of management in the new ministry is to provide preconditions for comprehensive applications of personal initiative and creative skills."[136] These institutions also acted to protect their members from retaliation for their political beliefs. The most prominent example was when Václav Trojan, Václav Žák, Vojtěch Sedláček, Václav Benda and Jan Sokol, all members of the software group at VÚMS, signed the reformist manifesto Charter '77. When the institute's director, a party member, threatened them with job loss and retaliation against their families, the other non-signatory programmers and scientists threatened to resign *en masse*.[137] This was an uncommonly public act of dissent, and then a move to protect the dissenters, from a

[135] Peters, *How Not to Network a Nation*, 193.
[136] Josef Hejsek, "Za další, intenzivnější rozvoj československé elektrotechniky" (For the Further, More Intensive Development of Czechoslovak Electrical Engineering), *Planované Hospodářství* no. 6, (1980): 4.
[137] Trojan in discussion with the author.

community that, like their neighbors, typically behaved in a politically indifferent or apathetic manner during the normalization era.[138]

Nevertheless, Czechoslovakia's situation in the 1970s and early 1980s gave technologists pause. Afflicted both by the CoCom embargo, which inflated the price or outright barred the import of cutting-edge computers, and by export demands to CMEA countries, which did not even stimulate qualitative growth since Soviet standards were low, to "move fast and break things" in the pursuit of the nebulous promises of STR was high risk and low reward. The calculated response was to move forward cautiously, to preserve the practical bargain they enjoyed—an adaptation to circumstances. In Czechoslovakia there was neither enough social space for a bottom-up computing initiative, such as the hobbyist computing movement in the USA, nor sufficient coordination, expertise or funds for a successful top-down imposition of centralized computing.[139]

Neither was the 1970s *vnye* milieu simply reacting to the political disruption of 1968; their caution was also a response to technological disruption—a tactic for life on the political and technological periphery of two empires in the Cold War world. Domineering systems could not be escaped during the long 1970s—"big iron" came as mainframes and tanks. A Slovak programmer's joke comparing programming to drug use reflects the mood: "police are helpless [in the face of] the increasing use of programming languages among young people. Large-scale police enforcement usually results in the detention of small programming teachers or small computer owners, while programming language authors and large computer owners [institutional

[138] Ibid.
[139] Švelch, *Gaming the Iron Curtain*, 33-34.

mainframe users] live with quite an impunity."[140] Ironically, given the undertone about secret police, a lack of government control was a factor encouraging computer professionals' restraint toward adopting new technologies—even when their institutions could acquire them, it was far more challenging for Czechs and Slovaks to accommodate computers from all over the world, often cheaper or older machines that sold poorly elsewhere (such as the Tesla 200 before the license was acquired from Bull-GE in France), than if there had been a top-down strategy for computer production and implementation in the command economy.[141]

This caution constituted a mature re-appraisal of Czechoslovakia's horizon of technical possibility in the 1970s. Hungarian economist János Kornai spoke for the consensus interpretation when he argued that innovation is by far the most important narrative, and that the socialist system was inferior when thus measured. However, we can relate a narrative of late socialist computing as a representative, not in priority or commercialization, but in maintenance, tinkering and adaptation.[142] In other words, Czechoslovakia's system (and its state socialist contemporaries) is likely a more accurate representative of how most people, in most emerging societies, appropriated and incorporated technologies originating in the wealthiest countries.[143]

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[140] "Ako sa píše vo včerajšom vydaní denníka New York Times, polícia je voči rozmáhajúcemu sa užívaniu programovacích jazykov medzi mládežou bezmocná. Výsledkom rozsiahlych akcií polície býva spravidla zadržanie drobných učiteľov programovania alebo majiteľov malých počítačov, zaťialčo autori programovacích jazykov a majitelia veľkých počítačov žijú celkom beztrestne na slobode." "Televizní noviny – Sofsemovské texty" (Television news—SOFSEM texts), Anti-SOFSEM '79. Found on "30 Let Sofsemu," (30 Years of SOFSEM) a CD-ROM containing most of the conference's history from 1974 to 2003, provided by Miroslav Bartošek and in the author's possession.

[141] Trojan related a particularly challenging contract for the Prague Institute of Transportation Engineering where he had to program in COBOL an interface between some "some crazy computer, British," that the institute had somehow acquired years earlier, and the normally incompatible digital plotters VÚMS had produced, which had originally been designed to work within the JSEP framework. Trojan in discussion with the author.

[142] János Kornai, *The Socialist System: The Political Economy of Communism*, Princeton: Princeton University Press, 1992: 294-301.

[143] This extends beyond computing. Consider John DiMoia's article on the acquisition of nuclear power technology in South Korea, which might equally and accurately describe the Czechoslovak computing scene: "This is not a celebratory story of a scientific community developed through a top-down blueprint or plan, but instead a story of the accumulation of personnel and expertise out of contingency and dire necessity. … If the developmental state model has typically prioritized the role of the state in directing technological and economic growth, here it was the

The computer system under Svoboda, broadly, was a thoroughgoing effort to develop an autochthonous computer industry, focused on genuine innovation/invention inspired by the inventor's time in the United States during World War II. The 1970s featured the cadre of Czechoslovak computer technologists coming to terms with, and making the best of, the country's actual position, politically and economically and technologically, within a Cold War world that seemed eternal.

In practical terms, and as we shall encounter in subsequent chapters in more detail, this meant that the *vnye*-feeling milieu of computer professionals in the long 1970s were at times disgruntled, but rarely active dissenters. "We often cursed," Augustine recorded one automation engineer saying "because we were forced to reinvent the bicycle or had to improvise a solution to make something work because it was not possible to do it in a way that would have been logical from a technical standpoint."[144] Many other professionals, however, welcomed the stability of a slowly advancing field. Knowledge of Czechoslovakia's delayed technological status was widespread, but also widely accepted. Gruska, one of the most prominent computer scientists in former Czechoslovakia, reflected at some length on the relationship between material conditions and political dissatisfaction at that time:

> People work with the machines they have, and they like them, they have relations to them. Moreover, there's not much sense in wondering about something you cannot change. There is a certain point to measure society by amounts and quality of cars or computers, but this is far from the whole story. … A big problem is not so big when everybody has it; the problem is if your neighbors don't have a problem and you do! That

end users—a core group of scientists—who frequently acted at odds with negotiators, at times with their Korean ministerial colleagues and even with the South Korean state." John DiMoia, "Atoms for Sale?: Cold War Institution-Building and the South Korean Atomic Energy Project, 1945-1965," *Technology and Culture* 51, no. 3 (July 2010): 596-597.

[144] Augustine, *Red Prometheus*, 292.

> is the problem that can be very unpleasant. For example, very few people, if any, are unhappy that they did not go to the moon yet![145]

According to Havel, the technological lag was an accepted fact, and perceived in so many arenas of the everyday that it no longer registered as a crisis to most technologists at the time. “There was a general knowledge,” he admitted, “about the fact that we are very, very delayed comparing to the West. And it was so normal, the knowledge, that nobody was concerned by the lag.”[146]

Of course, the rhetoric of the scientific-technical revolution, adopted by government officials and repeated by technologists in their own publications, and which ostensibly guided the field during the 1970s, was filled with hortatory language of acceleration, improvement and change. But in the real world of computing, as opposed to the visions set out by futurists on both sides of the Iron Curtain, change was considerably slower and more fraught. As Mar Hicks has observed, even in the considerably wealthier United Kingdom: “Computers and computer workers existed on two planes: first as cultural ideals that represented a new, modern, technological society, and second as actual artifacts and actors within a world that was changing less quickly than rhetoric might make it seem.”[147] Computer professionals in Czechoslovakia, much as elsewhere, had therefore grown accustomed to this fact of everyday life, and so the disconnect between official rhetoric of the scientific-technical revolution and the reality of the computer gap was not a significant cause of instability or ideological disaffection.

Official STR rhetoric was the cause, however, of jokes. One of the highlights of each year’s SOFSEM gathering, which brought together dozens of the country’s programmers, mathematicians and computer hardware engineers into one conference, was the so-called “anti-

[145] Gruska in discussion with the author.
[146] Havel in discussion with the author.
[147] Hicks, *Programmed Inequality*, 100.

SOFSEM," a sort of carnival-within-a-conference that allowed attendees to let their hair down by singing songs, swapping stories and even making up fake conference programs that mocked the official version. The anti-SOFSEM program in 1976, for example, featured a panel on "therapy methods for programmers of SCHIZO 1080/1080" and a lecture by deceased Holy Roman Emperor Charles IV about "teaching programming at my university."[148] In 1979, attendees gathered to watch a sketch at that year's anti-SOFSEM, a parody of official "television news" and the government's rhetoric of the scientific-technical revolution:

> Hundreds of Praguers gathered this morning to witness the execution of the outdated [IBM] DOS 2 operating system, which no longer met the modern requirements of remote data processing. The system's shooting was carried out by the well-known firing squad of gunner Hajek, who inserted dynamite logic formulas into 4,000 pre-selected points in the system. An explosion occurred when the system started up, turning it into a bumpy pile of bits. The work was immediately taken over by foreman Staudek's squad, which poured the bits into the physical layer and flushed them where they would not interfere. A new modern DOS 3 system will be built in place of the old system.[149]

The television news parody struck at the government's official discourse of the scientific and technological revolution which, borrowing from much older rhetoric that had once been applied to industries like steel production, continually proclaimed the need to push ahead into the future as fast as possible and at any cost.[150] Of course, to insiders the parody worked on a number of other levels. Software was not tangible, and could not easily be replaced with something

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[148] Michal Chytil, "Program AntiSofsemu '76 - Sofsemovské texty" (Program of Anti-SOFSEM '76—SOFSEM texts), Anti-SOFSEM '76. Found on "30 Let Sofsemu," (30 Years of SOFSEM) a CD-ROM containing most of the conference's history from 1974 to 2003, provided by Miroslav Bartošek and in the author's possession.
[149] "Stovky Pražanov sa zhromaždili dnes v dopoludňajších hodinách, aby boli svedkami odstrelu zastaralého operačného systému DOS 2, ktorý už nevyhovoval moderným požiadavkám diaľkového spracovania dát. Odstrel systému vykonala známa deštrukční skupina strelmajstra Hájka, ktorá do 4000 vybraných miest systému vložila formule dynamitovej logiky. Po spustení systému nastala explózia, ktorá ho zmenila na neforemnú hromadu bitov. Práce sa okamžite ujala skupina predáka Staudka, ktorá bity nasypala do fyzickej vrstvy a spláchla niekam, kde nebudú prekážať. Na mieste starého systému sa vybuduje nový moderný systém DOS 3." "Televizní noviny – Sofsemovké texty"
[150] See, e.g., deputy minister for technological and investment development Vladimír Vokálek's belated recognition that a "frontal assault" (*čelní útok*) on electronics was no longer the right solution—in 1983. It had been the dominant rhetoric for the previous twenty years. Vokálek, "Uživatelé stále zanedbávají efektivitu," 1.

completely new no matter how much violence or intimidation brought to bear against it—an operating system like IBM's DOS was complex and iterative, as were its successors and even its Soviet-developed branch for JSEP computers, EC OS, so this parody poked fun at out-of-touch Communist party elites who were unlike the younger, more technically savvy computing *vnye* at SOFSEM.

This raises the question of how much of the discourse of the "scientific-technological revolution" that framed computer professionals' working lives in the long 1970s was simply ritualized speech acts, performative both for colleagues and any officials reading through the discourse, and how much of it a genuine belief in a better socialist future, rationalized with computers. Participation in the CMEA Unified System of Electronic Computers had initially seemed to offer an answer to the nationwide shortage of machines and the practical difficulties Czechoslovakia had encountered both in attempting to afford Western imports and pursuing limited autarky in computing. As such shortages and technological lag continued, however, the shift in STR discourse, which continued to dominate official rhetoric in the pages of Czechoslovak periodicals, likely followed the pattern of official political ideological discourse during late socialism.

Computer professionals learned to master STR rhetoric as one important performative dimension of their work, but in Yurchak's words "the constative dimension of these acts become open-ended, indeterminate, or simply irrelevant," to them.[151] In the absence of any obvious mechanisms or routes for political or social change open to them, and with the official technological discourse of STR less and less meaningful as it shifted away from its initial 1966 reformist roots (Richta and his colleagues recanted most of their more challenging reform ideas

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[151] Yurchak, *Everything Was Forever*, 26.

centered on participatory technology in 1972), the only remaining avenue of hope for computer technologists interested in reform was the seemingly inevitable process of technological change.[152]

Conclusion: Instability Returns—
Computers and Users, 1984 and Beyond

By the end of the stable system in 1984, computer technologists and government planners faced a quandary. The heroic age of Svoboda, the brilliant and charismatic scientist who had returned from America after World War II with the ambition of turning Czechoslovakia into a computer powerhouse, had ended two decades prior when he left the country with many of his best students in 1964. Since then, Czechoslovakia had ceased its initial efforts to develop an entirely self-sufficient, world-leading computer industry, and in fact the memory of Svobodá and his early accomplishments was deliberately buried by the regime.[153] In 1975, on its 25th anniversary, the directors of the Research Institute of Mathematical Machines (VÚMS, *Výzkumný ústav matematických strojů*), which Svobodá founded and led for its first decade, could only celebrate their founder anonymously—his name never appears in their records, and his groundbreaking electronic SAPO computer was dismissed in later memory as just "a famous kind of experiment … a rumor."[154]

[152] Švelch, *Gaming the Iron Curtain*, 11.
[153] Durnová, "Sovietization of Czechoslovak Computing," 28.
[154] "Po převedení Ústavu matematických strojů pod ministerstvo Svoboda fakticky přestal být jeho ředitelem. Když v roce 1964 emigroval, byl Ústav přejmenován (1965) na Výzkumný ústav matematických strojů Závodů průmyslové automatizace. Když se v roce 1975 oslavovalo 25 let VÚMS (tedy přesněji 25 let od založení Laboratoře matematických strojů), bývalí spolupracovníci se sice velmi kladně vyjadřovali k osobě tehdejšího ředitele ústavu, avšak Svobodovo jméno ve sborníku nenajdeme." Durnová, "Antonín Svoboda (1907-1980," 327. The memory of SAPO comes from: Pajas in discussion with the author.

Instead, during a period lasting from the mid-1960s to the mid-1980s, the country accepted its position on a kind of double periphery while taking steps to preserve and extend its comparatively advanced scientific-industrial base. On the political margin of a Cold War fought between Moscow and Washington, a lesson brutally reinforced by Soviet-led Warsaw Pact forces in 1968, Czechoslovakia also found itself on the technological margin of a world whose pace was set in the Armonk, New York headquarters of IBM and, somewhat later, the Maynard, Massachusetts headquarters of DEC (Digital Equipment Corporation).

Professionals and policymakers all sought to integrate computers into government, industry and the military, imported experts, machines and best practices, exported talented students and professionals, and avidly followed developments in international scientific journals—a vast expensive global race into an uncertain future. Czechoslovakia did not escape this trend. Like their counterparts in Mexico, Chile, Egypt and India, Czech and Slovak computer technologists in the 1970s often felt left behind by the blistering pace of technological developments, forced by poverty, geography, political circumstance and contingency to watch cutting edge research and successful commercialization take place in Kyiv and California, Moscow and Minnesota.

For twenty years, the rhetoric of the scientific and technical revolution seemed to offer a way to this Eden—rapid technological change brought about by ever more powerful centralized computers rationalizing government planning and industrial production. It had guided the work of policymakers and technologists alike. Microelectronics upended these plans and threatened to unsettle nearly every element of the bargain between technologists and state power. "Just at random—how extensive will be the demands for electronic equipment for the commercial network, automobiles, electric engines and chemical processes? Or, in another area—how popular will microwave cooking, videotapes, and electronic games be?" asked Josef Hejsek plaintively in 1980.[155] Computer technology was not only developing too fast for the research institutes to keep up, but integration of microelectronics into laboratory measuring equipment, consumer electronics and industrial automation demanded new kinds of contact and enhanced responsiveness within the mesocosm, something the stable system could not easily accommodate.

This was a crisis in Czechoslovak computing. It unfolded throughout the 1980s, and was only resolved by the Velvet Revolution in 1989, the break-up of the federal state in the Velvet Divorce of 1993 and the gradual end of Czechoslovakia's distinct computing traditions as the country enrolled in the global network of the Western computer market in the course of the 1990s and 2000s. In his recent book *Gaming the Iron Curtain* (2018), Švelch frames this period as a "clash of teleologies" between the technocrat professionals of the long 1970s and the younger hobbyist technophiles of home computing in the 1980s. "The ministry [and by extension the whole mutually imbricated computing *vnye*] considered computers a means to an end, whereas hobbyists saw them as ends in themselves—as more autonomous, independent objects."[156] The clash of teleologies between the mature group of computer technologists, who represented the stable system of the 1970s, and the emerging group of younger users of the 1980s is best represented in Švelch's text by the stance of Ivan Malec, then an assistant to Kubát, who argued that the country could only modernize through a massive investment in upgrading its domestic manufacturing capacity, and not by wasting money on home computers, which could do very little.[157] Computer professionals had developed a vested interest, during the long 1970s,

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[155] Hejsek, "Za další, intenzivnější rozvoj," 4.
[156] Švelch, *Gaming the Iron* Curtain, 33.
[157] Ibid, 29-31.

in protecting the stable system of mainframe and mini-computing because it embodied and maintained their privileges, culture and material interest. Perversely, Czechoslovak computer technologists' resistance to system change because of sunk costs was much higher, precisely because the comparatively few computers they enjoyed access to—precious expenditures of hard currency—counted as one such privilege.[158]

In fact, even as the Central Committee began to take domestic microcomputer production seriously in the seventh five year plan (1981), the youth of the 1980s suffered from the cautious, somewhat myopic design decisions and culture of older professional computerists. Švelch notes that the early Czech microcomputers were designed largely as hobbies by engineers like Roman Kišš and Eduard Smutný who already worked for large industrial government concerns, produced them in small batches with CMEA-only components, never designed them to be commercialized on a wider scale or to be inexpensive (since they were hardware engineers, the artifact itself was their sole concern, not marketing or ease of use). They did not even include diacritics for text programs in Czech or Slovak, since the engineers assumed these machines would only be used for programming instruction, dominated by global English.[159]

Yet this mismatch of attitudes and assumptions about the future of computing in Czechoslovakia had its roots in a particular kind of socialist success, not stagnation. This chapter demonstrates that the 1970s should be understood as a period of profound change and growth even it was not experienced that way by contemporaries. From a disciplinary standpoint, it was a

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[158] "Changes in the system also make hardware capital obsolete. Faced with these eventualities, the people and the investors in technological systems construct a bulwark of organizational structures, ideological commitments, and political power to protect themselves and the systems. Rarely do we encounter a nascent system, the brainchild of a radical inventor, so reinforced; but rarely do we find a mature system presided over by business corporations and government agencies without the reinforcement. This is a major reason that mature systems suffocate nascent ones." Thomas P. Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm, 1870-1970*, Chicago: University of Chicago Press, 2004: 461.

[159] Švelch, *Gaming the Iron Curtain*, 24-26.

time when academics and professionals began to claim computer science as their own, engaging in boundary disputes and poaching students from mathematics, physics and engineering.[160] Thousands of women began to work with computers—indeed the 1970s was the high water mark for Czech and Slovak women's participation in computing, in contradiction to trends in the West, where women were progressively pushed out of the field beginning in the 1960s.[161] The key academic conferences that underpinned national professional exchange in the field, MFCS and SOFSEM, were founded in the 1970s and carried on past 1989.[162] Finally the generational milieu of the 1970s, which organized and sustained hobbyist electronics and, eventually, the computer club life of the 1980s, first cohered and grew during this period of relative stability.[163] The eventual failure of the Unified System, on its own terms, does not erase and should not undermine the vision of the future it represented, nor the labor— political negotiation, design, skills acquisition, ordinary maintenance, everyday on-site operation—that sustained this technological network across the CMEA bloc in the 1970s.

The '70s in Czechoslovak computing also offers a partial glimpse into the kinds of accommodation and negotiation that characterized both the specific, mutualistic interplay of the community around computers themselves as well as everyday life under late socialism. As historians like Kevin McDermott and Paulina Bren have pointed out, the traditional outside understanding of state socialist societies in East Central Europe as totalitarian misses the mark to

[160] In 1973, squarely in the middle of the 1964-1984 period discussed in this chapter, "several full-fledged programs dedicated to computing opened at Czechoslovak universities, later complemented by programs on automation." Ibid, 18-19.

[161] Figures for 1986, somewhat outside the scope of this chapter, record women making up 58.3 percent of Czechoslovakia's 7,338 listed programmers. Ibid, 20; Hicks, *Programmed Inequality,* 13.

[162] Jozef Gruska began to organize MFCS (Mathematical Foundations of Computer Science) in "late 1972"; SOFSEM (Software Seminar) began meeting in 1974. Gruska in discussion with the author.

[163] Petr Holan, (Solutions Engineer (SQL/ETL) at GoodData), in discussion with the author. October 30, 2017 and April 14, 2018.

a considerable degree.[164] These were lively societies in which ordinary people carved out niches of autonomy in their workplace, in their hobbies and in their small *chata* outside of town on the weekends, a phenomenon Bren has titled "private citizenship."[165] In turn, the government accommodated and even encouraged many of these private activities, so long as citizens agreed to withdraw from open political dissent. This private citizenship informs our understanding of the 1970s' accommodation and stability-seeking on the microcosmic level, but examining the computing actor-network turns our attention a step higher, to the mesocosmic level of heterarchical push/pull between and within research institutions, government ministries and large industrial concerns.

While this "stable system" of computing endured for approximately two decades, 1964 to 1984, an entire generation of Czech and Slovak computer technologists came of age under the ideological aegis of Richta's scientific and technological revolution, which laid out a techno-utopian path toward a future of true socialist abundance delivered by powerful central computers that would set quotas, take inventory, allocate goods efficiently and relieve drudgery. "The present-day era of the scientific and technical revolution can also be termed the era of electronics" Kubát, then the deputy federal minister of technical and economic development, proclaimed in 1976. He continued: "At present, there exists practically no field of human activity where electronics does not play an important role … electronic means [will] be employed in solving problems in connection with the general development of the productive potential in the second half of the twentieth century."[166] Kubát soon ascended to a higher post, in charge of the

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[164] Kevin McDermott, *Communist Czechoslovakia, 1945-89: A Political and Social History*, European History in Perspective, New York: Palgrave Macmillan, 2015: 18.
[165] Bren, *The Greengrocer and His TV*, 207.
[166] Prof. Milan Kubát, CSc., "Electronics as an Integrating Factor of International Economic, Scientific and Technical Co-operation in Computer Engineering," *Kovoexport* 22, no. 2 (April 1976): 2.

entire country's electrotechnical industry by late 1979, from which he continued to powerfully advocate these views.

For example, in a February 1983 article plastered across the front page of *Hospodářské noviny* Kubát, by then the federal electronics minister, continued to insist that the country's problems in computing related not to the policy of centralized computing itself (and all related policies, like involvement in JSEP) but because "We have still not sufficiently accelerated technical progress or made it more effective."[167] The destination could not be doubted; the speed was insufficient. Even this rhetorical recognition, however, would prove insufficient to address the concerns of Czechoslovakia's computer technologists as they scrambled to integrate a younger generation and address the unfolding crisis of computing in the 1980s.

[167] Prof. Milan Kubát, CSc., "Rozpoznáme pouze výsledky" (We Will Recognize Only the Results), *Hospodářské noviny* (February 11, 1983): 1.

Chapter 2
Living by a Machine Code:
The Social Dimensions of Czechoslovak Computing

My spirit craves knowledge as my blood craves oxygen.
– Ivan M. Havel, *Modes of Cognition*, 1985

Though it had grown steadily and somewhat quietly over the previous decades, the community of computer users in Czechoslovakia reached a tipping point in 1985, when a new cohort of young people interested in home computers joined forces with tens of thousands of engineers, technicians, programmers and mathematicians, generally older working professionals who had more directly experienced the political upheavals of 1968.[168] This chapter will examine who these technologists were. Where did they come from? Did they share interests, values and aspirations? What is their significance to understanding the history of computing in Czechoslovakia, in East Central Europe, and in a global context? What complicates this examination is that historians cannot neatly divide a study of this kind along generational lines.[169] Hailing from a variety of careers and personal backgrounds, what organized technologists as a distinctive scarcity-rooted subculture in 1980s' Czechoslovakia was their

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[168] According to a Hungarian report, "In 1978 there were 55,730 people working in various areas of computer technology (52,797 in 1977) [in Czechoslovakia]. The ratio of those who had graduated from university or college was 21.9 percent in 1978 (20.6 percent in 1977)." "A számítógépes technológia helyzete Csehszlovákiában," 9.

[169] Clive Glaser, in a recent AHR roundtable on the subject of "generations" as a useful historical concept, argued that one might use the concept to "track particular age cohorts as they progress through time" or "analyze conflict or contestation *between* generations." This narrative of Czech and Slovak computerists takes neither approach. The object of this particular work is not to stalk a particular age cohort (say, just the youth of the 1980s) since it is focused on the computerist community of the country as a whole. Additionally, while this work does portray some contestation between younger and older computer technologists in regards to their attitudes and embrace of home computers, as opposed to mainframe and mini-computers, the evidence that this amounted to anything significant is scant, and the conditions of scarcity typically drove young and middle-aged computer technologists together physically, materially and ideologically. Taking into consideration Wang Zheng's observation that generational divides can be an analytically useful framework in the case of sudden ruptures or changes in a society, as for example "the sudden and massive onslaught of capitalist consumerism" in the recent history of the People's Republic of China, any future work that juxtaposes the computing culture of Czechs and Slovaks by analyzing the youth of the late twentieth as opposed to the early twenty-first centuries might be able usefully to compare the differences between a culture born in scarcity and one arising from abundance. Abosede George, Clive Glaser, Margaret D. Jacobs, et al., "AHR Conversation: Each Generation Writes Its Own History of Generations." *The American Historical Review* 123, no. 5 (2018): 1507, 1509.

relationship to a common object of interest, the artifact of the computer and its associated ecology of hardware peripherals and software.

Czech and Slovak technologists, both older and younger, formed a distinctive subculture of computer users that, while emerging from the older tradition of mechanical and electronics tinkering and production (especially radio amateurs, as we observed in the last chapter), shared a common interest in computing and the computer itself, and whose origins and values were linked to long-standing material conditions of scarcity which persisted throughout the late socialist period and after the revolution in the 1990s. The goal of this chapter is not merely to examine who Czech and Slovak technologists were, but also to identify their shared subcultural ethos, or the set of aspirations, values, prejudices and eccentricities that distinguished them from their neighbors, and that linked them across the political divisions of the Cold War world with their brethren in other countries. This will be a largely qualitative assessment informed by technologists' own memoirs and biographies, as well as personal interviews, archival documents from conferences and symposia, and contemporary reporting on club life and education.

This chapter lightly touches on the education, family and socioeconomic background of Czech and Slovak technologists who were active in this period, 1975-1995. There are some commonalities between users regarding their parents' professions and early childhood education; ultimately, however, Czech and Slovak technologists came from a diverse set of backgrounds that render our conclusions intriguing but provisional. However, interviews and two sets of survey data from hundreds of users in the 1980s and early 1990s can pinpoint certain geographic disparities, career trajectories and informal networks of exchange.[170] While much of the data on

[170] One of these survey sets comes from computer enthusiast publication *Mikrobáze*'s inaugural fall 1985 survey, which featured responses from 298 readers. The other survey was my compilation of a database of over 700 computer enthusiasts who advertised their possession of, or desire for, computer hardware, software (usually

Svazarm and SSM, the two pre-eminent organizations that ran youth computing activities in Czechoslovakia, was lost in the 2002 Prague flood (which inundated the Czech Statistical Office), period reporting in the popular technical press offers a glimpse into the role of state-sponsored computer propagation.

Nor was the social life of computer technologists limited by their youth. The two most important sites of computerist socialization in Czechoslovakia during the 1970s and 1980s, outside of work, were the two major annual conferences founded by Jozef Gruska, MFCS (Mathematical Foundations of Computer Science) and SOFSEM (Software Seminar) which catered to slightly different though largely overlapping technologist audiences. Fortunately, a rich repository of songs, poetry, photos and other archival documents from SOFSEM survived and these afford us a privileged view of a kind of technologist creativity we rarely see.

Hackers, cypher-punks, geeks and whiz kids—whatever the preferred nomenclature, a large body of English-language secondary scholarship already focuses on these mostly male, mostly young technophiles. It will be useful to contrast these findings against the Czechoslovak case, both to understand technologist subculture as an early harbinger and reflection of globalization, and to tease out important differences between Czechoslovak technologists—generally older, poorer, more skeptical of capital and hardware-oriented—and their Western relations. While gender is a crucial aspect of any such examination of the social dimensions of technologists, serious obstacles remain for researchers attempting to ascertain, for example, the narratives of the women (*operátorky*) who worked as card punch operators and did a great deal of the daily work of machine maintenance, program patching and other indispensable technical

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games), peripherals such as printers, programming manuals, and so forth between 1987 and 1997 in the *Redakční oznamovatel* and *Čtenářská burza* sections of the popular youth-oriented magazine *ABC Mladých Techníků a Přírodovědců* published by Mladá fronta.

labor. In interviews, they come down to us mostly as unremarkable go-betweens in the memories of male technologists.[171] Nevertheless, women's roles in this mostly male community are critical to a comprehensive understanding of technologist subculture and this chapter assesses them.

Thus, this chapter seeks to define the subculture of a little-studied and now mostly-vanished community of computer users, both in their own right and in the light of others very like them. The portrait of these users will appear sometimes familiar, and sometimes exotic, but certainly not in the literary tradition of innovators' hagiographies and thrilling cyber-crime reporting. For the most part these are, *pace* software historian Nathan Ensmenger, "the stories of merely average computer workers" which "seem at first glance mundane and inconsequential."[172] Yet it is important for historians to represent the narratives of ordinary people to the world. This is especially so in East Central Europe, where excessive focus on histories of innovation and 'firsts' typically eclipses the region, and fascination with cyber-criminality and hacking risks reifying long-standing and damaging prejudices about 'backwardness' in half the continent. Nathaniel Wood's observation of Polish cycling enthusiasts around the turn of the 20th century is equally applicable to Czech and Slovak computer hobbyists decades later: "Early adopters … participated more or less simultaneously in the age of speed but felt more acutely the contrasts of speed and sluggishness as they noted the gap between the modernity embodied in these swift new machines and the general lack of infrastructure that surrounded them."[173] These otherwise ordinary computer users were extraordinary by virtue of

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[171] In Petr Pospíšil's memory "in the Academy of Sciences they had a woman who worked as a typist and then punched the program out for me. Only users of the machine; they didn't fix it themselves." Petr Pospíšil, (Software consultant – Computing and Information Center, ČVÚT Praha), in discussion with the author. December 15, 2017.
[172] Ensmenger, *The Computer Boys Take Over*, 3.
[173] Nathaniel Wood, "'A Main Station at One's Front Door': Bicycles, Automobiles, and Early Adopters' Dreams of Personal Mobility in Poland, 1885-1939," in Anika Walke, Jan Musekamp and Nicole Svobodny, eds., *Migration and Mobility in the Modern Age: Refugees, Travelers, and Traffickers in Europe and Eurasia*, Bloomington: Indiana University Press, 2016: 57.

their circumstances. Their technological enthusiasm, perhaps pedestrian in Palo Alto, was preternatural in Pardubice. Under the straitened conditions of state socialism the computer hobby was more like a vocation, not simply a job or career but a consuming feeling of being called to perform a service or duty in the face of obstacles or without remuneration. A detailed, broad-spectrum analysis of the social dimensions of Czechoslovak computing will reveal much of value in the biographies of this community of technological practitioners.

Microelectronics Arrive: Crisis and Opportunity Shape the Computing Scene

By the mid-1980s, Czech and Slovak youth interest in computing was red hot. Since the late 1970s, young people kept abreast of new developments in the field by reading the domestic popular and professional technical press. *Amatérské Radio*, for example, switched their 'News from the GDR' section to 'News from Texas' in 1978 to more closely follow microelectronics coming out of Texas Instruments and Fort Worth-based Tandy (which produced the TRS-80 microcomputer starting in 1977).[174] Meanwhile *Věda a Technika Mladeži*, *Technický Magazín*, and *ABC Mladých Techníků a Přírodovědců* all ran articles extolling the virtues of powerful, new desktop computers like the Hewlett Packard 9845 and invited their readers to imagine a heady future—the "microprocessor era" when computers might do more than crunch numbers and display simple games on a television set.[175]

Circa 1985, much of Czechoslovakia's technical intelligentsia, industry and government decisionmakers were primed to embrace computing wholesale. Government ministries had new

[174] Jiří Mrázek, "Trumfové eso z Texasu" (Top Aces from Texas), *Amatérské Radio* 26, no. 1 (1977): 10-11.
[175] "Mít tak doma Einsteina!" (Have Einstein at Home!), *Technický Magazín* 21, no. 3 (1978): 39-41; "Počítače se zmenšují" (Computers are Shrinking), *ABC Mladých Techníků a Přírodovědců* 23, no. 3 (1978): 2.

jobs in abundance as they adopted computers at an exponential rate—until 1983 ministries possessed fewer than 2,000 digital electronic computers; five years later the number stood at almost 16,000.[176] Working professionals and young hobbyists with career aspirations were thus bound closely to state employment in one variation or another for their livelihoods until 1989. The first halting steps toward domestic microcomputer production had finally begun with the Czech-made IQ 151 and the Slovak-made PMD 85 in initial batch production during 1984 before the government began distributing these 8-bit machines to dozens of schools in 1985. Older machines like the SAPI-1, designed in 1980 by the entrepreneurial brothers Eduard and Tomáš Smutný, could already be found in some Slovak schools, such as in Pezinok, running a pirated version of Gary Kildall's CP/M on East German (U880) and Czechoslovak (MHB8080A) clones of the Intel 8080 microprocessor. Such underpowered machines were incapable of offering more than "learning exercises … for teaching basic programming and computer systems." Nevertheless, Bratislava newspapers reported, "the interest in this subject is extraordinary."[177]

Distribution of and access to computers was still highly uneven in the late socialist period however. Mapping more than 700 Czech and Slovak computer users in the late 1980s and early 1990s affirms some pre-existing suspicions. Access to computers was most common in the more developed urban centers, such as Prague, Brno, Bratislava and Plzeň, and per capita ownership appears to have been more than twice as high in the more industrially developed Czech lands as compared to more rural Slovakia. A couple interesting trends do emerge from the data. One is the unusual prevalence of computer ownership in rural areas and small towns clustered along the Czech border with Poland and the GDR, which likely indicates cross-border smuggling as most

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[176] Český Statistický Úřad, *Stav a Využití Výpočetní Techniky v roce 1978 v ČSR*, "využití produktivního času počítačů a provedené práce pro cizí org. za rok 1978 - číslicové počítače celkem," 62. Data from 1979-1988 originates from this same series of statistical yearbooks.

[177] "Nadšení mládeže pro práci na počítači" (Youth Enthusiasm for Computing), *Technické Noviny* 32, no. 22, Bratislava (1984): 1.

of these were Western computers such as the Commodore 64 and Atari 800 XL, especially from Poland's relatively more open economy.[178]

An additional surprise is just how widely distributed home computers appear to have been during the late socialist period. While there are mysterious regions of low computer density, such as in Vysočina and Pardubice, in general terms a map of computer users circa 1989 may be evenly superimposed on a map of the country's population with little outstanding difference.[179] While this does not contradict Czech and Slovak memories of computer scarcity at that time, it does suggest that ordinary users would likely have been able to access a home computer of some kind in their city or town, though it may have involved extra frustration and reliance on local clubs, schools, extended family or mutual acquaintances. Since these maps record the distribution of privately owned home computers, they over-represent imported machines and do not adequately account for other hardware access, such as the Czechoslovak computers the government distributed to schools, as previously seen.

Finally, in addition to broad-based hardware access the government had taken steps to formalize programming education in schools and clubs. Formerly this had been the province of DIYers like the young programmers and SOFSEM members Miroslav Bartošek and Zlatuška, who had received ad hoc instruction from older colleagues, the occasional chance to study

[178] "Michal Vít, Bedřichov 75, 543 51 Špindlerův Mlýn – výmění programy a hry na Atari 800 XL. Odepíše všem, kdo zašlou seznam." *ABC Mladých Techníků a Přírodovědců* 32, no. 12 (1987); "Jan Matysík, Křinická 192, 550 01 Broumov – v. Hry na Commodore 64/n. Joystick Match-Pro (autofire), mikrospínače za 200 Kčs." *ABC Mladých Techníků a Přírodovědců* 36, no. 13 (1991).

[179] *Concentration of Czech and Slovak Computer Users* [map], scale not given. 1987-1993. Generated by Robert P. Jameson using "Google Maps". Available publicly from: https://drive.google.com/open?id=1isVvIcEFXUwt0JIw9s-P5Koy2_s&usp=sharing. *See also*: *Concentration of Czech Computer Users, 1993-1997* [map], scale not given. 1993-1997. Generated by Robert P. Jameson using "Google Maps". Available publicly from: https://drive.google.com/open?id=1ddjrmkaqowbGJtHGm5-niFbO67nNRw1t&usp=sharing. Data sets were split by author due to the 1993 Velvet Divorce and the rapid decline of *ABC*'s distribution in newly independent Slovakia. See: Appendix E, [Figure 26] and [Figure 27].

abroad or whatever dog-eared manual in Russian or English they might find.[180] This did not guarantee that the quality of the instruction would be appropriately high. Burgeoning programmers continued to fall back on their own resources.

Mathematician Martin Mareš recalled that his was one of the few early schools in the middle 1980s with an actual computer lab—though even there they did not teach programming. "We had four to eight lessons in programming as part of our math class," Mareš said "and they had to invite some lady working with some big machine at some company [in to teach], but she was incompetent." One could give credence to the truth of Mareš' memory here: the instructor might have been poorly prepared to teach his class, since the government training program for existing school teachers was never successfully implemented at scale, and a professional computer worker brought in as a guest to instruct a classroom of teenagers without pedagogical training would likely have struggled to communicate effectively. However, Mareš' description of the "incompetent" woman also closely fits to stereotypes of women's inherent insuitability for computer work bruited about in an increasingly masculine computer culture. In any case, Mareš ended up explaining programming in Basic on the new IQ 151s to his own classmates—at 14 years old.[181]

Still, it was an exciting time and the government was finally making major resource commitments to foster youth interest in the community of computer technologists. As discussed in chapter one, the government had long provided substantial support to the emerging profession of computer work throughout the long 1970s, particularly at and through the mesocosmic level of research institutions, large enterprises such as Tesla, and university faculties of mathematics

[180] Bartošek in discussion with the author; Zlatuška in discussion with the author.
[181] Mgr. Martin Mareš, Ph.D., (Assistant Professor – Department of Applied Mathematics, Charles University), in discussion with the author. November 10, 2017, and June 18, 2018.

and physics. Significant support to youth hobbyism and provision of computers to SSM, DDM, Svazarm and so-called “stations of young technicians” was a novel phenomenon of the 1980s. Plans to develop computer centers administered largely by the clubs and other such social organizations as a solution to the command economy’s inability to supply the consumer market had been in the works for years. A front-page editorial in *Sdělovací Technika* displayed the government’s 1981 vision in meticulous detail:

> The rapid entrance of electronics on the scene in all branches of our industry is possible only if schools of all types contribute effectively to it. In the process of getting broad technical circles of the public acquainted with the ways in which microelectronic circuits can be utilized, we expect a good deal of work to be done by key social organizations, such as, for example, the ČSVTS (Czechoslovak Scientific-Technical Society) or Svazarm (League for Cooperation with the Armed Forces). Technical literature remains somewhat in the background for the time being, even though that is precisely what must play one of the key roles in the expected entrance of microelectronics on the scene. Constant propaganda and popularization must create successive pressure on all components of the economic mechanism in our republic. It would be desirable to see to it that national and professional pride be increased in an appropriate form, and that critical admiration of foreign achievements be balanced by efforts to get our technicians acquainted with successful domestic constructions.[182]

Soon, a great deal of this previously envisioned infrastructure was finally in place. The year after the editorial in *Sdělovací Technika*, for example, one of the primary providers of computer centers, the ČSVTS (Czechoslovak Scientific and Technical Society), had only recently established its second nationwide location, in Bratislava. However, 40 such locations would eventually operate around the country, each of them oriented to the goal of “the preparation and instruction of users of micro-electronic systems in order to train specialists in this field … The training is conducted in such a fashion that the students are able to apply in practical exercises what they’ve learned at the centers.”[183]

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[182] “Chceme Mikroprocesor?” (Do We Want a Microprocessor?), *Sdělovací Technika* 29, no. 12 (December 12, 1981): 441.
[183] *Pravda* (January 28, 1982).

ČSVTS also played a vital role in obtaining permissions for its members' work-related foreign travel. According to Bartošek, organizations like ČSVTS were "helpful for doing other things. For example, if you want to organize a trip somewhere, it was a greater chance that you will succeed going abroad if you were covered by this organization. It's not just that some people wanted to go there, yeah? It was, at least in my [memories] … that these organizations were cover for doing things," you already wanted to do.[184] The state-sponsored organizations and clubs might not have enjoyed genuine popularity, but they were recognized and widely used for their instrumental value. As a young engineer at INORGA, Studenka had exploited the openness of the Prague Spring period to travel with his brother to Switzerland and West Germany in early 1969.[185] Although the conservative crackdown, including a gradual rollback of freedoms like travel to the West, had already begun Studenka took advantage of the rapidly narrowing window of permission.[186] It was his last chance to travel for almost two decades, until ČSVTS afforded him the ability to attend a conference in Austria in 1984 on automatic control systems used in planning housing developments.[187]

Other social clubs besides ČSVTS sprang into action at this time. Toward the end of 1985, Josef Kroupa, the secretary of Svazarm's 602nd Z.O. in Prague, which focused on

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[184] Bartošek in discussion with the author.
[185] A brief introduction to INORGA: "The INORGA personnel are responsible for the development of software and for the implementation of programs. They are little involved with hardware, although an individual factory could not purchase a computer without the approval of the Ministry, and that approval would not be likely to be granted until INORGA had been consulted. INORGA is also responsible for the coordination of developmental efforts. If, for example, a particular company developed a computerized materials-requirement-planning system, it would be up to INORGA to know which other companies, if any, with similar requirements could use it." Jan Kroužek, "INORGA—Ústav průmyslového řízení automatizace v Praze" (INORGA—The Institute of Industrial Management [of] Automation in Prague), *Automatizace* 34, no. 12 (1980): 546.
[186] Although the Soviet-led invasion of Czechoslovakia crushed the Prague Spring reform movement in August 1968, the re-imposition of controls on movement, purges of the Communist Party of Czechoslovakia membership and other aspects of the normalization era retrenchment took time to implement. Dubček's position as First Secretary of the party technically did not change until April 17th of the following year, although of course his effective power was greatly diminished; the mass purge of party members, expelling one-third, took place under Husák only in 1970. Otto Ulc, "Czechoslovakia," in Teresa Rakowska-Harmstone and Andrew Gyorgy, eds., *Communism in Eastern Europe*, Bloomington, Indiana: Indiana University Press, 1981: 113.
[187] Studenka in discussion with the author.

electronics and programming, promoted the club's popular courses on microcomputers, begun that year, in a front-page interview in *Amatérské Radio*. Svazarm had won the funding to expand its courses to an additional 3,500 applicants in the Prague area alone for 1986. At a high price of 592 crowns—approximately a fifth of an average worker's total monthly income in 1985—these courses were expensive, yet all indications (such as Kroupa's warning that late applications would cost even more, 796 crowns) are that they filled up quickly with enthusiastic pupils.[188]

Kroupa and Svazarm also worked hand-in-hand with *Amatérské Radio* to establish a brand new publication, *Mikrobáze*, which would serve as a dedicated, nationwide flagship for the interests of the computerist community. Up until 1985, *Amatérské Radio* had done the job itself, first starting to pay serious attention to microelectronics and digital technology in 1978. Since 1952, Svazarm had published *Amatérské Rádio* nationwide as a magazine for those engaged in electronics and radio engineering. It contained brief news items, articles on new circuit designs, interviews and theoretical problems in electronics. As Christophe Lecuyer conclusively demonstrated in his study of Silicon Valley in the early-to-mid 20th century, the path from amateur radio hobbyism to electronics and computing enthusiasm was short and well-worn.[189] Since thousands of Czechs and Slovaks were clamoring for additional access to, and education in, computing it was clear that *Amatérské Radio* could no longer adequately service their interests, which also could not be fulfilled by other popular publications like *ABC*, which catered to a younger audience. The answer to the problem in the fall of 1985 would be a brand new

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[188] "Náš interview s Josefem Kroupou" (Our Interview with Josef Kroupa), *Amatérské Radio* 34, no. 10 (1985): 361-362; Czech Statistical Office, "Gross Average Monthly Wage," accessible from: https://www.czso.cz/csu/czso/2-eng_mzdy_1985_.

[189] Lécuyer, *Making Silicon Valley*, 15-17, 295.

narrow-interest publication, *Mikrobáze*, which Svazarm subsidized and computer enthusiasts among the editors of *Amatérské Radio* staffed.[190]

The name of the magazine, *Mikrobáze*, is an English-Czech portmanteau that implies a database of information about ‘microcomputing,’ which was the term many Czechs still used into the 1980s to describe early personal computers (sometimes also called ‘home computers’ *domácí počítače* or ‘self-actualized’ *samočinné* computers—a contrast with dumb mainframe terminals). The earliest published issues tended to run much longer than 35 pages, occasionally as long as 85 pages in the June 1986 issue, though a range of 50-65 pages an issue was more common. Moreover, the magazine was only published irregularly, on a schedule that was not quite quarterly, for the first two years of its life, 1985-1987. Only in January 1988 did a monthly publication schedule begin. *Mikrobáze* had a nearly identical format and was in many ways a natural outgrowth of the *Amatérské Rádio* readership, with additional funding and sponsorship from Kroupa’s Svazarm, the Union for Cooperation with the Army.

Bound by Binary:
Social Origins, Education and Community Ethos

Readers of *Mikrobáze* were just one facet of the broader computer technologist community in Czechoslovakia, which formed a motley crew. They were often precocious and young, like Mareš was when he took over his fellow pupils’ programming instruction. They were programmers, service technicians, mathematicians, educators and hobbyists; what bound them together was the artifact of the computer and its related ecology of software and peripherals in a time and place were computing was not yet a dominant force in everyday life. Because the

[190] “Redakce časopisu Amatérské radio jako iniciátor Mikrobáze a 602. ZO Svazarmu v Praze 6 jako realizátor …” “Slovo k náhodným čtenářům.” *Mikrobáze* 5 (January - March, 1987): 55.

artifact itself had still not achieved rhetorical "closure," a term derived from sociologists of technology Trevor Pinch and Wiebe Bijker to refer to the socially constructed agreement on the form, utility and vocabulary of a technological artifact.[191] While governments, businesses and families struggled to make sense of the personal computer's affordances and dangers, the uncertainty also made the technology socially open, at least to a degree—almost anyone (any man, at least) could convert to the high church of computing. However, Eden Medina offers a useful definition of this category of workers as generally "white-collar professionals with technical expertise, such as cyberneticians, engineers, computer scientists, operations research scientists, statisticians, and, at times, industrial designers."[192]

Due to the knock-on effects of the initial suppression of cybernetics in the Soviet bloc and the correspondingly delayed introduction of formal computer science courses and education in Czechoslovak universities, the category of computer work was unusually fluid. Prior to the mid-1980s, the clubs—local branches of state-sponsored organizations like Svazarm or SSM—acted as a kind of underground university system for technical talent. Even in the 1960s and 1970s, Pajas recalled:

> Cybernetics was not allowed, it was philosophically not considered the right way of being involved in [socialist society] … so these were clandestine to some extent or very, very limited to those people, like those who organized it, who had a good kind of background in the political situation in the country. They would not be able to do it completely freely. There were of course some courses on computer use in these clubs of Pioneers, or wherever they existed, but it was never on a high level as far as I know.[193]

Pajas earned hard currency in the gray economy by reporting on physics and mathematics to the Max Planck Institute. He had to make ends meet, and was too occupied with everyday life and

[191] For instance, "home video" was an emerging mass market concept in the 1980s that was similarly "open" rhetorically—a welter of incompatible systems such as Betamax, VHS, laser disc and CEDs (capacitance electronic discs) competed against one another while governments and Hollywood studios debated how to regulate and profit from the new technology. Pinch and Bijker, "The Social Construction of Facts and Artifacts," 44.
[192] Medina, *Cybernetic Revolutionaries*, 6.
[193] Pajas in discussion with the author.

the care of his family to become involved in much of the social life other computer technologists partook of in the clubs. His punishment for referring to the Soviet invasion of Czechoslovakia as an ‘occupation’ was typically harsh. The government barred him from employment in physics for life and tossed him into the Institute of Transportation, which re-trained and employed him as a programmer. There was no opportunity for formal education in computer sciences for Pajas or many others like him.[194]

The porous professional boundaries of the computer technologist community admitted talented individuals from completely unrelated studies and nominally unsuitable backgrounds. While physicists like Pajas made sensible computerists, a philosopher like Ivan Chvatík or a sociologist and musician like Trojan were not obviously well-fitted to the field. In fact, Trojan was so determined to pursue a Ph.D. in the humanities that he had to be virtually kicked into computing twice. First in 1969, after he organized a student strike to protest the Soviet invasion of ’68, he was ejected from his Ph.D. in sociology and sent to the Research Institute of Mathematical Machines (VÚMS). Second, after he signed Charter 77, the Communists blacklisted him from finishing a Ph.D. in philosophy. He found joy in computing, in the challenge for instance of designing alternative ways to use the lookaside buffer in IBM virtual memories without infringing on jealously guarded patents.[195] At age 72, he happily pronounced, “I still don’t know what I am!”[196] While this was something several individuals noted about their pasts during interviews, many concluded that it was part of the larger phenomenon of labor in the command economy of Czechoslovak state socialism. Sometimes due to punishment, but even

[194] Ibid.
[195] Trojan in discussion with the author.
[196] Ibid.

more often related to contingency and connections, workers frequently found themselves in positions they were ill-trained or under-educated for, and simply had to learn on the job.

This was especially the case in computing, where there was a desperate shortage of talented labor and the earlier suppression of cybernetics and post-’68 crackdown on political dissent had destroyed the flow of talented university graduates that Western economies relied on to fill the ranks of engineering careers.[197] Although the Soviet anti-cybernetics campaign had ended during Khrushchev’s political thaw in the late 1950s, the effects on Czechoslovakia were prolonged due to the cautious conservatism of political elites under the leadership of hardliner Antonín Novotný; de-Stalinization in Czechoslovakia would not occur until 1963. Correspondingly the impact of the Soviet choice to, in Gerovitch’s words, place “emphasis on the narrow technical functions of computing and information theory and [ignore] any potential conceptual innovations,” acted as a drag on Czechoslovak computing for years longer than in the USSR and was a factor in lead scientist Svoboda’s emigration to the United States in 1964.[198] An official report commissioned by the Ministry of Transport in 1972 outlined the key labor problems in the computing field at this period in the early 1970s:

> The users are often not ready for computer installation; this applies particularly to the readiness of users for the installations of devices for data collection and transfer. In order to use the computers efficiently, attention has to be given to decreasing the unproductive time, particularly for the domestic computers, and to the technical servicing of these computers. The training of computer experts is still not satisfactory. The rather extensive fluctuation in the amount of workers of all related professions is another drawback.[199]

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[197] “Cybernetics was not allowed … so these [computing organizations or clubs in the 1960s and 1970s] were clandestine to some extent or very very limited to those people, like those who organized it, who had a good kind of background in the political situation in the country. They would not be able to do it completely freely. There were of course some courses on computer use in these clubs of Pioneers, or wherever they existed, but it was never on a high level as far as I know, or had been confronted with.” Pajas in discussion with the author.

[198] Slava Gerovitch, “‘Russian Scandals’: Soviet Readings of American Cybernetics in the Early Years of the Cold War,” *The Russian Review* 60, no. 4 (October 2001): 566-567.

[199] “Využití výpočetní techniky v Československu v roce 1972,” 2.

While Ensmenger correctly identifies a shortage of talented programmers as a perennial complaint in American industry as well, the seeming parallel to the situation in Czechoslovakia does not hold up.[200] In the United States, Japan and the other earliest large-scale adopters of digital technology, market-driven demand simply grew too fast for the supply of programmers. These workers could not be churned out in the quantity needed with any reliable quality, given the highly individualistic and creative nature of the work and the apprentice-master system it relied on.

Even in the wealthiest and most industrially developed economies of the CMEA bloc, such as Czechoslovakia and East Germany, whose situations more closely approximated less computer-saturated Western economies such as Spain, Finland and Greece, demand was far lower. This was in part due to resistance to computer implementation among workers and on-site management, who correctly surmised that 'computerization' of manufacturing and inventory meant a tighter leash and higher quotas in the command economy. This was euphemistically referred to by central planners as "stubborn retention of traditional production methods by Czechoslovak user industries," but it is difficult to fault the workers when the same report estimated that "application of electronics in the Czechoslovakian economy [by 1990] will release about 300,000 workers for other jobs …"[201]

There were other endemic structural problems. In Czechoslovakia, for instance, no education pipeline existed, the work was poorly remunerated, suffered low prestige, was subject to inconsistent levels of funding and attention to research and development projects, and the

[200] Ensmenger, *The Computer Boys Take Over*, 21.
[201] "CSSR-Manager werden endlich die Datenverarbeitung vorantreiben" (CSSR Managers Will Finally Push Data Processing), *Computerwoche*, Munich, July 29, 1983, 44.

apprentice-master system of training was too frequently disrupted by emigration.[202] The flight of Svoboda in 1964 to the United States, along with many of his prize students, effectively decapitated computing in Czechoslovakia for nearly a decade as those who knew him, like Chvatík and Trojan, attested.[203]

The disruption that such emigration and political repression posed to training and education was especially severe in the field of programming. Rather than the kind of technical training Communist policymakers envisioned, an assembly line of talent (at least in terms of the desired speed, quantity and orderliness of new skilled technician training), programming skills were transferred as a kind of craft knowledge within the apprentice-master system, what H.M. Collins and others refer to as the 'enculturational model'.[204] There were occasional exceptions, like Mareš who, at the age of nine, acquired a machine code manual from his parents' colleagues at Český Rozhlas and commenced two years of intense, solitary study before he produced his first program.[205] Most budding programmers learned from others, however.

These close relationships between mentors and apprentices often became emotionally intense and lifelong. Petr Pospišíl recalled one particularly serious disagreement with his instructor, Jiří Raichl from VÚMS (Výzkumný Ústav Matematických Strojů), a man so dedicated to his craft that he zigzagged up the Mathematics Faculty's flights of stairs every day because it was more algorithmically efficient than proceeding in a straight line. As he related the story, Pospišíl had spent months working on paper with Raichl on matrix, or Gaussian,

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[202] Durnová, "Sovietization of Czechoslovakian Computing," 27-28.
[203] Trojan in discussion with the author; Ing. Ivan Chvatík, Dr.H.C., (Center for Theoretical Studies), in discussion with the author, June 7, 2018.
[204] H.M. Collins, "Expert Systems and the Science of Knowledge," in: Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, MA: The MIT Press, 1994: 331
[205] Mareš in discussion with the author.

elimination problems and attempted to create a program in machine code that would speed the solution. However, he was still an inexperienced programmer, and erroneously began his binary language program with ‘1’ instead of ‘0’—a single mistake which sent them back to square one with null results. Raichl was furious. He dragged him before a university commission demanding they expel Pospišíl. He defended himself, arguing that his program would have worked but for its single input error. His apprenticeship with Raichl clearly at an end, and with no other options, Pospišíl escaped expulsion but chose to leave the program prematurely.[206]

Solving for Scarcity: Spontaneous Network Formation and Homebrew Innovation

In the absence of a competent, meritocratic and state-sponsored system of education, training and employment, Czechs and Slovaks created powerful informal networks that supplemented the formal rules of everyday life under state socialism.[207] These consisted of essentially three categories. The first and most important were the personal connections formed between individuals inside Czechoslovakia. These might have been family members, workplace colleagues, roommates at university or otherwise trusted friends. Pospišíl, who in the 1980s worked in weather modeling at the Institute of Atmospheric Physics of the Czech Academy of Sciences, easily recalled more than thirty years later the names of his two trusted dealers of Texas Instruments digital calculators—essential to his work. “Mrázek, a science popularizer over

[206] Pospišíl in discussion with the author.

[207] For more on these educational and economic “pipelines” that helped produce regional clusters of industry and innovation in computers, see: AnnaLee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Cambridge, Massachusetts: Harvard University Press, 1994. Successful cases, such as Silicon Valley, the Route 128 corridor in New England and the mini-computer and super-computer industry in Minnesota, shared attributes: “academic ‘steeples of excellence’; corporate-funded interdisciplinary centers in strategic engineering specialties; a business incubator … a technology park,” and strong ties to institutional government support, especially Cold War defense contracts. Stuart W. Leslie, “Regional Disadvantage: Replicating Silicon Valley in New York’s Capital Region,” *Technology and Culture* 42, no. 2 (2001): 238.

at the Geophysical Institute, was a dealer of Texas Instruments calculators. He had a TI with 200 programmable steps, magnetic cards—we made comparisons with them."[208] Jan Kašpar, a close friend of Pospišíl's and today a professor of mathematics, also slung Texas Instruments' wares to calculator-starved technicians around the country as a side business to his academic employment. He had greater latitude to travel under socialism, and so he picked up small shipments from friendly colleagues at conferences in Japan and the United States.[209] Unlicensed and unofficial side hustles such as this were both an illegal (though typically difficult for the state to discover, arrest and prosecute, if the hustler was careful) and increasingly common piece of the informal economy under late socialism.

These commercial contacts also proved invaluable for young people in the 1980s. It was the primary distribution network for software, a fact so widely recognized in society that by the end of the decade Kubát could baldly assert that there was no software shortage in Czechoslovakia—after all, it was "lying on the street; you just have to pick it up."[210] The reality was a little more difficult for technologist users. Computers were a precious possession, expensive and risky to obtain. This was true both legally, since many computers were smuggled across the border to avoid paying steep import taxes (which could amount to 7,200 crowns, or two months' salary in 1987), and financially, since it was possible to commit scarce hard currency to a computer like the Sord M5 or Sam Coupé without realizing it was a technological dead end with little or no software support.[211] This last scenario was so common among Czechs and Slovaks that journalist Jiří Franěk warned against their consumer ignorance when visiting

[208] Pospišíl in discussion with the author; Kašpar in discussion with the author.
[209] Ibid.
[210] Jaroslav Švelch, "Building a Lightning-Fast Sneakernet: Infant Distribution of Home Computer Software in Communist-Era Czechoslovakia," a talk delivered at computing history workshop "Hardwired at Heart: The Everyday and Extraordinary in 20th Century Czechoslovak Computing," in Prague, May 16, 2018.
[211] Švelch, *Gaming the Iron Curtain*, 48-49.

Western shops specifically in his advice column "How (Not) to Buy a Computer."[212] For many Czechs and Slovaks, their computers could also become virtually impossible to maintain properly for lack of spare parts and Czech-language hardware and software manuals.

It was not unusual in the late 1980s, according to Michal Beneš, a secondary school teacher in Rakovník, to travel an hour by bus into Prague, the nearest sizable gray market of music, films and software, to get computer-related materials.[213] Pajas, who was *persona non grata* with the Communist regime, found himself largely isolated from the friends and acquaintances that usually constituted informal networks of mutual technological interest and exchange. "I did not have directly these kinds of relationships because I was a person to some extent persecuted and considered to be outside of society. So to have many friends was dangerous <u>to the friends</u>."[214] As a result, he had to resort to Tuzex, the government's official import/export store, and its wildly inflated prices. The ZX Spectrum he was able to eventually purchase for his sons in 1984 cost "something like 3,000 crowns; 30, 40, 50,000 crowns today," and approximately twice his entire monthly salary at Prague's Institute for Transportation.[215] Since the ZX Spectrum famously retailed for £99 in the United Kingdom starting in June of 1983, Pajas was paying at least ten times the normal retail price so his sons could experience their first home computer.[216]

Alongside the commercial interior networks of informal exchange were the commercial exterior networks. These formed a kind of lifeline of technological materials from abroad into Czechoslovakia through legal imports and illegal smuggling. Legally imported machines could

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[212] Jiří Franěk, "Jak si nekoupit počítač" (How [Not] to Buy a Computer), *Počítačové Hry* 1, (January 1989): 3.
[213] Michal Beneš, (Teacher - Střední Průmyslová Škola Emila Kolbena, Rakovník), in discussion with the author. March 8, 2018.
[214] Emphasis original. Pajas in discussion with the author.
[215] Ibid.
[216] "Spectrum prices are slashed," *Sinclair User* no. 15, (June 1983), 13.

be accessed at the closed import/export Tuzex shops in major cities like Prague, but demanded exorbitant amounts of hard currency, often several months to a year's worth of an average worker's salary in crowns. Enthusiasts or their relatives might also legally purchase computers in foreign shops, such as in Munich or London, declare them to customs upon return and pay steep excise taxes. Illegal smuggling, particularly from more open markets in state socialist Poland and Hungary, was common for microcomputers in the 1980s, since they could be disassembled and hidden in luggage or within an automobile; smuggling software on tape cassettes was even easier. Demand for imported software at that time—especially games, but also text editors, operating systems like CP/M, and spreadsheet programs like Lotus 1-2-3—is difficult to overstate.

Informal international distribution networks were so well-organized toward the end of the Cold War that it might take less than two weeks for brand new software of Western origin to be smuggled into the country. Smugglers usually skirted the Iron Curtain via the northern route in Poland or the southern route in Yugoslavia, before passing their wares on to talented Czech and Slovak intermediaries who cracked the software and sometimes added rough translations from English to Czech for their end users.[217] Software then found its way to marts in all the major cities of Czechoslovakia, and clubs in rural areas centered on the Atari 800 or ZX Spectrum pooled their funds and dispatched dedicated shoppers to the metropolis with procurement lists drawn up by popular vote.[218] Such software was, however, usually missing any accompanying manual and most often in English, which led young users right back into the arms of formal exchange networks—the state-sponsored organizations like Svazarm and SSM, where they had

[217] Švelch, "Building a Lightning-Fast Sneakernet."
[218] Karel Buďa, (Private Collector – IBM Brno), in discussion with the author. March 29, 2018.

no qualms about asking the government to provide them with Czech-language manuals for stolen software.[219]

Smuggling could also be a personal endeavor involving no intermediaries whatsoever. Indeed the feeling of "getting one over" on the government added to the satisfaction of personal computer ownership. In the mid-1980s, the Paris-based Coordinating Committee on Export Controls embargoed 16-bit processors like those in the Atari ST from Soviet-bloc countries. As Beneš recalled: "Because these computers, as I [heard] … maybe it's not true, but I heard that these computers were too powerful, and you could compute the ballistic curve for missiles," and so even 8-bit home computers like the Commodore 64 were illegal to sell to the Soviet bloc until after 1985.[220] Of course, Czechs and Slovaks like their counterparts throughout East Central Europe had worked around this problem for decades. Lewis H. Young, the former editor-in-chief of *Business Week* interviewed Soviet bloc technicians in the 1960s:

> The embargo clearly has hurt Eastern progress and it is the cause of irritation to many Eastern engineers. In their zeal for trade, however, some Western countries are fudging the embargo rules. Thus, in the German Democratic Republic, for example, a microwave engineer says he gets Western high-frequency instruments even though they are on the embargo list. 'A Japanese company will leave one part of the instrument off, a part that we can easily replace, so that it meets the embargo rules. When we receive the instrument, we add in the part and so we have instruments that can measure up to 2 gigahertz, even though anything above 300 megahertz is embargoed.' Fey, at the Institute for Telecommunications [in Prague], claims he has studied every type of integrated circuit built in the U.S. 'We get them around the corner, not straight,' he explains with a sly smile.[221]

Circumventing any and every control designed to keep one away from the latest technology, or useful tools, held a universal appeal to Czech and Slovak technologists. In this case, it redounded to the benefit of the Czechoslovak government. Nevertheless, it also frequently backfired as

[219] *Mikrobáze* 2 (February - June, 1986): 8. Refer to question L. "U kolika procent programů, které mám, mi citelně chybí manuál pro výuku jejich ovládání."
[220] Beneš in discussion with the author.
[221] Young, "Electronics in East Europe," 164.

technologists took matters into their own hands in ways that damaged the government's ability to implement computing in society and negotiate the digital transition.

As observed earlier, the total number of available computers in Czechoslovakia continued to rise, and entered a period of steep geometric growth beginning in the middle 1980s. However, this is misleading and does not adequately reflect computers' economy of use during that time. Limited domestic production coupled with scarce hard currency for imports meant that computer technologists had to adopt narrow horizons—an emphasis on the short term future and working within the margins of the adjacent possible; what could be accomplished tomorrow, not next month. To explain what it was like to get your work done on an everyday basis with older machines that ran poorly and broke down frequently, Pospišíl recounted a newspaper story from his time spent studying in the Soviet Union. "When in Russia I read their newspapers, and I remember the director of an agricultural cooperative, they wrote, we have 30 combine harvesters, but only 10 work. From the other 20, we take parts."[222] This was an enduring scarcity that directed Czechs, Slovaks and their computerist counterparts throughout East Central Europe in the direction of tinkering, DIY culture and maintenance. In a socialist society without an abundance to distribute and a consumer society with very little to consume, ordinary computer enthusiasts were oriented to practical, short-term goals and types of work, an experience that has a great deal in common with the everyday use of technologies in peripheral societies around the world.

Pospišíl's work experience provides an example of this kind of arbitraging labor, always running to stay one step ahead of break downs and shortage. His office at the Czech Academy of Sciences had only two computers, a relatively good German EC-1040 and a "terrible" Soviet

[222] Pospišíl in discussion with the author.

EC-1045. "We had terminals, but every row I wrote I used the save button because every moment the machine could crash. They had a problem with the disks, with the tapes," and it was common to cannibalize parts from brand new machines to keep these older units running because support and installation (from Národní Organizace Technické Obsluhy/NOTO and Kancelářské stroje) could take months to arrive, if ever.[223] According to a report in Bratislava's *Pravda* in 1983, "last year only 40 percent of all newly purchased computers were installed within 3 months after delivery and more than 100 computers were stored for more than 6 months. More than 1 billion [crowns] of investments were thus tied up in idle computers last year."[224]

Technologists could not afford to sit on their hands and bide their time, because they still had deadlines to meet and projects they were interested in completing. But the long-term result of this tinkering based on short-term horizons was damaging to the speed of computer adoption and efficacy in Czechoslovakia. Four Slovak engineers aired their dissatisfaction with this system publicly in a 1983 editorial: "The speed and completeness of spare parts deliveries from the service organizations of NOTO … are unsatisfactory, and accordingly it is impossible to repair defects and carry on technical maintenance to the required extent and on time. For this reason, two-thirds of computer system users perform their own maintenance, even though this requires much more manpower and spare parts."[225] This situation did not endear technologists and state policymakers to one another. Government officials argued against spending precious hard currency on expensive Western imports as existing computers on the books went under-

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[223] Ibid.
[224] "Nečinné počítače" (Idle Computers), *Pravda* (November 7, 1983), Bratislava, 2.
[225] Adam Lascik, Jozef Sojka, Juraj Ondris, and Ivan Schnapp, "Současné problémy ve využití počítačů a simulačních technik" (Current Problems in Utilization of Computers and Simulation Techniques), *Ekonomický Časopis*, no. 12, (1983), 1066.

utilized, but technologists saw new machines rotting away in crates from lack of support and software.[226] They felt they ought to scavenge what they could from the government's mess.

Forms of scavenging remained an essential part of computer technologist culture in this period, whether filching parts from unused computers or hunting down a bargain. Reconceptualizing technological diffusion or transfer in this way, as Edgerton has suggested, by narrating computer users as active agents involved in chasing down machines, altering hardware and evading border controls helps revise historians' understanding of what is often presumed to be a passive, uninteresting or natural process of innovation flowing down a gradient from wealthier countries to poorer ones.[227] In this period of strict export controls, Slovak computer scientist Gruska remembered spending one trip in Hamburg bouncing from shop to shop until he found one with a fraternal Polish technician willing to sell him an Atari of forbidden power. Gruska brought it back into the country by dismantling the machine, hiding the 16-bit microprocessor in his hand luggage, and sending his wife, who was toting the monitor, printer and all other materials (not embargoed), out of Germany on a separate train to a different destination.[228]

Most Czechs and Slovaks quite literally could not afford such actions. The government usually did not permit them the travel necessary to shop abroad, and they lacked the connections necessary to get restricted items through customs. Typically, if you owned a home computer in

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[226] "Although the amount of basic software delivered is satisfactory, the applications software delivered is poor and in insufficient supply. But the availability of heavily used standard applications software is critical for many computer users." Ibid.
[227] See Edgerton's argument that invention and innovation are excessively prioritized in the historiography of technology, while "diffusion and use is the province of market research. Technique-in-use ceases to become technology, and becomes cars, aeroplanes, water, electricity etc; the banal accoutrements of everyday life." Edgerton, "From Innovation to Use," 126.
[228] Gruska in discussion with the author.

the 1980s, you were one of the “geeks or the rich,” as Beneš ruefully recalled.[229] What it meant to be “a geek” in late socialist Czechoslovakia is not entirely clear; Beneš is a computerist who seems nevertheless not to have included himself in that category. What it meant to be rich was, if anything, equally confusing in an officially classless society and, moreover, one in which an occupation in the manual trades or as a craftsman frequently netted one’s family substantial sums of money under the table for work done off-schedule or on the weekends, as Beneš admitted.

Finally, computer enthusiasts both rich and poor found it necessary to plunge into the world of non-commercial, informal networks of exchange. Especially for education, training and socialization, these networks were the *sine qua non* of computerist existence and should not be overlooked as a formative element of the Czechoslovak computer technologist subculture. Western imports were scarce and usually unaffordable, as previously observed. Many Czech and Slovak youth of the 1980s and early 1990s, therefore, experienced computing for the first time at the keyboard of a homemade and often homely IQ 151, PMD 85, Ondra or Didaktik machine.

This was especially so in Slovakia. As the data from a survey of over 700 computer users in *ABC*’s classified ads (*čtenařská burza*, later *redakční oznamovatel*) as well as statistics on total computers available to various government bodies suggests, computer ownership in Czechoslovakia was widely dispersed. Home computers were more evenly distributed across the Czech lands than in Slovakia, where young people would have relied more heavily on the youth computer clubs run by social organizations like Svazarm, DDM and SSM. This variation, though noteworthy, does not appear to have given rise to any significant deviation between Czech and Slovak computing cultures, perhaps because the country’s market for hardware and software was already so small, and materials so scarce, that foregoing Czech-language periodicals, or

[229] Beneš in discussion with the author.

developing Slovak-only games and social contacts, made little practical sense. One scrounged for computer access as best one could. Mareš, for example, spent 1987 and 1988 hanging around the DDM club in Prague's Kobylisy district, where volunteer and paid instructors were on hand to teach programming in both Basic and Assembler (only a step above machine code).

That club, and another one he frequented at the Czech Academy of Sciences, were stocked with domestic computers—primarily Didaktiks, but also a couple surplus IQ 151s and PMD 85s, and even an Ondra microcomputer, one of Eduard Smutný's pet projects from the early 1980s. "It was very easy to start programming in Basic," according to Mareš, "but quite soon you discovered the abilities of the Basic interpreter were quite limited, so it forced serious users to switch to machine code, which required mastering the machine."[230] Due to universal shortages, these young computer users often repaired their local club's computers and mentored newcomers. Domestic production simply could not keep up. Ladislav Zajíček, former managing editor of *Mikrobáze*, recalled that even Didaktiks, which were pushed out to market as fast as assemblers in Skalica could make them, fell short of official targets: "Over 50,000 of these machines were sold," he recalled, "but demand vastly exceeded supply."[231] Petr Holan led an SSM youth computing group from the mid-1980s on. He recounted "a big push" from state policymakers after 1985 to acquire and distribute computers for clubs and schools around the country.[232] Hard currency, which was in dwindling supply in the 1980s, was disbursed to SSM and other organizations in order to acquire Western imports when Czechoslovak production failed to meet demand.

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[230] Mareš in discussion with the author.
[231] Zajíček (1989) cited in Jaroslav Švelch, "Say it with a Computer Game: Hobby Computer Culture and the Non-Entertainment Uses of Homebrew Games in the 1980s Czechoslovakia," *Game Studies* 13, no. 2, 2013.
[232] Holan in discussion with the author.

These state-financed and -run clubs and youth organizations were formal exchange networks that enjoyed a hub-and-spoke interaction with the informal exchange networks. They served as foci, temporary gathering points where expertise, education, commercial deals and friendships sparked and spun off. As computer scientist Zbigniew Stachniak has noted in the case of the USSR, these hobbyist clubs had an international dimension as well. They were not just hubs for domestic informal exchange, but "managed to fulfill the unforeseen function of linking the Soviet home computing experience with the Western computing heritage by allowing first-time computer users to experience the 8-bit digital world as fervently and passionately as their Western counterparts had done years earlier."[233] The clubs afforded ordinary Czechs and Slovaks the opportunity to feel connected, to be participants in the global cross-currents of technology and popular media. These interactions in turn led to the kind of second-order innovations in adaptations and maintenance that historians all too easily overlook. Although František Fuka, a recognized programmer *wunderkind*, rarely visited his local club, the friends and acquaintances he met there were always the initial audience for his newest games, like Tetris 2 or the version of *Indiana Jones and the Temple of Doom* he had quickly programmed after reading its description in an American magazine.[234]

Numerous Atari owners, who might have considered themselves fortunate in not having to use inferior Czech-made computers, nevertheless benefited directly from hardware hacks like the Turbo 2000 cartridge. Cooked up by the user community in the clubs (the JRC and RICO groups) and batch-produced by state industry, in this case the collective farm Český ráj Podůlší, the Turbo 2000 dramatically hastened software loading times on the popular Atari 800, from 600

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[233] Zbigniew Stachniak, "Red Clones: The Soviet Computer Hobby Movement of the 1980s," *IEEE Annals of the History of Computing* 37, no. 1 (January-March 2015): 21.
[234] František Fuka, (Programmer – Tetris 2), in discussion with the author. June 14, 2018.

baud to anywhere in a range of 2,000 to 6,000 baud.[235] This dramatically prolonged the useful life of an 8-bit computer well into the 1990s, as the survey data on Atari and Spectrum ownership demonstrates.

Finally, whether they owned an imported computer at home or hung around the clubs for time on domestic models, Czech and Slovak users depended on their peers as a source of software, repair, and translation services. Packaged with the diffusion of foreign computers into Czechoslovakia was a concomitant expansion of the English language, linked to the popularity of the British Sinclair ZX Spectrum and its library of games and, as historian Michael D. Gordin has noted, part of a larger narrative of the growth of English as the dominant international language of science and technology in the late twentieth century.[236] While some individual users were patient enough to learn English, German or Russian on their own, most were not and needed the help of friends and acquaintances to pore over foreign newsletters and manuals, a local instance of the kinds of friction that stood in the way of smooth technological diffusion and straightforward consumption in most peripheral societies.

Longstanding material scarcity and this multi-decade mixture of formal and informal exchange networks had an equally enduring impact on the subculture of computer technologists in Czechoslovakia. First, this environment fostered practices of intensive, and not extensive, computing. That is, Czech and Slovak technologists pushed the ultimate hardware limits of particular machines in the demoscene and in the peripheral world due initially to scarcity. Such scarcity was hardly unique to users in state socialist societies, of course, and characterized hobbyist/enthusiast cultures elsewhere, such as Latin America. However, it was a pervasive fact

[235] Martin Jaroš, "Můj první počítač: Atari 800 XE," Personal Blog, February 26, 2012. http://www.jarosovi.cz/atari-800-xe/. Buďa in discussion with the author.
[236] Michael D. Gordin, *Scientific Babel: How Science was Done Before and After Global English*, Chicago, Illinois: University of Chicago Press, 2015: 294-295.

of everyday life in late socialist East Central Europe—it simply had to be dealt with. As editors of the volume *Hacking Europe*, Gerard Alberts and Ruth Oldenziel observed, shortages shaped the available scripts for user-artifact interaction in such a context:

> For example, if you bought an Amiga on the Polish market and brought the machine home to Krakow, you could not simply plug it in with US manuals and scripts, as if it were a universal machine with a fixed meaning and stable functionality. What it meant to own a computer in Poland within the Cold War context, the implications of having one, and what it would be used for — all such aspects of a cultural script — were yet to be inscribed into the machine. Neither the itinerary nor the form of ownership was firmly set; nor could the route or mediation process which shaped the use be assumed. In most cases, hackers adopted US-standardized parts, rejected some, tinkered with others, and created new assemblies and new meanings to fit local uses. In the process, these users helped co-construct the new products.[237]

Such co-constructed products then became authentically autochthonous creations of Czechoslovak (or Polish, or Turkish, or Brazilian) talent. How else can we understand a product like Fuka's *Indiana Jones a Chrám zkázy*? It was a game he had never played, and was unavailable in Czechoslovakia. He programmed his copy in Basic simply on a description of what the game was like in an American magazine. The code was entirely his creation, as were the various traps and enemies that made the platformer challenging to play, and the Czech-language script.[238] Yet Fuka's direct inspiration was an American intellectual property.

In turn, this prompts a discussion of the global connections, or universal elements, of computer technologist subculture. Having firmly established that circumstances of education, employment, material scarcity and exchange networks conspired to shape the Czechoslovak environment in irreproducible ways, one might wonder whether computer technologist culture behind the Iron Curtain evolved in a vacuum. As Fuka's case indicates, the answer is no — not only were computer technologists striving to copy or integrate materials and software from

[237] Gerard Alberts and Ruth Oldenziel, eds., "Introduction," in *Hacking Europe: From Computer Cultures to Demoscenes*, New York: Springer, 2014: 13.
[238] Fuka in discussion with the author.

beyond their political boundaries, they also tended to share commonalities in family life, hobbies and interests, and mentalities.

Grandfathered In:
Technical Enthusiasm and DIY Ethos as Family Values

While the Cold War divide is readily apparent in the kind of education programmers and other computer technologists had access to in the West, as opposed to the East, one interesting commonality was the family background from which such individuals emerged. Briefly, computer technologists tended to have at least one talented, educated or highly-skilled parent that acted as a formative influence in their early years. Lee Felsenstein, one of the founding members of the Homebrew Computer Club in 1970s California, is one example. He grew up in post-World War II Philadelphia with a grandfather (William T. Price) famous for improvements that dramatically shrank the Diesel engine and a father who shared with his son books like Ivan Illich's *Tools for Conviviality*, which argued for a culture of tinkering, direct experimentation and a democratic distribution of tools for self-sufficient living.[239]

In the same post-World War II timeframe, but approximately 4,000 miles away, Czech computer programmer Božena Mannová's father was the only educated member of his family. He had come up from a peasant background to become a teacher of mathematics and physics at the second level of their village, Čáslav's, basic school. Her father always wanted a son, but initially had only two girls (both of whom later became electrical engineers). He had a side business repairing radios and televisions in the 1950s that Mannová remembers helping him tinker with, and she read her father's subscription to *Amatérské Radio* avidly. "I think for a girl,"

[239] Lee Felsenstein, "Where I Come From: Philadelphia 1945-1963," Personal Web Site. Available from: http://www.leefelsenstein.com/?page_id=16. Steven Levy, *Hackers: Heroes of the Computer Revolution*, Sebastopol, CA: O'Reilly Media, 2010: 151.

she said, "it was exceptional. It was not normal" to be so interested in technical pursuits from an early age.[240]

Trojan's mother was the exceptional one. She spoke ten languages. A cosmopolitan, she was born into a wealthy family in Vienna—her father established the first Czech travel agency, Čedok, in 1920, and she worked during the interwar years in foreign broadcasting at Radio Prague on Vinohradská ulice.[241] "She spoke on the radio until 1938 when the Germans came and kicked her out," Trojan recalled, "but before that she studied physical chemistry in Leipzig, and she attended [theoretical physicist Werner] Heisenberg's lectures also. So she passed Heisenberg's course!" he exclaimed. In addition, Trojan's father became famous throughout the Soviet bloc after the war for composing the music to the puppet films of Jiří Trnka, sometimes known as the Walt Disney of Eastern Europe.[242]

Having educated, highly skilled parents unsurprisingly often led to entrée into the kinds of formal and informal networks of exchange—especially education and training—that significantly improved the odds of a young person developing a durable passion for the solitary, almost monkish studies of mathematics and fledgling computer science. Zlatuška's mother was a secondary school teacher of Czech and history, while his father was a university instructor of Latin and classics in Brno. As a teenager, he received two hours a week of "private lessons in mathematical logic," by friend of the family and well-known dissident professor of philosophy and logic Pavel Materna, whose *curriculum vitae* features a telling gap between 1967 and

[240] Mannová in discussion with the author.
[241] "My grandfather from the mother's side, he established Čedok, the travel company, which still exists and the name Čedok, he always said, was my idea 'Československá dopravní kancelář!'" Trojan in discussion with the author.
[242] Ibid.

1990.[243] Materna's influence, not the paternal bond, was the driving force in Zlatuška's education and career choice—a reunion between the two at SOFSEM later in the 1970s led to Materna urging Zlatuška to finish his university studies a year early, so as to begin serious work closer to him in Prague, at the Institute of Computer Science.[244]

Even without such a direct line to privilege, even in more prosaic biographies, we can observe the first stirrings of a lifelong fascination in science and mathematics. For some of the earliest teenaged programmers at MIT in the 1960s, the logic of switches and circuits that undergirded the Tech Model Railroad Club enthralled them and engendered a life dedicated to the beauty of efficient instruction sets. Pajas, who grew up around the steel mills of northern Moravia, remembered the contradiction between his Catholic upbringing and the fossils he found while playing among the slag heaps as a child. He doggedly pursued truth, and the fossils were "a first introduction into a different side of the stories about the creation of the world, so that at my early age," he recalled, "about the second or third year of basic school, I already had a quarrel with our priest about what is really true and what is not."[245] It was a commitment to objective truth that doomed him after 1968 when he refused to call the Soviet occupation of the country anything other than what it was.

Other young men had technological enthusiasm run in the family like Holan, whose grandfather had already acquired a driving license for a steam-driven plough in 1916. Fully enamored with motoring, he became a professional driver after World War I, where he worked in Prague and chauffeured the directors of famous banks in prestigious limousines. His last vehicle before retirement in 1952, when there were fewer bank directors and more bureaucrats, was the

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[243] Zlatuška in discussion with the author.
[244] Ibid.
[245] Pajas in discussion with the author.

famous Tatra 87 with aerodynamic lines and a powerful engine that made it a toy for German field marshals and Egyptian kings.[246] The technology 'bug' passed on from father to son to grandson as the three sat quietly building crystal radio sets together on the family farm in Svratka, in the Czech-Moravian highlands.[247]

Once infected with an enthusiasm for electronics and other technical pursuits, Czechs and Slovaks behaved much like their counterparts in the West. In his seminal book *Hackers: Heroes of the Computer Revolution*, Steven Levy provided both a "hacker ethic" and a raft of examples of behavior among the computer technologist community that coalesced in the 1970s and '80s at production sites in Texas, the California bay area and the Route 128 corridor in Massachusetts. Technologists, Levy observed "believe that essential lessons can be learned about the systems — about the world—from taking things apart, seeing how they work, and using this knowledge to create new and even more interesting things. They resent any person, physical barrier, or law that tries to keep them from doing this."[248] This phenomenon was both universal and case-differentiated. In Czechoslovakia, as we have seen, individuals frequently evaded government restrictions and the astronomically high prices of official imports by engaging in widespread smuggling of computers and related materials as well as partaking in gray and black markets as producers and consumers of software. In doing so, Czech and Slovak computerists were not just pursuing the same feelings of mastery and demonstrations of technical prowess as their Western counterparts—the context of their activities, a state socialist society in which personal expression was more curtailed, mattered a great deal, altering the quality and enhancing the sensation of computer use.

[246] Among the famous owners of the Tatra 87 were German field marshal Erwin Rommel, penultimate king of Egypt Farouk I, surrealist writer Vítězslav Nezval, and president Edvard Beneš.
[247] Holan in discussion with the author.
[248] Levy, *Hackers*, 23.

Besides scavenging and evasion, Czech and Slovak computer technologists turned to innovation as an adaptive strategy for everyday life, a set of practices that became deeply embedded in the community in the years to come. A 2015 article in *Hackaday* drew attention to the handcrafted computer mice that Czechs came up with in the 1980s due to a much-lamented shortage of peripherals that also included essential items like printers and disk drives.

> As housing for the mouse they used [a] plastic kitchen spice can. Inside the can they placed a circuit board on which were two mutually perpendicular metal rollers. On both rollers there was a jagged aperture made from a thick paper. Its position was read using a LED and a pair of phototransistors. There were two buttons at the front. Each button was created from a cap screw and a pair of shortened and bent safety pins. (Why? Well, because micro switches were unobtainable for a long time in Czechoslovakia!) The ball, an important part of the mouse, was replaced by a ping-pong ball. ... All of this was manufactured and supplied as a kit. You could buy it in the store and then assemble at home.[249]

There is also a glimmer of the entrepreneurial spirit here sitting alongside necessity. Speaking of these individuals as entrepreneurs in the typical sense might assume a kind of functioning capitalist marketplace with the ability to reinvest profits, incorporate and form legally protected businesses and engage in open commerce. This was not the case for Czechs and Slovaks even during the brief political thaw of *přestavba* from 1987 to 1989. It may make more sense to refer to them as small-scale "socialist proto-entrepreneurs," as Jouko Nikula and Ivan Tchalakov did in their recent (2014) book.[250]

While accumulating significant wealth was essentially impossible, such petty trades, risk-taking, negotiation and exchange did serve as a way to supplement official salaries, and was a common feature of late socialist life that ironically sustained and complemented a formal economy of shortage and maldistribution. Creative technologists like these mice manufacturers,

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[249] Martin Malý, "Peripherals Behind the Iron Curtain — Computer Mouse," *Hackaday* (April 13, 2015). https://hackaday.com/2015/04/13/peripherals-behind-the-iron-curtain/.
[250] Jouko Nikula and Ivan Tchalakov, *Innovations and Entrepreneurs in Socialist and Post-Socialist Societies*, Newcastle-upon-Tyne, UK: Cambridge Scholars Publishing, 2014: 11.

above, or Fuka, who sold bootleg copies of Western films with his own voice dubbing the audio track in Czech, sometimes turned into major businesses in the 1990s once political and economic conditions had changed.[251] The world's largest antivirus company, Avast, is one such example, with the kernel of its code written in 1987.

Indeed, this kind of adaptive behavior, which sought access to the benefits of technology that Czech and Slovak users could see in other countries continued after the fall of Communism in 1989. In 2001, the 'Ronja' wireless internet project connected tens of thousands of ordinary Czechs in an effort to avoid the stiflingly high costs regulator Československé spoje allowed internet service providers to charge in a country that was still poor and recovering from decades of command economy mismanagement. First invented and disseminated on the Web by Karel Kulhavý, Ronja was a system of optical devices that used beams of light along direct lines of sight to transmit data wirelessly among computers in a community—say, from apartment building roof to apartment building roof. The system was tremendously popular and significant local networks emerged in both Prague and Plzeň, with tens of thousands of users.[252] Swedish scholar of science and technology studies Johan Söderberg observes:

> Ronja offered the cheapest, fastest, and most reliable method to connect computers at the time. The project was guided by the idea that anyone without previous knowledge in electronics should be able to build a Ronja device. To make that vision come true, the mechanics and electronics were designed from generally available off-the-shelf components. Improvements to the technology were discussed in a community of developers and users, and designs and schematics were published under a free software license. These principles were thematized under the label 'user-controlled technology.'[253]

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[251] Fuka in discussion with the author.
[252] Söderberg, "Free Space Optics in the Czech Wireless Community," 423-450.
[253] Johan Söderberg, "Users in the Dark: The Development of a User-Controlled Technology in the Czech Wireless Network Community," in Gerard Alberts and Ruth Oldenziel, *Hacking Europe: From Computer Cultures to Demoscenes*, New York: Springer, 2014: 234.

As the price of internet access dropped toward the end of the 2000s, Ronja—which had always demanded a certain level of technical competence, not to say confidence, and which suffered from signal attenuation and packet loss with distance and in foggy or rainy weather—became more of a curiosity than a practical necessity. Still, it offers a vibrant illustration of behavior and preferences among Czech computer users that conforms to the hacker code Levy discerned in his series of interviews with American technologists in the 1970s and 1980s.

The 'Ronja' project offers a glimpse into the impulse toward openness and egalitarianism of computer technologists who worked to ensure broader access to the Internet in under-served communities. However, just as in the West, there was a darker side of arrogance and elitism that too frequently served to exclude potential converts from joining in the community. In her 1997 memoir of a programmer's life, Ellen Ullman wrote of the strange sense of shame she felt while developing a system for a non-profit organization that would organize access to social services for AIDS patients. "The whole project smacks of 'end users'," she observed, "those contemptible, oblivious people who just want to use the stuff we write and don't care how we did it."[254] Later on, as she casually dated a younger programmer, Brian, she learned of his scheme to avoid U.S. tax law and set up an offshore porn server in Mexico. "The whole complicated business of international pornography had devolved … to the level of a mathematical problem, some famously difficult proof, a challenge of the mind. He seemed neither attracted to nor repulsed by the content of the stuff he would be sending around. To him, it was just bits, stuff on the wire," to be shuffled through the silly and artificial impediment of borders and laws."[255] And yet she saw this moral quandary in herself. She too wanted to avoid dealing with messy personal

[254] Ellen Ullman, *Close to the Machine: Technophilia and Its Discontents*, San Francisco, CA: City Lights Books, 1997: 9.
[255] Ibid, 61-62.

interactions, with the rough edges and complications of the real world—ultimately, she concluded, the detachment and "arrogance is a job requirement."[256]

Forgotten Mothers, Founding Fathers: The Labor and Exclusion of Czechoslovak Women Technologists

Arrogance was certainly on display among computer technologists in Czechoslovakia as well. In 1986, *Mikrobáze* published a joking series of 'horrific conversations' between those in the know and the "contemptible" end users Ullman described. A beleaguered everyman is pictured sitting at the telephone on one end of a help line while irate housewives, mathematical illiterates and ignorant teenagers form an endless parade line of abuse:

> "Good day, this is X from the town of Y. Please, my husband would like to ask you how to stop the game."
> "Well, give him to me."
> "You can tell me, I'll direct him."
> "You can work with your computer?"
> "No, my husband bought it for himself."
> "Well, tell him to call me."
> "But I would like you to tell me, I'll write it down."
> "Madam, it really will not work like that. The problem is [too] broad; moreover, I need to know to what extent your husband has experience with this. Right now, [the situation is like] you calling some physicist [and telling him] that your husband would like to know how to stop the nuclear reaction in the reactor of a nuclear power plant, and then [after writing it down] you would direct [your husband] how to sort it out."
> "Well, at least try."
> I initiate a fireworks display of programming finesse on the dissimulation of games.
> "Wait, I think I can still call my husband."
> "Goodbye."[257]

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[256] Ibid, 98.

[257] "'Dobrý den, tady X z města Y. Prosím vás, můj manžel by se vás rád zeptal, jak má zastavit hru.' ‚Dobře, tak mi ho dejte.' ‚To můžete říct mně, já mu to vyřídím.' ‚Vy umíte pracovat s počítačem?' ‚Ne, to manžel si ho koupil.' ‚Tak mu vyřiďte, ať mi zavolá.' ‚Já bych ale ráda, kdybyste mi to řekl, já si to napíšu.' ‚Vážená paní, to takhle opravdu nepůjde. Problematika je to široká, navíc potřebuji vědět, do jaké míry ji váš manžel má zažitou. To byste teď mohla zavolat nějakému fyzikovi, že by váš manžel rád věděl, jak zastavit štěpnou reakci v reaktoru atomové elektrárny, že mu to pak vyřídíte.' ‚Tak to aspoň zkuste.' Spouštím ohňostroj programových fines na tajení her. ‚Počkejte, já asi přece jen zavolám manželovi ...' ‚Na shledanou.'" Ladislav Zajíček, "Mikrobází hovory – horory," *Mikrobáze* 4, (December 1986), 20-21.

Besides the smug superiority on display here—the "fireworks display of programming finesse" and the comparison between the programmer's work and that of more highly esteemed nuclear physicists—there is certainly a gender script in this exchange that was repeated in two other conversations in this series.[258] Ignorant, meddling women—usually someone's wife—were portrayed by Zajíček as not understanding, or caring to understand, the vast importance and significant labor of the mostly male programmers.

A number of scholars have begun to address the gender gap and treatment of women in computing in recent years. Some of the most important works include books on the history of British women programmers by Marie Hicks (*Programmed Inequality*, 2017), Janet Abbate's *Recoding Gender* (2012), and *Algorithms of Oppression* by Safiya Noble (2018). Official Communist rhetoric called for the inclusion of women and girls in computing and other male-dominated branches of engineering and technics in Czechoslovakia, even if in occasionally condescending terms like when it told girls "Don't fear physics!"[259] However, the reality of everyday labor was just as Iowa State University historian Amy Bix described the American 20th century context: "Women's engineering ambitions were of a more deeply transgressive nature because technical knowledge—with its ties to industry, heavy manual labor, and the military—was a far more masculine domain than science was."[260]

The popular and professional technical press in Czechoslovakia was full of photos of women in technical settings: sitting at computers, leaning over equipment, brows furrowed in study or shoulder-to-shoulder with the boys in a social club setting. However, unlike their male counterparts, these women were almost never identified by name in photo captions or the text of

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[258] Ibid, 20-23.
[259] "Nebojte se fyziky," *ABC Mladých Techníků a Přírodovědců*, 28, no. 13 (August 3, 1984), 26-27.
[260] Amy Bix, *Girls Coming to Tech! A History of American Engineering Education for Women*, Cambridge, MA: The MIT Press, 2013: 4.

the article. They were women first, appealing objects to look at rather than technicians worth knowing, a practice that was common on both sides of the Iron Curtain. Men patrolled the gender boundaries of computer culture—"Computing imagery participated in defining, rather than just reflecting, what computing was," according to Marie Hicks. "The positioning of women operators as passive or the confusion of workers with models made—and continues to make—a material difference in how we understand computing's past and write computer history." In my survey of two decades of publications aimed at Czech and Slovak technologists, only a handful of articles crop up that include named female subjects.

Indeed, by the 1990s male computer technologists had virtually purged women from many of the social spaces of hobbyist and personal computing in Czechoslovakia. This was in stark contrast to the reality of women's high participation in the professional computing labor force during the late socialist period, when the government had a formal, ideological commitment to their inclusion. Švelch notes: "According to 1986 data, the total percentage of women in the field was 59.4 percent. As in the West, women clustered in less lucrative clerical jobs, making up 97.2 percent of data-entry personnel, and only 29.2 percent of management. But women also accounted for 58.3 percent of the country's 7,338 professional programmers."[261] Yet a survey of 743 young computer users who wrote into *ABC Mladých Techníků a Přírodovědců* over ten years from 1987 to 1997 reveals only 12 women or girls—1.6 percent of the active community. The result was a stiflingly homosocial space. One forlorn 15-year-old, Jiří Hajzl from Heřmanův Městec, a small town in the center of the country, wrote in 1996 that he

[261] Švelch, *Gaming the Iron Curtain*, 20.

was looking for a girl who could share his interests in cycling and PC programming.[262] While Hajzl was too young to have played much of a role in keeping women out of computing in Czechoslovakia, his older peers had for decades dismissed the value of women's work and moved to actively exclude them, especially from hobbyist spaces.

Moreover, these attitudes were not peculiar to Czechoslovakia but held across the entire bloc of socialist states, as Dolores Augustine (East Germany) and Don Raleigh (USSR) have demonstrated.[263] Indeed, they were part of an emerging global pattern of changing demographics in computer use around the world. Janet Abbate, a science, technology and society scholar, documented the worldwide decline in women's participation in academic and commercial computing beginning in the early 1990s and coinciding with a culture of personal computing that was dominated by "the popular image of the computer geek—an obsessive, antisocial, hygienically challenged male—and … the largely masculine subculture of computer gaming," an important component of acquiring interest and skills during childhood and adolescence.[264] In contrast, earlier computing work—especially data processing and computer operation—had largely been "gender coded" as clerical or administrative work, and therefore more feminine. Men in most countries therefore did not work against or behave with open hostility to women's inclusion in these spaces, although this began to change by the late 1960s and early 1970s in countries like the United Kingdom as the salaries and cultural cachet of computer work rose and

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[262] "Jiří Hajzl, Nám. Míru 187, 538 03 Heřmanův Městec – Hled. kamarádku nejen k dopisování. Zájmy: cyklistika, PC programování. Věk okolo 15 let. Foto nutné – vrátím." "Redakční oznamovatel," *ABC Mladých Techníků a Přírodovědců* 41, no. 23 (1996), D12.

[263] Arkady Darchenko, an English-speaking physicist from Saratov, "also considered computer programming a man's profession. 'Although there are female programmers, it's simply not their thing. In the same way that being an electrical engineer is not a woman's thing and a nuclear scientist even more.'" Donald J. Raleigh, *Soviet Baby Boomers: An Oral History of Russia's Cold War Generation*, Oxford: Oxford University Press, 2012: 258; Augustine, *Red Prometheus*, 280.

[264] Abbate, *Recoding Gender*, 149.

men redefined computer work as professional and masculine.[265] Even during the period of late socialism in Czechoslovakia when women's participation in computing was higher, however, they remained in a distinctly disadvantaged status compared to their male peers and often had to take unconventional routes to pursue their work.

A telling example of unequal status is the punishment Communist officials meted out to Mannová when she returned home with her husband in 1972 after years spent abroad in Sudan and Canada. While politically suspect men like Pajas were barred from working in their field and shunted into different assignments, such work was still usually at a comparable level of prestige and salary, as Pajas' work at the Institute of Transport suggests. Mannová, by contrast, was barred from entrance to Ph.D. programs, stripped of her career at Aritma and relegated to secondary school teaching to make ends meet.[266] Only at the very end of the 1980s, during *přestavba*, did the government relent somewhat. Officials allowed her to re-enter public life as the non-threatening expert host of *Logicky vzáto*, a television program that aired every Wednesday morning at 11:35am, meant to encourage children's interest in computers and mathematics.[267]

Mannová was an exceptional figure in many ways, however, a programmer widely recognized for talent among her peers and who continued to be invited to technologist gatherings like SOFSEM throughout the period when she was officially banned from working in the field. By far the most common form of computing labor that women performed in late socialist Czechoslovakia was machine tending. These '*operátorky*' ran the programs that came to them bundled in boxes of punched cards, patched them when they failed to run through the machine

[265] Hicks, *Programmed Inequality*, 80-81.
[266] Mannová in discussion with the author.
[267] Česká Televize, "Středa 20. Září," 1989.

properly, and performed maintenance. Sometimes this was merely the 'percussive' variety about which Chvatík, also an occasional machine tender, joked.[268] Yet it often involved a degree of self-taught or apprenticed skill that kept systems running in the absence of effective support from the male technicians at NOTO and Kancelářské stroje.

In return, these women were the butt of sexist jokes and the target of harassment by their male colleagues. In the July 1988 issue of *Mikrobáze*, among a series of articles examining the relationship between science fiction and computing, readers encountered a sexist joke about the *operátorky* (women computerists). To wit, that just as Communist officials exhorted them to save older computer equipment and make the best use of it, readers should consider the potential usefulness of those computers' (almost entirely female) operators, and not throw them out even if they were a bit old (and, implicitly, less attractive).[269] The author was not an insensitive teenager, but Jiří Hořejš, 55 years old and at that time co-founder of SOFSEM and at the peak of his career as department chair of computer studies at Masaryk University in Brno. He was later lauded by IEEE's Computer Society as its 1996 Computer Pioneer, a "founding father of informatics and computer science" in Czechoslovakia.[270]

Women computer operators also found their competency questioned by frustrated male programmers who would leave their compiled programs with them to be run over-night, and would sometimes return the next day (or days later, depending on circumstances) only to find mangled programs and nonsense results. While the earlier case of Pospišíl demonstrates that

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[268] His aging DataSaab computer had dusty, failing connectors which only worked upon regular, vigorous applications of a rubber mallet he kept for just this purpose. Chvatík in discussion with the author.

[269] "*Než něco z počítačového sálu vyhodíte, zjistěte, jestli to nedělá něco jiného (třeba i žádoucího), než co by to podle vás dělat mělo (a nedělá)* (Může se týkat třeba i operátorek)." Jiří Hořejš and Jiří Franěk, "Počítačová science fiction (1)," *Mikrobáze* 7 (July 1988): 7.

[270] "Jiri Horejs — 1996 Computer Pioneer Award *'For informatics and computer science'*," IEEE Computer Society, available from: https://www.computer.org/web/awards/pioneer-jiri-horejs.

programmers often committed plenty of their own rookie mistakes and oversights, it was also appealing for the men to blame careless, ‘airhead’ women. One example of this is a song, sung by a chorus of women computer operators at SOFSEM in 1983 to the tune of the Modřanská polka, better known in the West as the Beer Barrel Polka or Roll Out the Barrels, composed by Jaromír Vejvoda in 1927. With new lyrics by Hořejš, adapted from the original song “Škoda lásky” by Václav Zeman (1934), this song about “wasted love,” became about the “wasted [punched] tape,” programs left behind by careless or unlucky operators:

> Wasted tape/
> which I deleted/
> wasted disc/
> which I scratched/
> wasted labels/
> which I took away/
> if you were not disintegrated/
> you would have run.
>
> Waste of time/
> which I donated/
> to your class/
> before I spoke/
> wasted job/
> which I trapped in a loop/
> you'll forget it anyway/
> I will be your dear.[271]

We must assume the women singing this chorus were in on the joke and willing to poke fun at their own perceived failures in the workplace, but there is a troubling under-current here. As the operators list various failures, first apologizing to the tape program—that would have run if it were not totally disintegrated!—they conclude by addressing a presumably angry male colleague

[271] 1. Škoda pásky/kterou jsem vymazala/škoda disku/který jsem poškrábala/škoda štítků/které jsem odnesla v dál/kdybys je byl nerozsypal/už by jsi odstartoval.
2. Škoda času/který jsem věnovala/tvému classu/dřív než jsem iplovala/škoda jobu/který jsem zacyklila/stejně na to zapomeneš/budu zas Tvoje milá. Jiří Hořejš, *Operátorská*, Nápěv: *Škoda lásky* (Jaromír Vejvoda), ÚVT, Moravské trio, SOFSEM 1983. Found on “30 Let Sofsemu,” a CD-ROM containing most of the conference’s history from 1974 to 2003, provided by Miroslav Bartošek and in the author’s possession.

by telling him to forget about it, “I will be your dear.” Clearly, even at the highest levels of computer technologist subculture in late socialist Czechoslovakia, women faced possibly insurmountable hurdles of male expectations and prejudice toward their technical labor.

Even when women were explicitly included in the spaces of computer technologist culture in socialist Czechoslovakia, it was problematic. SOFSEM, the annual two-week conference Gruska and Hořejš had cofounded in 1974, quickly mandated a quota of 25 percent female attendance at each conference. That seems particularly progressive given the context of the time. Estimates of women’s participation in the university courses that most often led to computing careers, such as mathematics and philosophy and logic, can range somewhat widely. There is basic agreement though that the figures were low: 3 percent (at the technical university in Poděbrady)[272]; “two or three girls, among hundreds of boys” at ČVÚT’s Faculty of Nuclear Physics in the late 1960s, which must be compared with the almost certainly erroneous figure of “at least 20 percent women,” that Pajas recalls seeing at the same physics faculty earlier that decade[273]; “circa 5 percent” working in computing at the Czech Academy of Sciences.[274] In any case, it is not at present clear why Czechoslovak figures for female enrollment in engineering, physics and mathematics courses would have been so much lower than the GDR, a comparably developed state socialist society. According to Dolores Augustine, women there “were drawn in greater numbers to computer science than to traditional branches of engineering” and where after 1975 they “made up over half of students enrolled in the major 'Information Processing' [courses] (which focused on software).”[275]

[272] Mannová in discussion with the author.
[273] Trojan in discussion with the author; Pajas in discussion with the author.
[274] Pospišíl in discussion with the author.
[275] Augustine, *Red Prometheus*, 267.

One factor may have been the difficulty in retaining female students in engineering, mathematics and computer-related courses. Holan estimated that perhaps up to a quarter of his typical class at the Prague Technical University in the late 1970s consisted of women, but that about a third of these women dropped out in the first semester, along with many of their male counterparts. This was simply because the most demanding lecture, on mathematical analysis, was in the first year of study. Holan believed it winnowed the wheat from the chaff. However, when it came time for graduation, he estimates that fully a fourth of his graduating class were women, and indeed Holan's first wife studied theoretical cybernetics at the university.[276] At this point, some additional women may have quickly dropped out of the labor market due to marriage and the difficult burden of managing both domestic life in an economy of scarcity and gender expectations that still militated against women in computing.[277] Surely, however, this does not account for even a slim majority of those women who entered the profession after graduation in the 1970s and 1980s. Given the bias of outstanding sources toward male engineers and their interest, the challenge of incorporating women's history and contributions to the field of computing in Czechoslovakia remains serious and unanswered.

However, we can ask why the organizers of SOFSEM were so progressive in mandating women's participation. It must have been somewhat difficult to find dozens of women working at sufficiently high levels of mathematics, logic and programming. There was an ulterior motive. "They needed some women, you know, to dance with in the evening and things like that," Mannová recalled.[278] "Sofsem was for two weeks," Gruska, one of the two cofounders, said, "and we had some very special rules. One-third of the people were from the universities, one-

[276] Holan in discussion with the author.
[277] Augustine, *Red Prometheus*, 297.
[278] Mannová in discussion with the author.

third from research institutes, and one-third from practice. And at least 25 percent ladies. That created a very special atmosphere. There were some divorces, but …" he laughed.[279]

This was not altogether different from Caltech's motivation in admitting its first women to engineering classes in the mid-20th century, which was "to appease and retain its male students by providing them with girlfriends and social 'normality.'" "Picking up on that mentality," according to Bix, "many of Caltech's first female students had to fight to be taken seriously as students, fend off unwanted sexual approaches, and struggle to develop their own identity as women engineers."[280] Nevertheless, to Mannová at least, and likely for many of her American counterparts in the 1970s and 1980s, participation in conferences and seminars like SOFSEM—despite the sexism—was an entrée into an otherwise male-dominated social world, and she had fond memories of it decades later. "SOFSEM," she said, "was really something from social and professional life that was very, very good."[281] Mannová was a prominent participant in SOFSEM over the course of many years, and a well-known and respected educator and practical programmer in her own right who would later host a TV show in 1988 and 1989, *Logicky vzato*, devoted to popularizing computer science and mathematics. Most women computerists, however, worked as more obscure *operátorky* in data processing and are usually left unnamed in period photos.

Even those who were well-connected and experienced professionals found themselves shunted aside. This was the case with Helena Štefanová and Zuzka Durayová, annual contributors to SOFSEM who have only been memorialized as photographers who helped archive the conference's history, and with Sylva Prokšová who, despite co-founding one of

[279] Gruska in discussion with the author.
[280] Bix, *Girls Coming to Tech!* 21.
[281] Mannová in discussion with the author.

Prague's most influential computer clubs, remembers her role "was that of an intermediary," who held the social life of the club together and organized its activities, rather than butting heads with a mostly male membership in displays of programming finesse.[282] These interactions between men and women computerists prefigured the decline of women's role in the community after the end of state socialism. At times pushed out explicitly, women were also made to feel unwelcome by a changing and more masculine culture of computing associated with the hobbyist movement and computer games and, finally, replaced by automation and new technology which eliminated many of the previous data processing positions women had occupied.

Conclusion: The Soul of a Vanishing Community

There is significant historical value in understanding who users of a given technology are—what molds them, spurs them to innovation or dispute; the values they hold dear. This chapter examined pieces of the ordinary lives of men and women who shared a common identity as computer technologists. This identity had a powerful rootedness, perhaps in part because many technologists had such similar family and childhood backgrounds that tied them together. Decades later, Pospišíl still played squash every week with Kašpar, his old contact for Texas Instruments calculators.[283] Mareš bonded with his friends by recreating on the Web a virtual approximation of the old Soviet MINSK II mainframes that had been the bane of their existence when growing up.[284] A gap has opened up between the small and still cozy world of computer technologists from that time in the last days of state socialism, and the Czechs and Slovaks too

[282] Wiedermann, "XXX Years of SOFSEM;" Švelch, *Gaming the Iron Curtain*, 79-80.
[283] Pospišíl in discussion with the author.
[284] Mareš in discussion with the author.

young to remember anything besides the world of computers as consumer commodities, the world into which they were born.

In the 1970s and 1980s, computer technologists in Czechoslovakia formed a distinct subculture separate from other emerging pieces of a civil society that was still incubating within the structures of official socialism. Their education varied, but was often less formally credentialed than their Western peers due to both the vagaries of the labor market in a command economy and the Communist repression of cybernetics and, by extension, computer science. While their innovations under conditions of material scarcity were similar in some ways to the early hobbyist community in the United States during the 1970s, for instance, these conditions lasted much longer for Czechs and Slovaks.

For more than two decades, arguably through the mid-to-late 1990s, computer users in Czechoslovakia contended with the kind of software dearth and DIY hardware culture that had already disappeared in the United States and other Western countries by the early 1980s when computers became an affordable mass-market commodity.[285] Their culture was sustained by a series of interlocking and cross-penetrating formal and informal networks of exchange and mutual technological interest which, even when the state-sponsored organizations like Svazarm and SSM withered after 1990, continued as offshoots that formed into companies like Software602 or Avast, as well as smaller local clubs devoted to games or particular computers. Unfortunately, as we have seen, the computer technologist subculture was in many ways resilient in the face of material shortage and political crackdowns, but fragile in its general inability to accept women on equal terms. Czech and Slovak technologists insisted—a trait they shared with

[285] Based on a survey of 743 computer users in *ABC Mladých Techníků a Přírodovědců* from 1987 to 1997. The three most popular home computers up through 1997 remained the Atari 800, Commodore 64 and Didaktik Gama, all of which were 8-bit machines running off microprocessors that dated back as far as 1974 (the Intel 8080) and 1976 (the Zilog Z80).

Western counterparts—in patrolling gender boundaries by harassing and discouraging women and girls from joining their community. This was not a function of misogyny peculiar to state socialist societies or to the countries of East Central Europe (which had, after all, previously employed more women in the computing professions than the United States or United Kingdom). It was rather a global trend of capable women retiring from computer work, choosing to change careers or never pursuing an interest based on their talents because the culture of computing had become increasingly masculine—aggressive, adolescent, grubby and even elitist.

When Steven Levy wrote his panegyric to the mostly male hackers in 1985, however, they were already a dying breed. What had poisoned the personal computer revolution in their view, creeping in like the serpent in the Garden of Eden, was money. Richard Greenblatt, one of the cofounders of the hacking movement in America alongside Bill Gosper, opined that the joy of sheer technical competence had transformed into something base. “The real problem, Greenblatt says, is that business interests have intruded on a culture that was built on the ideals of openness and creativity. In Greenblatt’s heyday, he and his friends shared code freely, devoting themselves purely to the goal of building better products.”[286] The inspiration of those products, and that creative culture, in turn cascaded out into society at large. It led to sleepless nights and a sudden gush of frantic innovation—the GUI, the mouse, spreadsheets like Visicalc, word processors, e-commerce—that fostered the Information Society and to which we continue to make iterative improvements.

Much of that original inspiration, however, is gone. Computers are for almost all end users today no more than a window to something larger—the Internet and the World Wide Web—and not ends in themselves, not the tools for self-sufficient living that Felsenstein and

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[286] Levy, *Hackers*, 454.

other founders of personal computing believed they could become. “The relationship between person and machine is completely reversed on the Internet,” Ellen Ullman observed.

> The spreadsheet is the program that all but created the personal computer. The spreadsheet and the word processor—two tools empty of information, two little programs sitting patiently and passively for their human owners to put something interesting into them. Now, fifteen years later, the Internet browser is the program creating the second generation of the personal computer. The browser—a click-click baby tool for searching the Web, where everything of interest already resides. It is a journey through the looking glass in the age of information: one pill makes you larger, and one pill makes you small.[287]

We have already seen that the discourse and behavior of Czech and Slovak computer technologists mirrored the hacker code or set of principles that Steven Levy articulated in the mid-1980s. It makes the community particularly worth studying because the decline in this particular culture of technological engagement that Ullman laments above was necessarily delayed in Czechoslovakia due to the material and political circumstances of the country during and immediately following the end of the Cold War. What this entails is not just that the countercultural ideals of early personal computer use were preserved in amber across the sea. These must be married conceptually to the material scarcity that shaped the Czech and Slovak cultural approach to computing. That approach emphasized tinkering with and total access to hardware, open and freely shared software, and maintenance and bricolage rather than novelty and profitability.

As chapter five and the epilogue will cover in more detail, it represented a political and economic approach—computers for the community—that offered a promising, albeit short-lived, alternate digital modernity simultaneously more ecologically conscientious, egalitarian in access, less economically exploitative, with a slower, more deliberate and socially cognizant

[287] Ullman, *Close to the Machine*, 79.

implementation of computers into businesses, libraries, schools and community centers. Additionally, a study of the Czechoslovak community is fruitful for how it reframes the triumph of market capitalism after 1989 as a partial, inadvertent evolutionary outcome of state socialist investments and policy decisions, as well as how technological diffusion and appropriation can occur at the community level despite the lack of a market or coherent government industrial policy.

Many Czechs and Slovaks retained the capacity of wonder when it came to the personal computer. Not everyone lovingly maintained their first PC in the attic thirty years later, like the head of IT at Rakovník's ceramics factory did.[288] Yet a great many users from that time interacted with and understood their machines in a more intimate way. Daily life with older, more constrained equipment meant needing to know its hardware hiccups and being able to write machine code "on the metal" to make it run the programs you needed, as Mareš already knew at the age of ten. This kind of technological identity—as a forward-looking computer user in a country battling the specter of digital backwardness—shared a set of values like efficiency, egalitarianism, unimpeded access to tools and information, and meritocracy. Whether this extended to a common approach to politics during the late socialist period—were technologists natural-born dissidents?—is a question to which we now turn.

[288] Beneš in discussion with the author.

Chapter 3
I/O, I/O It's Off to Work We Go?
Cooperation or Dissent among Czechoslovak Computer Technologists

In 1987, the Czechoslovak police arrested Tomáš Smutný for the crime of repairing computers. Operating without a proper license from Prague to Košice, even patching machines with stolen parts, Smutný faced a prison sentence. Upon rumors of his impending arrest, he panicked, liquidating all his papers. However, when it came time for the court to charge him, the only expert witness it could produce was Vladimír Smejkal, Smutný's friend and a fellow member of the local Benešov computer club. Moreover, Svazarm, a state-funded civil defense organization, employed him as a much-needed technician. The court released him without even a fine. Years later, Smutný laughed at the memory. In one of the most hardline Communist regimes, he observed, computer skills granted a degree of immunity.[289]

Despite their small numbers, by the 1980s the community of Czech and Slovak computer hobbyists and professionals had already established their importance, and was busy delineating and patrolling some of the subcultural boundaries that would be familiar to computer users today. Victor Petrov rightly identifies that "a hacker-based cyberculture" as existed in the United States did not develop in CMEA-bloc countries like Czechoslovakia and Bulgaria in the 1980s, though glimmers of the rich 1990s' hardware hacking demoscene are visible in user-made hardware modifications to tape drives for the Commodore 64 and Atari 800. Rather, computer users young and old in Czechoslovakia sought "freedom in the creativity of the machines" in parallel with Western users, though for different reasons related to endemic scarcity.[290] Their values and priorities reflected this core precept, rejecting and navigating around any limitations

[289] "Oni prostě neměli nikoho, kdo by tomu rozuměl, jen lidi, co se pohybovali kolem nás." Martin Bach, "Muž, který bastlil v Československu herní automaty," In: Games.cz [online], 2012.
[290] Petrov, "A Cyber-Socialism at Home and Abroad," 33.

to their access, including software and hardware shortages, import restrictions and bureaucratic "technological conservatism."[291] Computers in the home and office were tools and toys, but they also formed an important piece of their users' identities in the 1970s and 1980s.

As computers grew ever more crucial to the transformation and success of entire economies in the 1970s and 1980s, Communist Party officials in Central and Eastern Europe experienced a crisis of doubt. Could they trust the technologists they relied on so heavily? Or would that growing category of white-collar workers be seduced by the superior reliability and utility of Western machines? Artifacts might offer material evidence of inferior quality and technological lag that official propaganda denied or minimized, spurring dissatisfaction and even dissent among the technical and scientific intelligentsia. Perhaps, in the late socialist period, their active support was not necessary—just their silence. As historian of science Slava Gerovitch has rightly noted, potentially subversive engineers and technologists (not to mention, of course, intellectuals and artists who were typically under heavier suspicion), was a common problem for state socialist regimes. Yet according to Gerovitch, technologists' "belief in a technological utopia fitted well with the Marxist view of the scientific and technological progress as a foundation for building a better society," with the result that active, open political dissent was rare.[292]

Indisputably, technologists were a pillar of the late socialist state, their work indispensable to the modernization of the economy in Czechoslovakia and its neighbors.[293] Even prior to Gorbachev's reforms in the late 1980s, officials like Josef Hejsek, the deputy chairman of the State Planning Commission in Czechoslovakia, viewed the so-called 'computerization' of

[291] Švelch, "Say It With a Computer Game."
[292] Gerovitch, *Soviet Space Mythologies*, 46.
[293] Of Yugoslavia in the 1980s, Kristian Benic writes: "Amidst the economic crisis, computer technology was viewed as a potential savior." Kristian Benic, *Geeks Behind the Iron Curtain*. On the GDR, see: Cortada, "Information Technologies in the German Democratic Republic (GDR), 1949-1989," 11.

industry as the best means to raise exports and garner the hard currency they needed to continue importing consumer goods. Contemporary articles from the early 1980s, published by officials in *Planované Hospodářství* and *Rudé pravo*, as well as editorials by engineers and other computing professionals in journals such as *Sdělovací Technika*, confirm that computerization of the economy, with a focus on microelectronics, was much discussed.[294] Unlike artists and the liberal intelligentsia generally, therefore, the work of computer technologists was important enough to making industry, the military and the bureaucracy more efficient, productive and competitive with other socialist states and the West to win them a degree of autonomy and privilege in exchange for outward signs of obedience, as Jonathan Bolton and others have highlighted.[295] As we will observe with an in-depth look at *Mikrobáze*, there is compelling evidence of mutual support, and perhaps political sympathies, between the government and the mostly young, mostly male technophile community it fostered.

To posit such a history of mutualism in Czechoslovakia is to join with recent scholarship by Ksenia Tatarchenko, Patryk Wasiak and Jaroslav Švelch that seeks to reframe Western historians' conventional assessment of state/technologist relations in East Central Europe.[296] This argument, that "the Soviet failure to mass produce personal computers was both a marker of and a contributor to the political failure of the system," is best illustrated in Simon Donig, Charles

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[294] Čechlovský, "Využít předností výpočetní techniky," 3; "Chceme Mikroprocesor?" 441; Hejsek, "Za další, intenzivnější rozvoj československé elektrotechniky," 1-6.

[295] This autonomy and privilege was also true, at least to some extent, of internationally recognized film directors and artists. Despite her most famous film *Sedmikrásky* (Daisies), being a rejection of socialist values which "privileges waste, destruction, and instant gratification" rather than labor, and a resulting ban from all credited work in film, director Věra Chytilová was able to leverage her international fame in a petition to General Secretary Gustav Husák to allow her once again to direct films and take part in international film festivals. Jonathan Owen, "'Heroes of the Working Class'? Work in Czechoslovak Films of the New-Wave and Postcommunist Years," *Framework* 53, no. 1 (Spring 2012): 196; Jonathan Bolton, *Worlds of Dissent: Charter 77, The Plastic People of the Universe, and Czech Culture under Communism*. Cambridge: Harvard University Press, 2012: 65.

[296] Scholars like James Cortada have called in recent years for case studies on computer adoption and use in Central and Eastern Europe by noting a gap in the existing scholarship - "much work remains to be done on the history of IT in Central and Eastern Europe." Cortada, "Information Technologies," 35; Cortada, "How New Technologies Spread," 235-236.

Maier and James Cortada's work.[297] According to this view, from the 1970s forward technologists and the socialist state were antagonists locked into mutually hostile positions over questions of censorship, controls on importing Western machines and software, and an underperforming, low quality domestic base of production. Evidence that supports this position fills the pages of *Mikrobáze*, and there is no reason to discard entirely this antagonistic aspect of state/user relations.

Charles Maier published an early take on this user/state antagonism in his 1997 book *Dissolution: The Crisis of Communism and the End of East Germany*. Surveying the landscape of Central and Eastern Europe in the 1980s, Maier noted, “modern authoritarian regimes had been governments based on projects. … Whatever the blueprint, they proposed an activist summons to some new physical or political construction” and yet by the 1980s, in his view, “no credible secular projects remained” and socialist governments withered, for there was no future left to build.[298] Simon Donig, meanwhile, did not blame the state for failing to blow the horn and summon socialist citizens to trail-blaze the digital frontier. He emphasizes instead the possibility that the state threw a party and no one came. Even in the 1970s, Donig observes, the GDR was concerned about the destabilizing effect an ostensibly neutral artifact like the computer could have on citizens exposed to Western variants. “East German specialists might grow 'indifferent' to the distinctive nature of technology under capitalist and socialist conditions and could start to value the foreign more than the national technology.”[299] Faced with the same conditions, artifacts

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[297] Ksenia Tatarchenko, “‘The Right to Be Wrong’: Science Fiction, Gaming, and the Cybernetic Imaginary in *Kon-Tiki: A Path to the Earth* (1985-86),” *Kritika: Explorations in Russian and Eurasian History* 20, no. 4 (Fall 2019): 755.

[298] Charles Maier, *Dissolution: The Crisis of Communism and the End of East Germany* (Princeton: Princeton University Press, 1997), 81-82, 105. Quoted in: Siegelbaum, *Cars for Comrades*, 72.

[299] Donig, “Appropriating American Technology,” 41.

and their ecologies might have been one agent in disaffecting young Czechs and Slovaks from the state.[300]

Yet these technologists were not drones, and they were not mindlessly directed by the force of technological determinism. As Jiřina Šiklová has pointed out, they existed in a kind of 'gray zone,' often conforming when the risks of disobedience seemed too high, but willing to read *samizdat* and *tamizdat* privately or engage in political criticism among friends and family. In this sense they were similar to much of the rest of Czechoslovak society, which for the most part occupied the ground between the minority of politically active Communist Party members and the even smaller minority of politically active dissidents.[301] However, computerists were uniquely attuned to questions of technological progress, economic and social modernization (which for them meant computerization, i.e. access and implementation of more, and more powerful, computers) and the government's fulfillment of policies and promises in those regards.

In a contemporary description of Gorbachev's reforms in the then-Soviet Union, social historian Moshe Lewin considered computer technologists and related technicians a powerful constituency for reforms of this particular, technocratic kind.[302] They were advocates of a more open society, particularly in regards to the public's access to computing and information within and without state socialist society. Ershov, for example, was one of many computer scientists, mathematicians and programmers to embrace "an all-encompassing vision of the information age that was opposed, both substantively and rhetorically, to the language of control and discipline

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[300] " … and their ecologies," I refer here, of course, not only to materials — peripheral devices such as printers — and spare parts, but also a more amorphous set of skills, techniques, know-how and attitudes that were sufficiently present in already industrialized (and digitizing) societies.

[301] "The gray zone exists within every defined social, professional, or interest group" in normalization-era Czechoslovakia, according to Šiklová. Jiřina Šiklová, "The 'Gray Zone' and the Future of Dissent in Czechoslovakia" trans. Káča Poláčková-Henley, *Social Research* 57, no. 2. East Europe: Where From, Where To? (Summer 1990): 352-353.

[302] Moshe Lewin, *The Gorbachev Phenomenon: A Historical Interpretation*, Berkeley: University of California Press, 1991: 143.

that dominated Soviet cybernetics" in the 1970s and '80s.[303] These technologist reform proposals, particularly a drive toward universal computer literacy involving accelerated production and distribution of microcomputers to schools, enterprises and youth clubs, took shape in the oft-forgotten and ultimately unsuccessful *uskorenie* program in the late 1980s' USSR.

Buttoned down socialist engineers have rarely played the lead role in our imaginary of anti-regime dissidence in East Central Europe. Yet in the 1980s the community was composed of relatively highly educated, younger individuals better connected to the outside world than many ordinary Czechs and Slovaks. Especially in the period of *uskorenie*, which responded to frustrations in the technologist cadre about the slow pace of computer modernization they perceived in the fields of education, industry, government and everyday life, they would seem likely candidates for dissent. That is, at least, when the term is more broadly considered than bodies on the barricade. As we will see, technologists were consumers of dissent, but they also manufactured it by smuggling technology, printing subversive materials, engaging in gray commerce and communicating political critiques in the difficult-to-surveil jargon of science fiction and computing.

It is worth considering what tied technologists together in late socialist Czechoslovakia by examining several critical questions. What political views did technologists hold, and what actions did they engage in during late socialism? How might we situate these individuals in a wider world of technologists who also grappled with rapid material, cultural and political change in non-socialist contexts? Did perceived technological backwardness translate into political

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[303] Gregory Afinogenov, "Andrei Ershov and the Soviet Information Age," *Kritika: Explorations in Russian and Eurasian History* 14, no. 3 (Summer 2013): 577.

dissatisfaction, as East German officials in the 1970s (among others) feared it might?[304] Does an examination of technologist politics produce a better understanding of the nature of dissent, conformity and apathy in the years leading up to 1989 in Czechoslovakia? This line of inquiry is divided into two parts: the case for support and the case for dissidence. Where individuals fell on this spectrum may help us ascertain not just the shifting state of politics in a small country in East Central Europe during the 1970s and 1980s, but also speak to pressing concerns about the role and responsibility of today's technologists.

To address these questions, this chapter will draw on a series of oral interviews conducted with Czech and Slovak mathematicians, programmers, educators, physicists and computer scientists. These individuals worked in a range of occupations during the late socialist period. They created computerized signalling systems to bring order to Prague traffic, built their own modems using off-the-shelf telephone transformers, conducted computerized linguistic analysis of the Koran in Khartoum, and co-founded Civic Forum. Supplementing their stories are letters to the editor, reader surveys, editorials, newspaper interviews and contemporary memoirs, as well as a wide body of secondary sources drawn from the history of technology and of East Central Europe.

Tools for Conviviality?
How Users and the State Organized around Computers

The socialist government of Czechoslovakia and its young community of computer enthusiasts enjoyed a mutualistic, or symbiotic, relationship for much of the 1980s prior to the collapse in trust engendered by the failure of the 1984 and 1985 Long Term Complex Plans for Electronization. The state actively supported the user community in both material and rhetorical

[304] Simon Donig, "Appropriating American Technology in the 1960s: Cold War Politics and the GDR Computer Industry," *IEEE Annals of the History of Computing*, 32, No. 2, (April-June 2010): 10.

terms, as we shall see, by providing computer use instruction, software libraries, and programming courses, among much else. Access to information technology in 1980s' Czechoslovakia was limited, as in most non-Western countries, and state support was critical to users' acquisition of skills, hardware, and even legal support.

Meanwhile, policymakers were aware of the pressing need for robust cadres of computer-savvy citizen experts, in line with the official discourse of the scientific and technological revolution which envisioned such experts using computers as powerful tools to construct the future socialist economy. The danger that such artifact-expert coupling might derail, ideologically, due to the increased practical friction of everyday technological interaction under late socialism (i.e., the dissatisfaction that arose every time a research scientist was forced to work with inadequate equipment, every time a faulty Soviet mainframe broke down, every time a user walked into a shop with empty shelves) appears to have been sidelined due to concerns over industrial and military competitiveness or gone unrealized by policymakers. Instead, they called on technologists to collaborate with each other, to volunteer technical articles to hobbyist journals, to share software and hardware innovations and to focus on creating economically useful or practical programs for society. This was a transactional relationship wherein state and technologist borrowed from one another, becoming stronger as they grew interdependent.

A distinct form of mutualism between state and technologist emerged out of the pages of *Mikrobáze*, because the state explicitly founded that publication to be an interface. To that end, editors there enjoyed an unusual degree of press freedom, publishing strong user critiques of state technology policy as early as its second issue in 1986. However, the magazine also presented the state's point of view to its computer-using readership, especially in regular page one editorials composed by an editorial board—editor-in-chief Jan Klabal, managing editor

Ladislav Zajíček, and secretary of Svazarm 602, Josef Kroupa—throughout its publication life (29 issues from 1985-1989). Notably, it is unclear how seriously readers engaged with these mostly state-positive editorials. Patryk Wasiak, writing on the history of the Polish computer user community, argues convincingly that socialist citizens in general were highly skilled at shucking off the outer layers of ideology and getting at the real content beneath.[305] Nevertheless, the state-supporting editorials (along with favorably worded questions in published interviews with officials) played an important role in bounding politically acceptable discourse for the technologist community.

Thus, *Mikrobáze* in its early years (1985-1987) reveals evidence of sincere material cooperation, empathy and mutual responsiveness between computer users and elements of the socialist state. This assessment of the user community around *Mikrobáze* is in line with Alexei Yurchak's observation that Soviet citizens living under late socialism were "actively engaged in creating various new pursuits, identities, and forms of living that were enabled by authoritative discourse, but not necessarily defined by it."[306] Users could be highly critical of, for instance, state censorship on software publishing and import restrictions. Official voices often condemned black and gray technology markets and users' frivolous, bourgeois devotion to computer games. However, the genuinely constructive aspect of user/state relations complicates and enriches the previous emphasis on opposition that exists in the literature covering the history of personal computers in East Central Europe.

[305] "The ease and selectiveness shown by young users in coping with the high threshold to access the technology and limited scripts are remarkable. Young people could visit a computer bazaar, an offshoot of the socialist economy of shortages, to obtain new software. They could read computer magazines adorning program listings with messages that typing those programs helped to strengthen the socialist economy. Having read those listings, they would reject the political messages then check the game review section to prepare for their next visit to the bazaar." Patryk Wasiak, "Playing and Copying," 129-150.

[306] Yurchak, *Everything was Forever*, 32.

In the fall of 1985, the 4,000 subscribing members of *Mikrobáze* received a survey. Its purpose was to assess the types of computers they owned, the software they worked with, their interest and enthusiasm in technical matters, and how the editors could best serve the burgeoning community of technologists in Czechoslovakia in upcoming issues. The community that formed around *Mikrobáze* is a glimpse of a new way to understand the interaction between user communities and the socialist state. This is the paradigm of mutualism. Historians often tell a story about a binary struggle in which an inflexible, sclerotic bureaucracy could never have successfully midwifed the transition to a digital era of personal computers that prized individual initiative, risk-taking and open markets.[307] Closely examining *Mikrobáze's* first survey to its readers, as well as the informal introductions and interviews published in subsequent issues, reveals a much more mutualistic relationship between the community of users and the state.

There is evidence that fits the traditional paradigm of an oppositional binary quite closely. When asked how they usually obtain software programs for their computers, respondents answered overwhelmingly (98.5 percent) that they did so "in exchange" rather than by purchase.[308] This is unsurprising, given the straitened conditions of software availability for purchase (at any reasonable price, and legitimately) in socialist Czechoslovakia. Asked how many would like to contact other readers the response was quite negative—only 29 percent

[307] Sometimes this is more literally a story than others. See Spufford's chapter on "The Unified System, 1970," "On 18 December last year Lebedev sat in a meeting at Minradioprom, the Ministry of Radio Production, and heard the assembled bigwigs of government and the Academy talk themselves into destroying the Soviet computer industry." Spufford, *Red Plenty*, 329-340.

[308] "Výsledky ankety Mikrobáze z roku 1985" (Mikrobáze Survey Results from the year 1985), *Mikrobáze* 2 (February - June, 1986): 5. Perhaps tongue-in-cheek, the editors playfully placed "no comment" under the section on software acquisition, acknowledging the dubious legality of piracy, swapping, and use of black/gray markets they would have known went on.

wanted such interactions.[309] This was unusual enough to warrant comment from the editors. "Is it so, that the computer should lead people to a deep individualism?" they wondered.[310]

Their amazement is sensible. At first glance, the two response sets — how readers obtained software programs, and whether readers wanted increased contact with one another — do not logically cohere. Readers admitted that they wanted to sample more software programs (100 percent positive response); tellingly, most of them revealed that half the time the programs they used were missing instruction manuals—these normally came bundled with the purchased program, and points to just how widespread the practice of swapping used programs among computing enthusiasts was.[311] Yet less than a third of them claimed they wished to meet each other, a prerequisite for the kind of software swapping and information exchange they claimed to utilize extensively.

A reasonable inference is that these readers were not antisocial, merely allergic to meeting each other under the aegis of state supervision. Certainly, computer savvy (or at least computer curious) readers wanted more social contact with one another. However, they correctly surmised that the type of contact *Mikrobáze* (and thereby Svazarm) would sponsor might be too intrusive and regulatory for their comfort. An additional tension that spurred users to abandon the clubs in favor of their own private work with computers, or with small circles of like-minded friends, lay in the perception of the clubs as "amateurish" or childish circles most often equipped with underpowered or older domestic microcomputers like PMD 85s, IQ 151s and Didaktiks.[312] More powerful, and more fashionable, imported computers like the Atari, Commodore and ZX Spectrum were less common in the state-sponsored clubs. However, groups of friends and

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[309] Ibid., 10.
[310] Ibid.
[311] "Výsledky ankety Mikrobáze z roku 1985," *Mikrobáze* 2 (February - June, 1986): 10; Ibid., 8. Refer to question L. "U kolika procent programů, které mám, mi citelně chybí manuál pro výuku jejich ovládání."
[312] Zlatuška in discussion with the author.

enthusiasts around the country had organized into small-scale specialist clubs around those individuals in their local networks who owned one, pooling software, manuals and funds for machine access.[313] This evidence neatly supports a view of users wriggling free of the state's supervision and control. Yet, additional evidence from the same survey supports a different, less antagonistic paradigm.

Three survey questions—M, N, and O—focused on how *Mikrobáze* might serve its readership base and solicited input: both on the kinds of software programs it might offer, and what the most convenient way to distribute them might be. This was a potentially essential service at a time when software programs were rather difficult to obtain. On a particular point, survey question M: "If I draw on all types of commercial programs from *Mikrobáze*, I'd rather … " readers were split on whether they wanted a single bulky instruction manual or a greater number of less detailed small manuals to accompany their programs.[314] The editors sought a compromise solution to please everyone, opting for one or the other choice depending on the complexity of the programs they sent out on tape.

Users pushed the eager-to-please editors to their limits. Their demands from *Mikrobáze* were lengthy and detailed. They clamored for "a high awareness of the status and development of microcomputer technology abroad," while they pointed out "that our internal business network cannot purchase any of our (nor foreign) computers and their peripherals, nor the necessary literature." Users issued "a cry for programming courses" since interest in the subject had overwhelmed educational institutions' capacity to offer courses taught by skilled instructors. *Mikrobáze*'s readers had a "strong interest in hardware involvement" and asked for the magazine to publish more instructions for home construction and repair of word processors, video-

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[313] Mareš in discussion with the author.
[314] "Výsledky ankety Mikrobáze z roku 1985," *Mikrobáze* 2 (February - June, 1986): 8. Question M: "Pokud budu čerpat ze služeb Mikrobáze v oblasti všech druhů užitkových programů, budu radši, když:"

digitizers, and the ZX Spectrum. Unsurprisingly as well, "members in the survey clamor[ed] for a greater number of games in the cartridges" that *Mikrobáze* distributed to its readership. Given their importance for teaching programming skills and their social currency as a form of artistic production users might share with each other, games were often professionally important, besides being good fun.[315] Finally, the editors of *Mikrobáze* bemusedly included a list of contradictory demands from readers. Survey respondents scolded the editors "Do not write so scientifically, we are not all engineers," while others pleaded that the magazine "go straight to more complex computing systems," and skip "the basics of programming or hardware for beginners" entirely.[316]

Due to a mix-up in the instructions for completion sent out to readers, subscribers returned only 298 completed surveys out of a distributed print-run of 2,500. Nevertheless, this constitutes a significant sample of both the *Mikrobáze* readership and the personal computer user community in Czechoslovakia as a whole in the mid-1980s.[317] In these suggestions and demands, we see an almost filial relationship between users and the socialist state. Users, like precocious teenagers (as many of them certainly were), felt that they were the future, and that they possessed

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[315] Fiona Beals, a young woman who began to learn programming as an amateur home user in 1980s' rural New Zealand, started out with "other peoples' game programs" on the ZX Spectrum. Melanie Swalwell, "1980s Home Coding: The Art of Amateur Programming," in *Aotearoa Digital Arts Reader*, Auckland: Aotearoa Digital Arts/Clouds, 2008: 196.

[316] 1: "Většina členů požaduje vysokou informovanost o stavu a vývoji mikropočítačové techniky v zahraničí ... ve vnitřní obchodní síti nelze zakoupit žádný náš (ale ani zahraniční) počítač a jeho periférie, ani potřebnou literaturu." 2: "V dotaznících se objevuje volání po kursech programování." 3: "Z ankety vyplývá výrazný zájem o hardwarová …" 4: "Jedním z častých návrhů je zavedení inzerce." 5: "Vyznívá požadavek, aby Zpravodaj vycházel častěji, např. jako měsíčník." 6: "Určité procento členů se v anketě dožaduje většího počtu her na kazetách." 7: "... nepište tak vědecky, nejsme všichni inženýři … ... navrhuji nezabývat se takovými věcmi jako jsou základy programování nebo hardwaru pro začátečníky, ale jít rovnou ke složitějším výpočetním systémům …" "Výsledky ankety Mikrobáze z roku 1985," *Mikrobáze* 2 (February - June, 1986): 4, 11-12.

[317] The size of the computing community in the country in the fall of 1985 as a whole is difficult to estimate. Government statistics from 1989 indicate that perhaps one-in-twenty people in Czechoslovakia owned a computer (or approximately 750,000 people) although this figure is subject to interpretation ("ownership" often simply meant access to a computer, whether at work, in school or at the clubs) and also reflected a community that had grown rapidly both in general during the late 1980s, and especially after the end of the CoCom embargo on 8-bit home computers in 1987, which led to a surge of imports, both licit and smuggled. Český statistický úřad, *Česká republika od roku 1989 v číslech—2016*, Prague: Czech Statistical Office, 2016. Available from: https://www.czso.cz/csu/czso/ceska-republika-od-roku-1989-v-cislech-w0i9dxmghn.

special skills or status that entitled them to certain preferences (educational courses, video game cartridges) and assumed the existence of a state that listened to them through their input to *Mikrobáze*. The editors of *Mikrobáze* represented the state-as-parent, reminding readers to be realistic and ironically pointing out their sometimes-contradictory requests. It is telling that the editors had to constrain such expectations in the first place. It points to a level of privilege, afforded by the state and its agencies to computer technologists, that ordinary Czech and Slovak workers might well have envied.

By the end of the 1980s, many well-connected technologists in Czechoslovakia and throughout the state socialist countries of East Central Europe enjoyed access to travel, publications, conferences and a level of funding that marked them as a *de facto* new class of favored workers. In December 1988 the *New York Times* reported on the high-tech success of the Slušovice agricultural cooperative near Zlín in Moravia:

> The farm "now does a budding business producing annually about 300 eight-bit research computers and 1,000 16-bit personal computers, plus software, for enterprises all over Czechoslovakia. It also trains computer programmers. … Slusovice's [sic] success and independence have even yielded a bumper crop of jokes. One goes like this: when Moscow decided to station new nuclear missiles on Czechoslovak soil to counter American Pershing missiles in Europe, the farm's directors refused to accept one on their land. They had enough Western money to purchase their own Pershing, they politely informed Prague."[318]

Technologists had enviable access not just to hard currency during this period, but another rare commodity ordinary Czechs and Slovaks craved—peace and quiet from meddling government officials. In a 2009 interview with *Respekt*, Milan Frnka, the former head of Slušovice's computer division in the 1980s, recalled, "Because the Communists absolutely did not

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[318] John Tagliabue, "Czechs Laud Shrewd Farm Co-Op," *New York Times*, December 19, 1988, D00001. https://www.nytimes.com/1988/12/19/business/czechs-laud-shrewd-farm-co-op.html.

understand computers, they left us in peace. At times, perhaps they were a little afraid that we might install something [malicious or subversive] somewhere."[319]

It is clear that government support for computer hobbyists and professionals was significant and welcomed by users in the 1980s. Yet perennial shortages of hardware, continuing import restrictions of foreign (especially Western) information technology, and a widely perceived lack of quality in domestic personal computers characterized user interactions with personal computers in late socialist Czechoslovakia. As examined in more detail in chapter five, conceptions of computer shortage were initially regulated by what sociologists Martin Hájek and Tomáš Samec term "the socialist discourses of thrift and saving" that encouraged so-called economically productive uses of the computer and exhorted DIY tinkering and craft production—"our amateurs can work miracles!"—as the solution to empty shelves.[320]

However, this complicates the existing literature on consumer shortages under late socialism because unlike consumer goods such as bananas or blue jeans, the computer held unique symbolic resonance as stand-in for the government's success or failure in keeping up with technological progress, and because of its potential "national economic benefits and [for the] defense of our homeland," as Svazarm proclaimed in 1982.[321] James W. Cortada notes the "paramount role of governments in effectively (or not) sponsoring the development of IT skills, access and hardware in a country."[322] In this respect, Czechoslovakia—like the GDR—placed much rhetorical emphasis and significant organizational effort and funding (through agencies

[319] "Protože komunisté počítačům vůbec nerozuměli, nechali nás v klidu. Občas se možná i trochu báli, že bychom mohli něco někam nainstalovat." Milan Frnka, quoted in Bára Procházková, "Zrod Kapitalismu Czech Made" (The Czech Made Origins of Capitalism), *Respekt*, September 28, 2009. https://www.respekt.cz/tydenik/2009/40/zrod-kapitalismu-czech-made.
[320] Martin Hájek and Tomáš Samec, "Discourses of Thrift and Consumer Reasonability in Czech State-Socialist Society," *Sociologický Časopis* 53, no. 6 (2017): 806; kš, "Na prahu páte generace," 4.
[321] "Zaměřit tuto zájmovou činnost tak, aby rostl počet techníků, hlavně mládeže, kteří umějí zvládat výpočetní techniku a budou ji schopni využívat ve prospěch našeho národního hospodářství i pro zvyšování obranyschopnosti naší vlasti," Amatérské radio, "Svazarm a výpočetní technika," *Amatérské radio* 31, no. A4 (1982): 140.
[322] Cortada, "How New Technologies Spread," 238.

like Svazarm, SSM, ČSVTS, DDM) on successfully navigating the personal computer revolution. However, this is not a simple question of a presence or absence of government support. It seems to be, instead, about the particular mix of policies employed by a state to advance its goal of fostering a technically perceptive generation of youth and workers. This particular recipe of policy decisions could be a difficult needle to thread.

Czechoslovakia could finance and organize the training of technically skilled cadres of computer users for the future through supporting the computing activities of youth and special interest organizations such as Svazarm, and by publishing *Mikrobáze* and other technically oriented magazines like *Věda a Technika Mladeži*. In Taiwan, Honghong Tinn points out that hobbyists acquired their expertise and ability to "powerfully revise or produce technological artifacts" via the kind of "informal channels or personal networks" Svazarm and other youth computer clubs were designed to complement or, ideally, supplant.[323] Unfortunately, this model—while it fits some of the evidence presented here, such as Smutný's prosecution at the introduction to this chapter—lends itself too easily to complacent assumptions about state socialism's inherent inability to master the personal computer revolution and the transition to a flexible, digital world.

Amateur miracles were possible, at least up to a point. For a brief span of years in the mid-1980s, from 1984 to 1987, the government's Long Term Complex Electronization strategies promised to implement needed reforms, expand the production of Czechoslovak microcomputers and address technologist concerns. While these state tactics were largely effective at keeping hobbyists and professionals on side during the mid-1980s, it is time to consider the origins of the technologist frustration that manifested in petition-signing, protest attendance, satirical songs and *samizdat* games by 1989. Dissatisfied technologists ultimately converted from a position of

[323] Tinn, "From DIY Computers to Illegal Copies," 75.

political indifference to a recognition that the government was an increasingly unsuitable partner, criticizing and acting out at a government they had often experienced as not just a support, but an ineffectual, blinkered and at times chaotic force in their lives.

'Apples of Discord': Artifact-Generated Dissent among Technologists

For many years, the common sense assessment of historians of technology has been that dissent was the most likely, if not default, political position of technologists living under state socialism in the last third of the 20th century. We have already observed Charles Maier's argument that by the 1970s and 1980s, state socialist regimes had exhausted their capacity to offer large-scale meaningful and transformative projects for its citizens to engage in with any kind of enthusiasm or hope for the future. To the extent that progress was measured in material, technological terms—ubiquitous telecommunication, more powerful computers—Simon Donig and a host of other scholars, such as János Kornai, David Wellman and Karen Dawisha, claim with significant evidence that technologists often equated state socialism's difficulty with technological innovation and distribution with a broader social and political backwardness.

Kornai asserts that among capitalist societies' triumphs "are for example the computer, the photocopier, synthetic fibers, and color television. ... There would be evidence for the superiority of the socialist system if at least a substantial proportion of these had been introduced in socialist countries first. With one or two exceptions, however, this was not the case."[324] Technologists were keenly attuned to this concretized form of backwardness. If we accept this

[324] "Ideologues brood over whether the user becomes 'Westernized' by using computer software-compilers and application programs - that have been generated in the minds of Westerners." Wellman, *A Chip in the Curtain*, 27; "… worrying to the regimes is the massive yet largely unofficial importation of home computers. Studies have shown that computer technology is the only branch of industry that Soviet-bloc youth are genuinely interested in entering. Here, the regime is concerned that young people are growing up with the view that Soviet-bloc technology cannot match the West." Karen Dawisha, *Eastern Europe, Gorbachev, and Reform: The Great Challenge*, Cambridge: Cambridge University Press, 1990: 127; Kornai, *The Socialist System*, 294-297.

premise, technologists in Czechoslovakia and elsewhere in the region were a fertile ground for the production, dissemination and consumption of forms of dissent in the years leading up to the 1989 revolutions. Although Czechoslovakia and other fraternal socialist countries were nominally workers' states, state-employed white-collar professionals (among whom we would certainly count mathematicians, programmers, hardware engineers and educators) had become the dominant class toward the end of the 20th century. Whether they were natural dissenters, and the extent to which they did, in fact, buck the system therefore holds significance for any understanding of the politics of everyday life under late socialism. To that end, it is useful to consider whether "artifact-generated" dissent existed or posed a significant political problem for state socialist governments, to parse the biographies of technologists in order to understand their political action and inaction, and to examine closely how they used the coded discourses of science fiction and computer science to communicate and affirm certain shared ideas about political reform.

We have already encountered Tomáš Smutný, the devil-may-care entrepreneur with the get-out-of-jail-free card. His brother Eduard, by comparison, was much more troubled when political scientist Karen Dawisha interviewed him in 1988. Smutný was well-known in the Czech computing community as the creator of the 'Ondra' which was held up by the government as an example of a truly Czech microcomputer (though its processor was not Czech, but in fact the U880, East Germany's copy of the Zilog Z80). To Dawisha, Smutný lamented:

> In Czechoslovakia there are at present several tens of thousands of Western-made microcomputers, and each summer their number increases by about 10,000. With these computers comes not only technology but also ideology. ... Children might soon begin to believe that Western technology represents the peak and that our technology is obsolete and bad. ... One of these days I will record on the tape for you what the children say and how they laugh when they see how we are unable to meet our plans for computer production, how they laugh when [the casing on] our computers [has] to be opened periodically to prevent them from burning out. ... We must look at it from the political

> point of view, because in 10 years' time it will be too late to change our children. By then they will want to change us.[325]

This widespread sense of wanting more in almost every way—better quality machines, more peripherals like printers and monitors, and a greater selection of software to choose from—haunted many young Czech and Slovak computer hobbyists and professionals in the 1980s. In that sense, computer acquisition at first glance appears no different than a number of other coveted consumer goods and status symbols, such as televisions, record albums or blue jeans. Acquiring a scarce and expensive computer, especially a popular Western model like the ZX Spectrum, "conferred an identity that set you off from socialism, enabling you to differentiate yourself as an individual … [in] an undifferentiated collectivity," as anthropologist Katherine Verdery asserted.[326] For younger users, it might not just signal a family's wealth (hard currency had to be exchanged into *bony*, a kind of coupons, to shop in the closed Tuzex import shops) but also an element of cosmopolitanism in a family's ability to travel to the West or correspond with relatives living and working in the United States, France or elsewhere.

Yet access to the computer meant more than a casual act of consumption, and it must be partially uncoupled from the category of other desirable consumer goods. As Patryk Wasiak has noted, the straightforward consumer "scripts" which influenced user/artifact interaction in the West between individuals and computers could not occur in the state socialist East.[327] In buying or accessing a computer, an individual typically became an active user who of necessity co-constructed new scripts of user/artifact interaction, often unique to them, by bartering for software, cracking British games, making hardware modifications to enable Soviet parts to work

[325] Dawisha, *Eastern Europe, Gorbachev, and Reform*, 127.
[326] Katherine Verdery, "What was Socialism and Why did it Fall?" in Vladimir Tismaneanu, ed., *The Revolutions of 1989*, London, UK: Routledge, 1999: 73.
[327] Wasiak, "Playing and Copying," 142.

with West German computers, or painstakingly programming imagined versions of unobtainable Western games seen in a magazine.

This was the case in state socialist societies but also in shortage or peripheral societies generally.Theodoros Lekkas describes Greece in the 1980s, where "the user had to develop a more active attitude towards his new computer in order to perform even the simplest of tasks, such as printing a character. A user could only manage this by experimenting with the software."[328] These complex, highly-involved and time demanding user/artifact interactions engendered powerful emotional connections to machines and software. Magda Krejčířová reviewed Czechs' nostalgia and contempt for the late socialist computing scene in "Home Computers—The Recent Past".[329] Beginning in the early 1980s, Czechoslovakia attempted to maintain pace with early home computers such as the Sinclair ZX-80 and the Commodore 64. The solution took form as domestic computers like the IQ 151 and the PMD 85.

Yet users' reactions to domestic computers were mixed at best. Although Krejčířová admits "these devices played an indispensable role in eliminating digital illiteracy," she insists that, growing up, "the faulty and incompatible PMD 85 and IQ 151 were the bane of our education."[330] Reactions to the IQ 151, in particular, were strongly negative in the 1980s and later. "It was the only computer about which I knew absolutely everything," one user recalled "beginning with the hardware (a flickering screen—it's warm—the cockroaches [slang for contemporary integrated circuits] would fall out and you'd have to climb [around] back and tuck them in), through the software and its unfailing ability in winter nights to heat up half the den."

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[328] Lekkas, "Legal Pirates Ltd," 83.
[329] Magda Krejčířová, "Domácí počítače—nedávné minulosti" (Home Computers—The Recent Past), available from: http://www.fi.muni.cz/usr/jkucera/pv109/xkrejcir.htm. 1999.
[330] "… poruchové a nekompatibilní počítače PMD 85 a IQ 151 byly prokletím našeho školství … skutečností však zůstává, že tyto přístroje sehrávají nezastupitelnou roli při odstraňování počítačové negramotnosti." Krejčířová, "Domácí počítače."

Due to the poor quality of the solder, the "cockroaches," a Czech slang term for integrated circuits, would detach from the motherboard when it was too warm. Users then had to reach around and re-attach their metallic 'legs,' or pins to the motherboard in the rear of the computer. Another user seconded the faint praise for the IQ 151's tendency to over-heat quickly during use. "I got a great multifunctional computer in the IQ 151," they reported. "This machine not only calculated, but could also boil water for coffee or tea or could serve as a heater."[331]

The Slovak-produced PMD-85 fared little better with users. Krejčířová recalls: "I met with the PMD-85 computer in the fifth grade, and it was my very first look at something which I totally did not understand, and I feel I do not understand it to this day. … Today all that I can remember is constantly checking the computer for how warm it was, usually then followed by an anti-fire provision—shutdown of the computer."[332] Czechoslovakia's 8-bit retort to Western computer imports "was an unreliable monster with surprising architecture. BASIC had to draw from ROM, video memory took up 16 KB (note, a third of RAM!) but only displayed the contents of 12 KB. The first version had a keyboard—with which you didn't know whether its 'click' was released by it or the broken bone in your finger."[333]

Daniel Vávra, the writer behind well-known games like *Mafia II*, remembers fondly his rare experiences playing with a classmate's Atari in 1980s' Czechoslovakia. "It was a feast," he recalls, definitely superior to the domestic-made computers at school (when those were even

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[331] "Byl jediný počítač o kterém jsem věděl naprosto všechno, počínaje hardwarem (blikající obrazovka = je mu teplo = rozmontovat a zastrkat vylezlé šváby zpátky), přes software až po jeho neutuchající schopnost v zimních nocích vytopit svým teplem půlku kabinetu." "... jsem se dostal ke skvělému polyfunkčnímu počítači IQ 151. Tento stroj totiž nejen počítal, ale mohl též vařit vodu na kávu či čaj nebo mohl sloužit jak topné těleso ..." Ibid.

[332] "S počítačem PMD-85 jsem se setkala v pátě třídě a byl to můj úplně první pohled na něco, co jsem naprosto nechápala a mám pocit, že nechápu dodnes. … Jedinné co si pamatuji, bylo neustálé kontrolování počítače, jak moc hřeje a pak většinou následovalo protipožární zaopatření = vypnutí počítače." Krejčířová, "Domácí počítače."

[333] "Byla to nespolehlivá obluda s překvapující architekturou. BASIC jste museli natahovat z ROM-ky, videoramka zabrala 16 kB (pozor, třetinu RAM!), ale zobrazovala obsah pouze z 12 kB. První verze měla klávesnici, při které jste nevěděli, zda ?klik? vydala ona nebo prasknutá kost v prstě." Ibid. BASIC is a set of programming languages designed around ease of use, created by John G. Kemeny and Thomas E. Kurtz at Dartmouth College, New Hampshire in 1964.

available—he recalls an instructor droning on about the properties of the diode before admitting to the class that no computers would be available for the class that year). When he was ten years old, Vávra held the PMD-85, made from "the same materials as radiators," and by the same company, in comparatively low esteem.[334] It is no wonder that East German officials worried about the "IBM hypothesis" in the 1970s. Users of both domestic and Western computers might start to value the quality and utility of the artifact itself, regardless of origin. This ostensibly de-politicized focus on the artifact was in fact fraught with political meaning in the ideological struggle of the Cold War.[335]

Preserving Dignity: Memories of Persecution, Adaptation and Dissenting Acts

It is tempting to view personal narratives of technological dissatisfaction as compelling support for artifact-generated dissent of the kind Donig, Cortada and other historians of technology have asserted. However, the balance of the available evidence does not bear this out, and the argument itself feeds a problematic narrative discourse about the end of the Cold War, in which American-style consumerism and superior material culture proved irresistible to pent-up populations behind an Iron Curtain. Holan and his friends were much too busy living life to the fullest: "Of course the information that [the] faculty is unable to service us with enough computer time with enough good computers was terrible, yeah? But in fact we were enjoying our

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[334] "Když jsem se přihlásil do kroužku výpočetní techniky, několik prvních hodin nám soudruh vedoucí popisoval co je to dioda, než se přiznal, že počítače letos nebudou. Ve škole jsme měli PMD, které se vyrábělo ze stejného materiálu jako topení (asi i stejná firma) a tím to haslo. Počítače se výhradně pašovaly ze západu, nebo kupovali v Tuzexu, což bylo oboje výsadou elity, takže u nás ve třídě měl jeden člověk Atari. Hry jsme mohli hrát, pouze když přijela pouť a s ní světský s maringotkou s deset let starýma automatama. To bylo posvícení." Daniel Vávra, "Za komančů bylo skvěle (když zrovna nebylo špatně)," Personal Blog, October 24, 2013. https://danielvavra.blog.idnes.cz/blog.aspx?c=371755&setver=touch.

[335] Donig, "Appropriating American Technology," 41.

hobbies, our friends, pubs, wine cellars. So, what's that?"[336] Technological lag, perceived as a *fait accompli*, was not the kind of acute harm that could provoke technologists to forms of dissent. Their treatment at the hands of the state, however, was another matter.

Gruska grew up in a family that suffered directly from the Stalinist political climate of the early 1950s. His father was imprisoned around 1950 and thrown into a heavy labor camp alongside officers and priests. He was only rehabilitated by the Party after his death in 1968.[337] Mannová, who worked at Aritma in Prague and later taught programming at a gymnasium in the city, remembered two of her uncles—one a volunteer Czech pilot in the British RAF—imprisoned by the Communists in Terezín, the former Nazi concentration camp, during the 1950s.[338] Zlatuška recalled the indignity of his mother, a secondary school teacher of history, first threatened and then fired from her job, banned from teaching history altogether and forced to earn a living as a Russian language teacher, because of her involvement in the 1968 Prague Spring.[339] Studenka, who worked as a programmer of hybrid ADT computers with INORGA during the 1970s and 1980s, shared his father's story: A skilled tailor and amateur musician, his father had gradually saved enough money to open a small clothing shop in the town of Slavičín, in Moravia. Then, in 1948-49, the Communists came and took everything without restitution. Studenka's father died a chimney sweep.[340]

Nor were these abuses confined safely to the Stalinist past. Mannová was on the edge of tears as she described how, upon her return to Czechoslovakia from Canada in 1972, she was blacklisted from her former employment at Aritma, prevented from pursuing her PhD, and struggled with the fact that her daughter was barred from studying what she wanted. "She studied

[336] Holan in discussion with the author.
[337] Gruska in discussion with the author.
[338] Mannová in discussion with the author.
[339] Zlatuška in discussion with the author.
[340] Studenka in discussion with the author.

agriculture and she is now a teacher and she's happy," Mannová said, "but anyway at that time it was not easy for me. If I was not allowed to do a PhD … this was my decision, but what about my daughter? She did nothing wrong."[341] Decades later, Pajas recalled how the normalization regime banned him and his friends from working in their field of expertise, and that this led directly to suicides among his circle of friends who could not bear a life apart from physics.[342]

From these accounts, it would seem that state persecution in various forms—imprisonment, threats, blacklisting, and so forth—was the normal experience for computer technologists in former Czechoslovakia, either for themselves or their families. However, interviews also revealed that this routine mistreatment did not axiomatically translate into overt opposition to the Communist Party and the government in late socialist Czechoslovakia. In Miroslav Vaněk's work *Velvet Revolutions: An Oral History of Czech Society*, he presents a range of ordinary Czechs, including technicians, who have a nuanced, even positive, interpretation of their lives under socialism.

Jaroslava Krudencová, for example, a data center worker, fondly recalled the employment security every Czech enjoyed under socialism, and this view was commonplace—as Vaněk wrote, "Almost everybody in our sample of three hundred interviewees welcomed the state's guarantee of full employment."[343] Acknowledging the scarcity or poor quality of some consumer goods, Gruska nevertheless agreed. One should note, he pointedly recalled, that:

> The situation in the country was not bad. For example, even now I think, people here are maybe richer than in Western countries. If you take their belongings — they have a house but they don't have to pay debts; they have this, they have that; and in the West, in Germany, people don't own their apartment, they have to pay, so finally what they have is [not much]. … In addition, in the village, it was common when two people got married they had a house in one, two years. A house! Without debts. So many of those things

[341] Mannová in discussion with the author.
[342] Pajas in discussion with the author.
[343] Vaněk and Mücke, *Velvet Revolutions*, 120.

were very different.[344]

Indeed, some of the younger computer technologists interviewed in this research expressed even more positive views of state socialism. Bartošek explained that both he and his parents had been members of the Communist Party during the late socialist era, and thus his first, rude awakening to many of the problems and grievances held in by other Czechs and Slovaks came only during the ’89 revolution. “I was very, very naïve,” he recalled. “I didn’t realize a lot of consequences and things like that, because for me, when I was young, it was quite normal, it was the society [in] which I [had] grown up, I never met with some people which really were hurt by the regime.”[345]

Overall, most of the subjects interviewed professed that, during the 1970s and 1980s, they held generally anti-Communist sentiments, due in part to their own, their family’s or their friends’ mistreatment at the hands of the party. Other shared sources of opposition included economic inefficiency, bureaucratism, censorship, import restrictions and the difficulty of foreign travel. These general sentiments, however, only sometimes transformed into the kind of direct action against the regime that has usually merited the label of ‘dissent’ in the West. Understanding the specific roots of inaction in this community, which mostly manifested as political indifference, aids historians’ efforts to analyze dissidence and dissenting actions more broadly. Dissidence and dissidents have been much studied in an effort to ascertain the causes of the 1989 revolutions in East Central Europe, but the complex community- and individual-specific rationale for indifference merits scrutiny as well. Unlike Poland in the 1980s, most Czechs and Slovaks presented as politically indifferent right until November 1989. Most computer technologists, too, did not attend rallies or sign on to Charter 77, as did Trojan and his

[344] Gruska in discussion with the author.
[345] Bartošek in discussion with the author.

colleagues in the software group Sokol, Benda, Sedláček and Žák. Mannová recalled how glad she was that no one ever asked her to sign the Charter, given the harassment she and her family were already receiving from the government at that time.[346]

Drawing on Michel de Certeau, Jonathan Bolton notes that computer technologists, just like the rest of their neighbors in Czechoslovakia, always had "room to maneuver, even in the most controlled situations. They can cross against the light and walk on the grass, reinterpreting restrictions to make them more amenable to their personal projects; they cocreate the contours of their lives, rather than passively accepting dictates from above."[347] Often, they had to find or create spaces of political expression and relative autonomy in everyday life.

Interview subjects themselves were not always sure what did and did not constitute dissent. Beneš remembers that his father "was involved in some activities. Not something like dissent, but he definitely was not [a] supporter of [the] communist regime. I remember there was a big hall for dancing and music, and the worker stole money here and let this building explode, to hide evidence. I remember," he said, "my father took pictures, secretly, of this 'accident' because you couldn't take pictures of anything at that time," and thus preserved and shared with others in the community the truth of the crime and attempted cover-up.[348] What would appear, to Western observers, clear acts of anti-Communist dissent were also by no means obviously so to contemporary Czechs and Slovaks. According to Trojan, even the consequences from the regime after his signature appeared on Charter 77 were completely unanticipated:

> I signed it before it was published. I signed it in 1976, in December, and of course Sokol, his father-in-law was Jan Patočka, and Jan Patočka was one of the writers of the Charter, so he in fact brought it to me and so we knew even in late 1976. So I am always saying that those people who signed Charter 77 in 1976, they were not so brave, because really I didn't expect what horrible … how they will take it! … I thought 'Well, maybe it will be

[346] Mannová in discussion with the author.
[347] Bolton, *Worlds of Dissent*, 21.
[348] Beneš in discussion with the author.

one or two investigations from the police, it's not important,' but it was incredible.[349] Pressure stepped up immediately. There were institutional threats to evict him and his other signatory colleagues from the software group at VÚMS. There were threats to ban his father's music and render him penniless. None of them materialized. He realized, he said, that "they needed us, of course. And it was big solidarity in the institute. Because the people in the institute said 'If you kick out Sokol, or Trojan, or Žák, we will all go out!' So they were a little bit nervous about that."[350] Computer technologists, members of the technical intelligentsia due to their skills, enjoyed an additional measure of autonomy within the socialist system compared to their fellow citizens. It can make their long-time political indifference as a community something of a puzzle: clearly, many technologists had greater latitude to openly dissent than their fellow citizens, but chose not to do so.

The late socialist system was also not particularly adept at consistently repressing computer technologists, even when that was the goal officials aimed at. Zlatuška came from a suspect family. His parents helped assemble *samizdat* literature, part of the Edice Petlice circle surrounding Ludvík Vaculík at the time. He gleefully recalled that, despite restrictions meant to prevent him from pursuing an education in his subject of choice, he found all the right loopholes. First, his participation in the well-known mathematical Olympiads allowed him entry to the right secondary school. When it came time to attend university, the regime threw up additional restrictions, but he dodged those as well:

> For the university studies I was admitted because of the results in competitions, some sort of that simple scientific work and so on, so I completely bypassed all entrance procedures. I was admitted without any exam. Which was quite advantageous because again in '77 that was the year of Charter 77 and somehow [additional] political pressures, so again it seemed that it might not be entirely easy to go into university studies, but it

[349] Trojan in discussion with the author.
[350] Ibid.

> turned out to be easier than I thought.[351]

Finally, he decided to pursue a PhD and faced one last set of political hurdles to overcome. At this time, he was already heavily involved with dissident literature, and had written an editor and printing software for publishing *samizdat* on personal computers. He was unable to enter a PhD program of study along normal lines. So he looked to the Soviet Union:

> I used the fact that I was admitted to Russia—or Soviet Union, it was actually Ukraine, the Glushkov Institute—so I used it here in the Czech Republic in order to completely bypass the system of political vetting for PhD studies. And I presented my thesis for defense without any supervisor, without any formal … just as a thesis … to a committee which was actually chaired by Jiří Hořejš, so I knew they would not kick me out! And I bypassed everything that was normally connected with PhD studies like obligatory classes of Marxism-Leninism.[352]

By the end of the 1980s, the system had in fact become sufficiently relaxed that Zlatuška was allowed to travel and work at the University of Delaware and to leave Czechoslovakia by car to attend the NATO summer school at Marktoberdorf in West Germany.

An important piece of Czechoslovakia's identity as a technological middle ground during the Cold War lay in its position astride such cross-currents of intellectual exchange and the social networks of scientists and technologists among and outside the fraternal socialist bloc. Riika Nisonen-Trnka's recent case study of two Czechoslovak scientists, František Šorm and Otto Wichterle (inventor of the contact lens), argues that Czechs and Slovaks were well-positioned in this sense compared to many fellow CMEA members. The research and products of the Czechoslovak Academy of Sciences (including VÚMS) were freely shared with colleagues in the Soviet Union, which was at least officially the model state for future political and technological developments.

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[351] Zlatuška in discussion with the author.
[352] Ibid.

This prompted two-way intellectual exchange, such as Soviet computer scientist Mikhail Shura-Bura's inspection tour of VÚMS in the late 1970s, and Pajas' years of study at Moscow's Lomonosov University (Moscow State University) in the late 1950s and early 1960s.[353] Government officials, meanwhile, often felt uneasy about the perception of the country's "dependence not only on the Soviet Union but also on Western cooperation," a fact scientists, engineers and other members of the technical intelligentsia were keen to exploit.[354] Participation in international conferences, continued correspondence with foreign colleagues, access to outside journals and other material: Even in the more conservative political climate under Husák in the 1970s and '80s, "contacts with the West were explained and motivated through a discourse of necessity" in which patriotic intellectuals might obtain "important scientific results that were not yet available in socialist countries."[355]

Zlatuška's story is a case in point of leveraging the international network of intellectual exchange to which Czech and Slovak computerists were privy to achieve a degree of autonomy in a nominally closed system. His personal and professional relationships with Hořejš and Materna, two of the most influential Czechoslovak technologists, insulated him from domestic political pressure, but only in combination with the agreement of Soviet colleagues at the Glushkov Institute to admit him as a student. The credentials and expertise he acquired from those studies was then used as rationale for extended trips, study and work in the West.

Nor was Zlatuška's experience unique among Czechoslovak computerists. Havel noted that "There were hundreds of ways people could avoid formal political obstacles," to their life

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[353] Trojan in discussion with the author; Pajas in discussion with the author.
[354] Riika Nisonen-Trnka, "Science with a Human Face: The Activity of the Czechoslovak Scientists František Šorm and Otto Wichterle during the Cold War," Ph.D. dissertation, University of Tampere, Finland, 2012: 117.
[355] Ibid, 180.

and work.[356] If you wanted to publish, you pursued local journals edited by friends you knew from the same conferences and university departments. Havel managed to publish an entire series of articles, *Filosofické aspekty strojového myšlení* in *Mikrobáze* in 1988 thanks to both friendly editors like Zajíček and a co-author, mathematician Petr Hájek, who was in good standing with the authorities. His first book, *Robotiky*, appeared in 1980 even though "I was already known as a *persona non grata* and [yet] here I had this book."[357] Nearly forty years later he was still puzzled how that had slipped by the authorities. Perhaps, he mused, the book had sat with the publisher for so long (four years) that the authorities had lost track of it, or perhaps the regime deliberately allowed publication because it was, for many years, the only book in Czech on artificial cognition.[358] In any case, such oversights and loopholes were common enough to make technologist dissent practical although, as Bolton notes, the regime's occasionally unpredictable nature could also make it more difficult to maneuver around.[359]

Speak, Friend, and Enter: Coding Reform Discourse in Science Fiction

Open conversations about political reform and organizing forms of dissent certainly occurred among technologists in the 1980s in professional fora like SOFSEM and MFCS, as well as at movie nights and underground speaking engagements. But when these conversations happened in print, they often took the form of a coded discourse, using the jargon of computer science and speculative fiction, linguistically bounding *nás a je*, them and us. The interest in science fiction as a way to explore possibilities and alternate futures outside the dicta of the

[356] Havel in discussion with the author.
[357] Havel in discussion with the author.
[358] Ibid.
[359] Bolton, *Worlds of Dissent*, 87.

state's official line often made it a locus to organize around and a common language that could evade censorship.

The post-Stalinist political thaw, which can be dated to Nikita Khrushchev's secret speech to the 20th congress of the Soviet Communist Party in 1956, but which arrived later in Czechoslovakia, with de-Stalinization and cadre changes implemented only in 1963, played a significant role in yoking science fiction together with socialist scientific intelligentsia, especially the emerging community of computer technologists.[360] A more liberated, less censored science fiction within the CMEA bloc (alongside new access to fiction from the West) presented scientists and engineers with a vast landscape of ideas about future societies and alternative social, economic and political arrangements that in the 1960s ran parallel to the political and economic ideas articulated by reformers prior to the Prague Spring. The late political thaw in Czechoslovakia coincided exactly (also in 1963) with Richta's first important writings on the scientific-technical revolution, *Člověk a technika v revoluci našich dnů* (Man and Technology in the Revolution of Our Times) and *Komunismus a proměny lidského života* (Communism and the Transformations of Human Life).[361]

Much as science fiction in the CMEA countries was aimed at addressing the fantasies and interests of "young, urban male members of the technical intelligentsia and skilled workers, fostered by the system, but with a keen sense of belonging to a global scientific community," Richta pinned his hopes for the future of socialism on the same cadres.[362] According to Czech historian Vítězslav Sommer, Richta's conception of the scientific-technical revolution

[360] Ulc, "Czechoslovakia," 106.
[361] 1963 also saw the debut of the most influential Czech science fiction film, *Ikarie XB-1*, directed by Jindřich Polák and depicting a peaceful socialist future where an international crew of experts, including mathematicians and sociologists, journey to Alpha Centauri. Markéta Uhlířová, "Voyage through Space, Time and Utopian Modernism in *Ikarie XB-1*," in Lucie Česálková, ed., *Czech Cinema Revisited: Politics, Genres, Techniques*, Prague: National Film Archive, 2017: 338-365.
[362] Patrick Major, "Future Perfect? Communist Science Fiction in the Cold War," *Cold War History* 4, no. 1 (2003): 74.

"characterized scientists and experts as new revolutionary subjects and bearers of all significant social and political changes."[363] In Richta's view, computer technologists and other members of the technical intelligentsia were the vanguard responsible for leading the way into a radically changed socialism, one less reliant on manual labor and heavy industry, where computerized automation of industry and efficient, faultless inventory, planning and distribution realized the promise of socialist abundance. Both Richta and Asimov, in other words, promised that the future rightfully belonged to technicians. Certainly by the 1970s, science fiction had become both the entertainment genre of choice among computer technologists in Czechoslovakia (and globally), an entrée into the community through its popularization of science among young people, and a shared system of signs and references, of visions of the future, that served as an important cultural touchstone for the community and a kind of shared language.[364]

Science fiction literature produced within the CMEA bloc typically occupied a kind of political middle ground, never engaging in open or radical dissent, but usually emphasizing the need for a more rational, hopeful and open socialist future. "In this sense," Istvan Csicsery-Ronay, co-editor of *Science Fiction Studies*, noted "sf served the purposes of the Thaw reforms perfectly. It encouraged the scientific intelligentsia and youth to imagine themselves as personally inhabiting the world they would construct—one adequate for them, replete with problems to be solved and obligations to be met … The pain of the past would be relieved by their futures."[365] This sort of mild reformist tone dovetailed neatly with state socialist

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[363] Sommer, "'Are we still behaving as revolutionaries?'" 106.
[364] For more on science fiction's role in science popularization in state socialist societies, see the work of: Il'ia Kukulin, "Periodika dlia ITR: Sovetskie nauchno-populiarnye zhurnaly i modelirovanie interesov pozdnesovetskoi nauchno-tekhnicheskoi intelligentsia," *Novoe literaturnoe obozrenie*, no. 3 (2017): 61-85.
[365] Istvan Csicsery-Ronay, Jr., "Science Fiction and the Thaw," *Science Fiction Studies* 31, no. 3 (November 2004): 343.

governments' adoption of the rhetoric of scientific and technical revolution in their economic planning and official pronouncements.

Yet such reformist rhetoric in science fiction adopted a new valence as frustrations rose among the computer technologist community amid the microelectronics crisis of the 1980s. The stable system of the long 1970s had seemed to deliver on the government's promises of technological progress by ensuring adequate levels of funding and computer acquisition for the research institutes, universities, and large enterprises, a growth in the ranks of computerists, and an informal social and political bargain of circumscribed autonomy and privilege. By the mid-1980s, this arrangement was collapsing. The appetite for more, and more powerful, computers in industry and the government (driven in part by rapid advances in microelectronics too fast for reverse-engineering and industrial espionage to keep up) was growing much too fast for the government to manage.[366] The result was a subversive turn in the science fiction discourse among Czechoslovak computer technologists. Padraic Kenney summed up the potential of the genre:

> Martin Klíma … found his way to opposition through science fiction. Sci-fi fan clubs were another layer of Czechoslovak normalization—another way to keep the kids quiet … For these students, sci-fi (like theater, or the Church, or philosophical debates) were ways to practice their critical voice while, in the proper Czech tradition, keeping to their studies.[367]

Klíma continued to pursue his interests, and became the editor of the sci-fi fanzine *Villoidus* at the end of the 1980s.[368] Holan, a cofounder of *Villoidus*, modestly described his magazine as a

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[366] For reference to this rapid growth in computer acquisition placing new strains on government budgets and practical implementation capacity, see Appendix E, [Figure 28]: Digital Electronic Computers in CSSR Government Ministries.

[367] Padraic Kenney, *A Carnival of Revolution: Central Europe 1989*, Princeton: Princeton University Press, 2002: 152.

[368] Martin Klíma is listed as editor-in-chief of *Villoidus* in the first issue of 1989. *Villoidus: Vědecko-Fantastický Zpravodaj a Informátor*, no. 1, 1989: 1. Copies of *Villoidus* are rare; copies cited here are in the author's personal collection.

kind of semi-*samizdat*, since print runs were faculty-approved. *Vega*, a fanzine that came out of Plzeň at that time, was on the other hand true *samizdat*, Holan recalled.[369]

Yet even semi-*samizdat* sci-fi could serve the ends of technologist dissent. An out-of-work Kája Saudek, Czechoslovakia's most famous illustrator but banned by the communists from 1971 onward for his style (considered overly American) and themes (too provocative, imagining a utopian future free of evil people, hate and death) found occasional work in the late 1970s and 1980s illustrating the manuals and packaging for unofficially distributed computer games on cassette tape. A mutual friend, Ondřej Neff (the doyen of Czech science fiction) introduced the under-employed Saudek to Holan, and for the next decade the illustrator's cat women from outer space and sword-wielding exotic creatures graced the covers of *Villoidus*. The government only allowed approximately thirty books of translated speculative fiction to be published each year, with a quota of half required to originate in the Communist bloc. For many young Czechs and Slovak technologists, their first exposure to the subversive and satirical stories of Philip K. Dick or Douglas Adams came through the fanzines.[370]

With the explosion of interest in science fiction and fantasy after the first nationwide convention in Pardubice in 1981 spawned dozens of local clubs and as many ephemeral fanzines, newsletters and mailing lists, the *normalizace* generation of Czech and Slovak technologists held the jargon and tropes of science fiction in common. General anti-communist sentiment was also the norm. Although Holan recounted that he was an exception to this trend, he still engaged in dissident activity by procuring a 16mm projector and banned films for university movie nights, and organizing a talk by the officially ostracized but still wildly popular talk show host Miroslav

[369] Holan in discussion with the author.
[370] The first appearance of Douglas Adams' work in Czech are excerpts of Adams' longer novels painstakingly hand-translated by Stanislav Švachouček. "Restaurant na konci vesmíru," "Život, vesmír a vůbec všechno," and "Sbohem a díky za ryby," *Villoidus* no. 4, 1985: 15-20.

Horníček.[371] Indeed, as we shall see, by the end of the 1980s, under Czechoslovakia's limited version of *perestroika*, technologists had begun to articulate a discourse of reform that was only lightly coded in science fiction and published for a much larger audience than any fanzine enjoyed.

In the summer of 1988, a year before the Velvet Revolution, *Mikrobáze*'s editors ran an unprecedented series of articles focused on computers in science fiction.[372] The authors were two men: Hořejš, since 1966 associate professor of computer science and, from 1979-1983, director of the Institute for Computer Science at Masaryk University in Brno; and Jiří Franěk, a writer and journalist interested in technology.[373] We last observed Hořejš as the thesis supervisor who helped a young Zlatuška slip past the regime's political controls on the way to his doctorate. Franěk had previously written about the computer community in Czechoslovakia a year earlier, in "My Chceme Počítače!" (We Want Computers!) for the popular youth magazine *Mladý svět* (Young World). Although his father had been an editor at *Rudé právo*, the flagship publication of the Czechoslovak Communist Party, Franěk left the party soon after he and Hořejš had finished writing for *Mikrobáze* in February 1989. Later that spring, Franěk became one of the signatories to the reform manifesto *Několik vět* (*A Few Sentences*), along with actor Zdeněk Svěrák and Havel's playwright brother Václav.[374] *Mikrobáze*'s editor-in-chief, Jan Klabal, and managing

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[371] Holan in discussion with the author.
[372] Hořejš and Franěk, "Počítačová science fiction (1)." *Mikrobáze* 7, Prague, Czechoslovakia: Svazarm. (July 1988): 4-7.
[373] For information on Hořejš (1933-2001), see his biography at the website for the Masaryk University Institute of Computer Science: http://www.muni.cz/ics/people/484/management_history. Accessed March 3, 2014. Franěk (1942-2011) was a well-known Czech writer and journalist. His obituary in *Lidové noviny* noted that he turned *Mladý svět* into a center of reporting on perestroika efforts, computers, programming and genetics. See: http://www.lidovky.cz/zemrel-publicista-a-komentator-jiri-franek-f29-/lide.aspx?c=A110127_222603_ln_domov_kar. Accessed April 11, 2015. His stories "Koniáš" and "Eden No. 2" are reviewed in these articles. He identified himself as "J. Franek" in the pages of *Mikrobáze*.
[374] Jiří Suk, "'A Few Sentences' on a Petition From 1989." Government Information Centre. June 19, 2009. Accessed April 11, 2015. http://icv.vlada.cz/en/media-centrum/tema/a-few-sentences-on-a-petition-from-1989-59398/tmplid-676/. For Franěk's involvement, refer to his Czech Wikipedia entry:

editor Zajíček had seen Hořejš and Franěk at the 1983 SOFSEM conference, and noted their "many interesting ideas sprawling not only into the fiction of the future, but also the present-day symbiosis of man/machine." Zajíček and Klabal wanted to ask them "the fundamental question—Quo vadis, computerized humanity?"[375]

Hořejš and Franěk wrote for a specific readership. They identified them early on, in their first article on "Computer Science Fiction"—"We believe that in this sense you all belong (at least) among virtual scifi enthusiasts, who O. Neff describes as 'people of specific sorts, who combine the experience of artistic creation with the need for intellectual speculation.'"[376] These enthusiasts for technology and science fiction constituted a small but growing and influential group in 1980s' Czechoslovakia. The *Mikrobáze* community—its readership as well as its editors and writers—worked similarly to Alexei Yurchak's study of late Soviet *Komsomol* organizations. Like many *vnye* groupings in late socialist societies, its relatively autonomous community had grown up like vines through the supportive trellis of the state. It was inextricable from state structures but preoccupied with practical, non-ideological and increasingly autonomous pursuits.

As Yurchak observed, groups living under late socialism in the 1980s were "actively engaged in creating various new pursuits, identities, and forms of living that were enabled by

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http://cs.wikipedia.org/wiki/Ji%C5%99%C3%AD_Fran%C4%9Bk_%28koment%C3%A1tor%29. Accessed April 11, 2015.

[375] Jozef Dujnic, Norbert Fristacký, Ludovít Molnár, Ivan Plander, and Branislav Rovan. "On the history of computer science, computer engineering, and computer technology development in Slovakia." *IEEE Annals of the History of Computing* 21, no. 3 (1999): 43. *See also*: SOFSEM's account of its own history: http://www.sofsem.cz/sofsem95/history.html. Accessed April 16, 2015. "Na SOFSEMu 83 vystoupili RNDr. J. Hořejš, CSc. a Ing. J. Franek s netradičně pojatou přednáškou. Obsahuje mnoho zajímavých myšlenek pnoucích se nejen k fikcím budoucí, ale už i současně symbiózy člověk/počítač, která mnohé literární fikce rychlými kroky překonává. Věříme, že vám ideje, extenze a metateze autorů vedle obveselení přinesou nejedno hlubší zamyšlení nad zásadní otázkou – Qou [sic] vadis, člověče počítačový?" Jan Klabal and Ladislav Zajíček, "Počítačová Science Fiction (1)," *Mikrobáze* 7 (July 1988): 5.

[376] "Věříme, že v tomto smyslu patříte (alespoň) mezi virtuální vyznavače scifi, které O. Neff charakterizuje jako 'lidí specifického ražení, kteří spojují prožitky umělecké tvorby s potřebou intelektuální spekulace.'" Hořejš and Franěk, "Počítačová Science Fiction (1)," 5. "O. Neff" refers to Ondřej Neff, the Czech science fiction writer.

authoritative discourse, but not necessarily defined by it."[377] Edward W. Constant referred to them as a community of technological practitioners, bound across disciplines and state/society boundaries by common interest and "technological knowledge … expressed in well-winnowed traditions of practice."[378] We have referred to them throughout this work as computer technologists or technicians, generously general terms that reflect their varying social origins and employment as we witnessed in the previous chapter. The 1980s was a decade of turmoil in the socialist bloc, as governments struggled to adapt to the microelectronics crisis in the midst of already straitened budgets and higher energy prices. *Mikrobáze*'s technologist readership often depended on the state for employment, but was critical of sclerotic bureaucracy; writers and editors at *Mikrobáze* knew censors watched them, but their readers demanded quality reporting and up-to-date technology news.

By the 1980s, tens of thousands of computer technologists lived in Czechoslovakia; the government had invested heavily in information technology since at least the early 1970s.[379] The public's interest in science fiction was also on the uptick in the '80s, as Neff observed.[380] Thus, Hořejš and Franěk only briefly summarized the science fiction stories they were ostensibly reviewing, and never introduced the authors. They relied on readers' familiarity not merely with famous names like Isaac Asimov and Stanislaw Lem, but also more obscure authors like D.G. Compton. This extensive knowledge of science fiction and crosscutting interest in computer

[377] Yurchak, *Everything was Forever*, 32.
[378] Edward W. Constant II, "The Social Locus of Technological Practice: Community, System, or Organization?" in: Wiebe E. Bijker, Thomas P. Hughes and Trevor J. Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge: The MIT Press, 1987: 224.
[379] There were certainly tens of thousands of computerists in the country by the mid-1980s according to the Czech Statistical Office's data, which recorded 7,338 programmers alone in 1986, not accounting for hardware engineers, repairmen, operators and research scientists. Český statistický úřad, *Stav a využití výpočetní techniky v roce 1986 v ČSR*, Prague: Czech Statistical Office, 1987; Cortada, "Information Technologies," 35, 39.
[380] "V průběhu osmdesátých let byla SF natolik populární, že se jí začali zabývat i někteří autoři mainstreamoví." (During the '80s, SF was so popular that it started to deal with some of its authors going mainstream). Ondřej Neff, "Pět etap české fantastiky," in: Ivan Adamovič, ed., *Slovník české literární fantastiky a science fiction*, Praha: A.F. BKK, 1995: 19.

technology was typical. When Švelch interviewed a man named Václav (born in 1977) about his media consumption in the late 1980s, his interests in science fiction and computers overlapped. He read *Ikarie XB-1*, a *samizdat* sci-fi magazine, but also sought any information about his Sinclair ZX Spectrum—*Mikrobáze*'s purview.[381]

Prior to the Velvet Revolution, Czechoslovakia was one of the most conservative regimes in East Central Europe. Censorship was still the norm, and for Czechs and Slovaks there were no years of *glasnost* in the 1980s.[382] Computer technologists, however, were intensely interested in both politics and science fiction, using the latter to talk about the former more safely, as Eva Hauser, the doyenne of Czech science fiction, has noted.[383]

Computer technologists used the ostensibly neutral language of science fiction and computers to turn one of the government's own publications into a platform for their political discourse. They were a subset of the technical intelligentsia, long a bulwark of the scientific socialist state. Paul R. Josephson argues that, if the structure of socialism depended on concepts of technological progress and modernity, then the computer technologists of *Mikrobáze* were not merely one small subculture among others. "Scientists and engineers were considered naturally more reliable than other intellectuals," Josephson asserts.[384] They were loyal pillars of Communist rule. Yet from July 1988 to February 1989, Hořejš and Franěk—a computer scientist and a journalist—used an official publication to urge substantial reforms to socialism.

[381] Švelch: "Ikarii jsi četl?" Václav: "No jasně, jak dlouho. To jsem měl předplacený kolik let. Ale pak člověk neměl tolik času, a jak se doba zrychlovala, tak mě v Ikarii půlka článků nezajímala, nebo mi nesedla půlka povídek, tak to padlo." Jaroslav Švelch, "Osmibitové „poblouznění": Počátky kultury počítačových her v Československu" (Eight-Bit 'Infatuation': The Beginnings of Computer Game Culture in Czechoslovakia), Přílohy k disertační práci, Univerzita Karlova v Praze Fakulta Sociálních Věd, Praha, 2013: 285.
[382] Gordon Wightman, "Czechoslovakia under Miloš Jakeš," *Journal of Communist Studies* 5, no. 3 (1989): 349-355.
[383] Hauser wrote "our common feeling in the early '80s [was] that the only theme worth writing about was totalitarianism. I myself felt that I couldn't really like any sf which was not about the manipulation of people, about the mechanics of totalitarian regimes." Eva Hauser, "Science Fiction in the Czech Republic and the Former Czechoslovakia: The Pleasures and the Disappointments of the New Cosmopolitanism," *Science Fiction Studies* 21, no. 2 (July 1994): 135.
[384] Paul R. Josephson, *Would Trotsky Wear a Bluetooth? Technological Utopianism under Socialism, 1917-1989,* Baltimore: The Johns Hopkins University Press, 2010: 107.

Hořejš and Franěk knew their readers were aware of the layers of meaning embedded in science fiction. Reading between the lines was an everyday skill in the Soviet bloc.

John Glad, a Soviet science fiction scholar, noted that censorship was more relaxed, as the "other-worldly setting" distracted censors.[385] "Scifi," Hořejš and Franěk therefore noted carefully, "may bring to light fragments of considerations that reflect the germs of real philosophical, social and even technical problems; these can sometimes be put together into mirrors set up to the future."[386] They parsed their language cautiously. Thus, Hořejš and Franěk listed the problems science fiction addressed as "philosophical, social and even technical" in nature. Politics were conspicuously absent.

Yet Hořejš and Franěk were much concerned with politics. Indeed, the first story they analyzed was about censorship. In "What's the Name of the Town?" by R.A. Lafferty, scientists task a future supercomputer to discover "something not known to exist, by a close study of the absence of evidence."[387] After studying gaps in encyclopedia articles and oddly excised song passages, the supercomputer concludes that a city named Chicago disappeared in a tremendous calamity 20 years ago. Incredulous, the scientists demanded an explanation. Why did they forget Chicago? A great censoring device, the supercomputer explained, was responsible:

> Even I … cannot understand how it worked. But it *did* work, and it simultaneously destroyed all printed references to our subject. This left holes in the references, and the flow of matter to fill those holes was sometimes of inferior texture … In more important documents, the text was flowed in automatic handwriting to fill the hole, and in close imitation of the original handwriting. But these imitations were often imperfect.[388]

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[385] John Glad, *Extrapolations from Dystopia: A Critical Study of Soviet Science Fiction*, Princeton: Kingston Press, 1982: 32.

[386] "A ještě konrétněji: scifi může vynést na světlo střípky úvah, které odrážejí zárodky reálných filozofických, společenských a dokonce i technických problémů ..." Hořejš and Franěk, "Počítačová Science Fiction (1)," 5.

[387] R.A. Lafferty, "What's the Name of that Town?" in *Nine Hundred Grandmothers*, New York: Ace Books, 1970: 270.

[388] Lafferty, "What's the Name of That Town?" 277.

Obvious gaps were evidence of censorship. Conspicuously not talking about political problems was how Hořejš and Franěk signaled readers to look for political subtext.

Hořejš and Franěk reinforced this point after the review. Specially framed by asterisks, and in bold text, they asserted, "**Suppressed information remains information.**" "The total deletion of information in sufficiently complex systems," they wrote "may not be feasible at all—afterwards a trace of the information remains in the form of 'black holes' or film negatives."[389] Although their commentary is nominally about writing, storing, recalling and erasing information on computer hard drives, the authors linked the story to human concerns. "It is logically and physically very easy to erase simple computers," they wrote. "But it is not inconceivable that in complex systems with many interrelationships and the complex structure of distributed memory, we might encounter situations *analogous to the state of man*—that DELETE operations will … represent a more difficult task than WRITE or UPDATE."[390] The information environment under state socialism was one in which propaganda (attempting to WRITE upon or UPDATE human memory) was commonplace, but also one in which the authors felt it was unrealistic for the state to use "DELETE operations" to make citizens forget. Censorship was a continuing focus in Hořejš and Franěk's writing—a preview of *Několik vět*, which explicitly called for freedom of the press, and which Franěk signed less than a year later.

Proponents of censorship inside Czechoslovakia might have retorted that a great deal of information the censor's pen marked out for deletion was worthless or harmful to society. Pornography, racist diatribes, foreign propaganda—what place did these have in a brighter

[389] "*** Potlačená informace zůstává informací *** Totální výmaz informace v dostatečně složitých systémech nemusí být vůbec proveditelný - po informaci zůstane stopa ve formě 'černé díry', či filmového negativu." Hořejš and Franěk, "Počítačová Science Fiction (1)," 7.

[390] My emphasis. "U jednoduchých počítačů lze výmaz provést logicky i fyzicky velice snadno. Není však vyloučeno, že u složitých informačních systémů s mnoha vzájemnými vazbami a složitou strukturou distribuované paměti se setkáme se situací analogickou situaci člověka - že operace DELETE bude (aspoň z hlediska robustnosti systému) představovat těžší úkol než WRITE či UPDATE." Ibid.

future? Hořejš and Franěk responded in the next month's issue to potential criticism of their attack on censorship in the very first paragraph. Drawing on one of Franěk's own stories, "Koniáš" they wrote:

> At a global data bank, which contains all the information accumulated by mankind, and which allows access to this data to anyone, after some negative experiences a selective protection algorithm is deployed: it discards the information that could directly or indirectly be used against humans. The result of the activities of this algorithm is the total dissolution of the entire databank — no information; it is left absolutely clean.[391]

Written in bold text immediately below they concluded: "Between the usefulness and safety of information there is clearly a 'trade-off'."[392] Readers likely agreed. A stifled flow of information was a competitive obstacle in the fast-moving fields of computer science and information technology. A few years earlier in 1985, *Mikrobáze*'s readers had begged the editors to publish even the advertisements for virtually inaccessible Western computers like the IBM PC and Sinclair ZX line. Such ads usually carried at least some information about the newest hardware specifications and capabilities.[393]

In contrast to this stultified atmosphere of censorship, Hořejš and Franěk asked computer technologists to imagine a better future. "Rousseau's return to nature with computers tucked under the sod," they proclaimed, "a golden age induced by advanced technology." Information wanted to be free—"to grow just like flowers." The language evoked computing as a synthetic resolution to the old tensions between Romanticism's attachment to nature and rejection of technology, and the Enlightenment's legacy of positivist materialism. Computers were the harbinger of an entire economic and social transformation; as Richta had foreseen, their users

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[391] "Na globální banku dat, která obsahuje všechny informace nashromážděné lidstvem a která umožňuje přístup k těmto datům komukoli, je po jistých negativních zkušenostech nasazen selektivní algoritmus ochrany: vyřazuje ty informace, které by přímo či nepřímo mohly být použity proti člověku. Výsledkem činnosti tohoto algoritmu je totální rozpuštění celé databanky — žádná informace nezůstane absolutně čistá." Hořejš and Franěk, "Počítačová Science Fiction (3)," *Mikrobáze* 9 (September 1988): 7.

[392] "Mezi užitečností a bezpečností informace je zřetelný 'trade off'" Ibid.

[393] "Jedním z častých návrhů je zavedení inzerce." (One of the most frequent proposals [by readers] is the introduction of advertising). "Výsledky ankety Mikrobáze z roku 1985," 12.

would harness the machine's speed and order in the "revolutionary project" of "building a post-industrial communist society and creating a new man freed from all the burdens of a declining industrial age and capable of permanent self-cultivation."[394] Speaking of cultivation, on the dry hillsides near Prague, patches of Breckland thyme grew. Traditionally, little old grandmothers, or *babičky*, gathered their leaves and made tea, improving blood circulation and digestion. Hořejš and Franěk envisioned a future where patches of "Pascal thyme, whose leaves will have favorable effects on the flow of information" in society were just as free to grow and gather.[395] Abundant information, organized rationally by computers, would surely lead to an abundant and conscientious society, one in which both individuals and nature would exist in harmony free from exploitation. Advocates of "computer liberation" like Ted Nelson, Stephen Wozniak, Stewart Brand and others, computer enthusiasts who formed a tech-savvy counterculture on the other side of the Iron Curtain in the 1970s, shared this dream and built Silicon Valley on its ethos.

In Czechoslovakia of the same period, meanwhile, computer technologists' grey reality was due to "normalization," the political crackdown that followed a 1968 Soviet invasion and the death of the Prague Spring reforms. Václav Havel described it as "a labyrinth of influence, repression, fear and self-censorship which swallows up everyone within it, at the very least by rendering them silent, stultified and marked by some undesirable prejudices of the powerful."[396] In this milieu, science fiction was a common language computer technologists used to cautiously discuss and agree upon the new society they would work toward with the new tools of the

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[394] Sommer, "'Are we still behaving as revolutionaries?'" 106.
[395] Hořejš and Franěk are referring to Niklaus Wirth's Pascal programming language. "Rousseauský návrat k přírodě s počítači schovanými pod drny, aurea aetas lidstva, zlatý věk navozený vyspělou technologií ... Na některých suchých stráních prostě vedle mateřídoušky obecné (Thymus serpyllum) poroste mateřídouška pascalovitá (Thymus pascali), jejíž nať bude blahodárně působit na tok informací v CNS právě tak ..." Hořejš and Franěk, "Počítačová Science Fiction (5)," *Mikrobáze* 1 (January 1989): 11.
[396] John Keane, *Václav Havel: A Political Tragedy In Six Acts*, New York: Basic Books, 2001: 273-274.

personal computer revolution. *Mikrobáze* became their forum for discussion and political criticism, wrapped in computers and science fiction, confounding censors or escaping their notice. Best of all, they reached thousands of readers across the country in every issue on the government's dime.[397]

Hořejš and Franěk concluded that the censorship and restrictions placed on the same computer technologists the state counted on to modernize Czechoslovakia was unreasonable. "The world of computers is closed due to operation monitoring," they emphasized. Appealing to computer technologists' hopes for a brighter future, they asked what excessive state supervision of computers would mean. "In relation to which other operations … is the world of computers in this sense closed? Today and tomorrow?"[398] How could the work of creative professionals, who would use personal computers in ever-larger numbers, really thrive in a controlled environment? How could software creation, an inherently individual, private and creative exercise, prosper?[399] These were crucial questions for the future success of Czechoslovakia.

They had to walk a thin line to raise these questions. Fortunately, they were creative. A cartoon that appears alongside their article shows robot and human, arm-in-arm, deliriously happy with an oilcan and beer bottle respectively.[400] Robots and humans, the cartoon implies, are essentially similar. Hořejš and Franěk therefore wrote guardedly about censorship as an issue of information deletion and recovery *in machines*, while the cartoon signaled readers to parse the subtextual commentary on censorship by pointing to similarities between machines and men.

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[397] Compare this to *samizdat*, where limited, expensive copies had to be painstakingly produced, illicitly distributed, and sometimes could only reach a narrow audience. Bolton, *Worlds of Dissent*, 103-105.

[398] "Svět počítačů je uzavřen vzhledem k operaci monitorování ... vzhledem ke kterým dalším operacím ... je svět počítačů v tomto smyslu uzavřen? Dnes a zítra?" Hořejš and Franěk, "Počítačová Science Fiction (5)," 11.

[399] Freiberger and Swaine provide an excellent overview of the mixture of self-abnegation, odd hours, happy collaboration and sheer luck programming took in the early days. See their description of Bill Gates' first big project, creating Microsoft BASIC in early 1975. Paul Freiberger and Michael Swaine, *Fire in the Valley: The Making of the Personal Computer*, 2nd ed. New York: McGraw-Hill, 2000: 178-179.

[400] Hořejš and Franěk, "Počítačová Science Fiction (1)," 7.

In contemporary East Germany, Sonja Fritzsche observed that "the sleuthing practice of 'reading between the lines'," in this manner was popular, and an unrecoverable joy of reading science fiction in the Soviet bloc.[401] Similarly, computer technologists saw in these reviews—in the arbitrary, bureaucratic, oppressive and absurd 'fictional' scenarios—the most common criticisms the technical intelligentsia held against the Czechoslovak Communist Party.

In general, Hořejš and Franěk offered a lightly veiled critique of the bureaucratic socialist state for removing itself too far above the level of its own citizens, centralizing command-and-control in inefficient, arbitrary and self-defeating ways. "A system of multiple levels ceases to be robust," they opined, "whenever only its highest levels are preferred. To put it another way: move too far away from the base, and there is a danger of a landslide affecting the entire building."[402] In such an overly centralized system of computers, they noted, absurdity was inevitable. "The adept user will know only that the compiler [of software code] knows what the programmer knew about the knowledge of the analyst, which consisted in the belief that the user knows what he wants."[403] An endless, and irrational, loop. Technological cadres had usually been the favorite sons of state socialism. Yet here influential members of those same cadres warned about the "danger of a landslide" affecting the entire edifice of state socialism in Czechoslovakia. This was a warning shot across the state's bow more than a year before the Velvet Revolution.

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[401] Sonja Fritzsche, "Publishing Ursula K. Le Guin in East Germany," *Extrapolation* 47, no. 3 (2006): 473-474.

[402] "systém o více úrovních přestane být robustní, jakmile jsou preferovány jen jeho nejvyšší úrovně. Jinak: vzdálíme-li se příliš od základu, hrozí nebezpečí sesuvu celé stavby." Hořejš and Franěk, "Počítačová Science Fiction (2)," *Mikrobáze* 8 (August 1988): 7.

[403] "Jinak bude adept vědět pouze o tom, že překladač ví, co programátor věděl o znalostech analytika, které spočívaly v přesvědčení, že uživatel ví, co chce." Ibid.

Conclusion: Re-Wiring, Not Revolution

Hořejš and Franěk offered solutions, not just warnings. Yes, everyone agreed that the bureaucracy was stifling innovation and souring relations between technologists and the state. But there was a way out. "The future will bring different structures of computer systems," they wrote "even regarding the relationship of processors and peripherals." So far, Hořejš and Franěk had established a mechanistic understanding of society in their articles, drawing parallels repeatedly between humans and computers, machines and the state. Czech and Slovak readers could easily infer another meaning here: Processors, which direct and control the streams of information inside a computer, might be read here as the government, and peripherals (a mouse, keyboard, a printer) the rest of society. Hořejš and Franěk continued: "Processors will be forced to communicate based on other logics (non-deterministic, non-binary, non-type, non-logical, or vice-versa all super-)."[404] This was a bold re-envisioning of the relationship between governors and governed. At the time of their writing (as indeed today) processors in computers issue instructions to be carried out by other parts, including peripherals like printers; it is a top-down set-up not dissimilar to the command economy of late socialist Czechoslovakia. What Hořejš and Franěk argued was that this relationship was going to change, that it might be "forced" to change from a vertical hierarchy to a network, a horizontal heterarchy of balanced interests.

Extending real political choice to Czechs and Slovaks in place of Communist Party dominance was a specific reform issue Hořejš and Franěk, and undoubtedly many of their readers, supported—but in a more general sense, so was ending the absurdities of life under late socialism. One of those absurdities, according to Hořejš and Franěk, was the seeming inability of

[404] "Budoucnost přinese jiné struktury počítačových systémů i pokud jde o vztah procesorů a periférií. Procesory budou nuceny komunikovat na bázi jiných logik (ne-deterministické, ne-dvouhodnotové, ne-typové, ne-logické, nebo naopak vše super-) …" Hořejš and Franěk, "Počítačová Science Fiction (6)," *Mikrobáze* 2 (February 1989): 14.

traditional dissidents to effect change. Respected in the West, their message often fell on deaf ears at home, as Paulina Bren noted in her work on the normalization period, and as dissidents themselves recognized.[405]

Gregory Benford's classic 1970 short story "Nobody Lives on Burton Street" is a stand-in for the costs and ineffectiveness of such traditional protest. A crowd riots and a policeman is shot—only later does the reader discover that the police were all robots, and Burton Street, where the crowd had smashed windows, looted stores? Nobody lives on Burton Street—the oppressive state had wisely created a space for its citizens to vent. "The price for this social valve is substantially relatively small" Hořejš and Franěk noted. "Both in terms of broken and burnt things, and in terms of the destroyed police—robots."[406] The impotence of the protesters in Benford's story was a feeling that would have resonated for Czechs and Slovaks that September. Twenty years prior, in August 1968, Soviet tanks and conservative communist elites who opposed the Prague Spring's reform agenda of "socialism with a human face" had crushed the nationwide movement with brutal efficiency. Only discursive niches like *Mikrobáze* and other small-scale groups (e.g. environmentalists, peace activists, student scifi clubs) were left, the dormant seeds of Czechoslovakia's post-1989 civil society.

Finally, Hořejš and Franěk argued that the state often failed to support sufficiently the work of its technological cadres. Hořejš and Franěk saw computer technologists as a sort of oppressed elite, the priesthood closest to the machine. Their fellow citizens, especially the bureaucrats, did not realize how much they needed computer technologists in order to keep up

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[405] "And although ordinary citizens might well be accused by the dissidents of not living in truth, these same citizens were not exactly convinced that truth was on the side of the dissidents either." Bren, *The Greengrocer and His TV*, 99. For Havel, dissidents were "a small subset of this much larger independent life of society." Bolton, *Worlds of Dissent*, 224.

[406] "Cena za tento společenský ventil je v podstatě relativně nepatrná. Jak pokud jde o rozbité a spálení věci, tak pokud jde o zničené policisty - roboty." Hořejš and Franěk, "Počítačová Science Fiction (3)," *Mikrobáze* 9 (September 1988): 8.

with the West. They referred to Henry Slesar's short story "Examination Day" wherein a student, Dickie Jordan, takes a government-mandated IQ test when he turns 12-years-old, just like every child. His parents wait nervously by the phone, and receive bad news. Poor Dickie exceeded the intelligence limit set by the government, so the state executed him. "The idea for this story," Hořejš and Franěk concluded, "we prefer to leave without comment—any ideas repeated often enough become increasingly likely to be realized."[407] Even as their publications, employment, training and social organizations were state-sponsored, and their access to computers largely dependent on the state, technologists could not shake the feeling of being restricted, even persecuted, by a bureaucracy that inadequately recognized their talents and important role.

However, the state was not doing its job, as Hořejš and Franěk's critiques revealed. On censorship, bureaucracy, elections, and the treatment of scientists and engineers Hořejš and Franěk laid out an explicit set of political reforms to state socialism that computer technologists could support. They evaded censorship by speaking in a coded, deniable language of science fiction and computer science where robots and computers often stood in for ordinary people and the bureaucratic 'machine'. Technologists easily decoded this language, and their participation in the discourse was active. They had to choose to read the articles in a certain way, unlocking their meaning by previous familiarization with science fiction authors and the politics of the genre. Ultimately, Hořejš and Franěk's use of science fiction to promulgate these reform ideas among technologists indicates the existence, if not the popularity, of particular, widely-shared reform ideas among a key community that is frequently overlooked by scholars searching for protests in the street and dissident manifestos.

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[407] "Ideu této povídky raději ponecháme bez komentáře - u každé dostatečně často opakované myšlenky roste pravděpodobnost jejího uskutečnění." Hořejš and Franěk, "Počítačová Science Fiction (3)," 9.

Such reform ideas, however, manifestly failed to inspire direct action among computer technologists as a distinct component of emerging civil society in late socialist Czechoslovakia. They are best understood as dissenting actions, and as expressions of the values and future visions of a significant community of interest in late socialist Czechoslovakia. As Bolton observes, "Opposition doesn't mean stepping completely outside a society, but rather finding new ways to participate in it, even as one imagines better worlds."[408] These technologist reform proposals are thus a glimpse into a social and political world unaware it was on the edge of a revolution, still advocating for participation in and the construction of a strong (but rational, efficient, and more open) state which would best promote the interests and values of computer-driven modernization.

This is key to understanding why an examination of technologist politics as fitting somewhere on a spectrum of collaboration or dissidence proves so frustrating to historians. Clearly, computer technologists had common interests and aspirations—even similar origins and mentalities, as chapter two identified—so it is tempting to view their frequently expressed discontent with certain government policies and actions as the precursor to open dissent in alliance with environmentalists, peace activists and humanist intellectuals. The next chapter addresses this puzzle of political impotency. It argues that political indifference was both the most common stance adopted by computer technologists at the time and perhaps a powerful interpretive framework for understanding ordinary Czech and Slovak attitudes toward the regime in the lead-up to the events of 1989.

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[408] Bolton, *Worlds of Dissent*, 284.

Chapter 4
'The Machine is Imminent':
Indifference, Mutualism and the Politics of the Scientific-Technological Revolution

"The computer has become a magic spell promising solutions and even hope."[409]
- Czech enthusiast and magazine editor 'kš', *Mikrobáze*, 1986

Our authors from the last chapter, Hořejš and Franěk, were already middle-aged in the late 1980s—they drew their ideals of a reformed, inclusive and rational socialism 'with a human face' from the 1968 Prague Spring. In February 1989, in their last article, they described what the computerized future, with its "new approaches to knowledge" might look like: "Who knows, maybe the Machine is imminent—some more generations of computers and a few discoveries in the field of psychology—and it will be for us just like for a man who, after a long time, climbed out of the bunker into the light."[410] By investing their hopes for the future in the inevitable transformation of rapidly developing technology, Hořejš and Franěk were simply reiterating the common faith of many technologists in the 'scientific-technological revolution'—not only in socialist Czechoslovakia but also around the world.

Matthew Wisnioski, drawing from Langdon Winner's 1977 work *Autonomous Technology*, refers to this as the "ideology of technological change".[411] Briefly put, this framed the increasingly widely perceived problems of the last third of the 20th century—pollution, the

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[409] "Počítač se stal zaklínadlem příslibem řešením i nadějí." "Na prahu páté generace" (On the Threshold of the Fifth Generation [of Computers]), *Mikrobáze* 3, (October 1986): 3.

[410] "Kdo ví, třeba je Stroj na spadnutí; nějaké ta generace počítačů navíc a pár objevů z oblasti psychologie—a bude nám tak, jako člověku, který po dlouhé době vylezl z bunkru na světlo." Hořejš and Franěk, "Počítačová Science Fiction (6)," *Mikrobáze* 2 (February 1989): 16.

[411] "By the late 1960s professional elites reached a consensus view that—building on the work of political theorist Langdon Winner and historian Rosalind Williams—I identify as an ideology of technological change. This way of seeing society posited that rapidly accelerating technological advances had produced an array of negative, unintended consequences that stressed existing institutions and patterns of life ill-equipped to handle them. These problems had only recently emerged, and were the result of technology's nature. Consequently engineers could not be blamed for the country's technological dilemmas. Engineers moreover would be best equipped to adapt society to technology by maximizing its positive opportunities and minimizing its negative effects." Wisnioski, *Engineers for Change*, 30, 63.

arms race, intensified alienation—as inevitable features of technology itself, and not as outcomes that technologists might have better managed or avoided by making responsible choices or organizing politically to demand change. This neatly sidestepped an existential crisis for technologists on both sides of the Iron Curtain. Their livelihoods depended to an unusual degree on funding and other forms of support from militaries, governments and large firms that drew increasing distrust from the public.[412] An ideology of technological change also resolved the dilemma of growing conscientiousness and even radicalism among individual technologists in the post-1968 period by offering a rationale for political indifference. New tools could fashion a new society.

Personal computers for instance, optimistic technologists believed, were fundamentally different than the centralized mainframes and mini-computers of IBM and the U.S. military. These were not instruments of "manipulation and control," as Marcuse had argued, but objects with "emancipatory potential … notably their mobilizing force [hobbyist communities organized around them], their anti-sectarianism and their egalitarianism" which promised to put powerful technical means of artistic and creative production in every home.[413] Virtual communities, like the WELL (Whole Earth 'Lectronic Link) would take the place of actual communes. Users of the WELL found comfort in a "rhetoric of disembodied collectivity that echoed the back-to-the-land movement of the late 1960s even as it embraced the computer networking technologies of the 1980s. ... the WELL offered a new, digital context in which to rebuild a communal dream that

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412 "public confidence in the performance of representative institutions in Western Europe, North America, and Japan has declined since the original Trilateral Commission report was issued" in 1975. Susan J. Pharr, Robert D. Putnam and Russell J. Dalton, "Trouble in the Advanced Democracies? A Quarter-Century of Declining Confidence," *Journal of Democracy* 11, no. 2 (April 2000): 9; "Between 1972 and 2012, Americans became significantly less trusting of each other and less confident and trusting in large institutions, such as the news media, business, religious organizations, the medical establishment, Congress, and the presidency." Jean M. Twenge, W. Keith Campbell and Nathan T. Carter, "Declines in Trust in Others and Confidence in Institutions Among American Adults and Late Adolescents, 1972-2012," *Psychological Science* 25, no. 10 (2014): 1914-1923.
413 Kees Brants, "The Social Construction of the Information Revolution," *European Journal of Communication* 4, no. 1 (1989): 80.

had in fact fallen apart some ten years earlier."[414] It is likely no coincidence that this shift to virtual communities and re-emphasized pronouncements of faith in the progressive nature of information technology assumed greater prominence as the 1970s transitioned into the '80s. In this period of renewed globalization, "PCs became the very symbols of global interconnection" as well as individual consumption and American entrepreneurship, according to global historian Thomas Borstelmann.[415]

Moreover, many of the early PC enthusiasts needed to believe in the inevitably democraticizing and beneficent nature of the personal computer as tensions grew within the community. Hobbies had transformed into livelihoods; serious sums of money were at stake. Factions formed, separating those who favored free and open-source software that anyone might use, like Richard Stallman and Richard Greenblatt, and those like Macintosh designer Bill Atkinson who insisted "the finances of computer and software development had changed radically," and end users had no right to open up, inspect, modify or copy the source code of their proprietary software.[416] In the U.S. and U.K. the counterculture waned as the right wing triumphed, brought to power by popular discontent stemming from a decade of oil shocks, deindustrialization, inflation, rising distrust in government authority and institutional expertise, and foreign policy debacles like the Iran hostage crisis; in the Soviet sphere, martial law in Poland had driven the popular Solidarity movement underground by the end of 1981.[417]

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[414] Fred Turner, "Where the Counterculture Met the New Economy: The WELL and the Origins of Virtual Community," *Technology and Culture* 46, no. 3, July 2005: 500.
[415] Thomas Borstelmann, *The 1970s: A New Global History from Civil Rights to Economic Inequality*, Princeton, New Jersey: Princeton University Press, 2011: 140.
[416] Fred Turner, "How Digital Technology Found Utopian Ideology: Lessons from the First Hackers' Conference," in David Silver and Adrienne Massanari, eds., *Critical Cyberculture Studies: Current Terrains, Future Directions*, New York: New York University Press, 2006: 262-263.
[417] Philip Jenkins, *Decade of Nightmares: The End of the Sixties and the Making of Eighties America*, Oxford: Oxford University Press, 2008: 179-183; Bradford Martin points out that the nuclear freeze movement of the 1980s reflected this shift away from the counterculture of the '60s and '70s. It "eschewed the excesses of 1960s activism" and "reflected the resurgence of a consensus-oriented, anti-dissent mood that pervaded the dominant culture of the

Although fatalistic, the inevitability of the so-called ‘scientific-technological revolution’ and engineers’ role in managing its discontents therefore strongly appealed to technologists on both sides of the Iron Curtain.

As established in the previous chapter, the official barriers of the Cold War hindered but did not totally obstruct the international flow of ideas in the global scientific-technical community. In interview after interview, technologists claimed that they enjoyed ready access, even if sometimes delayed, to Western publications in their field, such as *Communications of the ACM*. They traveled, trained and taught in Sweden, West Germany, Britain, Canada and the United States. The ideology of technological change therefore acted powerfully to pacify and confine dissent and other forms of political activity among technologists in Czechoslovakia, much as it did in the United States at the same time.

After all, many of the problems that plagued everyday life during the normalization era in Czechoslovakia, such as restricted access to information, bureaucratic inefficiency and maladapted production and distribution of goods, were problems that could be addressed by the organization and rationality of powerful future computers. As Dolores Augustine observed in the East German context: “Careerism, 'apolitical' enthusiasm for technology, and withdrawal into the private realm were three of the strategies that East German engineers and industrial scientists used to deal with heightened political control, the loss of technological utopianism, decaying infrastructure, and the narrowing of their sphere of action in professional life."[418] Coupled with a pre-existing fatalism, post-1968, about Czechoslovakia’s inability to free itself from the mesh of Cold War great power politics, we begin to understand why Czech and Slovak technologists, like

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1980s” in America. Bradford Martin, *The Other Eighties: A Secret History of America in the Age of Reagan*, New York: Hill and Wang, 2011: 5.

[418] Augustine, *Red Prometheus*, 263.

their comrades elsewhere around the world, never organized or activated their potential political power in the 1980s.

Ships in a Bottle: Political Indifference and Spaces of Technical Control

This belief in inevitable technological change is reflected in technologists' own publications. A Czech engineer's manifesto in *Jemná Mechanika a Optika* of June 1980 reads: "The qualitative changes which the application of electronics has and will continue to call forth have contributed to no small extent to the formulation of contemporary civilization and will to a decisive degree create its future form as well."[419] This idea followed a common pattern of technologist thinking, seduced into what Merritt Roe Smith called "a curious cultural and political fetishism whereby artifacts stand in for technology, and technology in turn signifies national progress."[420] The belief in inevitable technological change was also a faith in technological determinism, and one that was copacetic to existing Marxist thought. After all, if human history was determined by the material conditions of human existence, then epoch-making machines like the computer made history by changing those conditions.[421] After the crushing end of the Prague Spring reform movement in 1968, the notion that technological change would inevitably transform society for the better held great appeal to the citizens of a small country occupied by a world superpower. The global reach and power of the ideology of technological change therefore engendered a kind of fatalism or overweening trust in

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[419] "K problémům rozvoje elektronického průmyslu" (On the Problems of the Development of an Electronics Industry), Ministry of Electrotechnical Industry Report: Its Future Tasks, *Jemná Mechanika a Optika* 25, June 1980: 146.
[420] Merritt Roe Smith and Leo Marx, eds., *Does Technology Drive History? The Dilemma of Technological Determinism*, Cambridge, Massachusetts: The MIT Press, 1994: 39.
[421] Ibid, 69.

technology's inherent capacity to alter the world in favorable ways without open and personally dangerous dissent.

In Hořejš and Franěk's conclusion to their third article on science fiction in *Mikrobáze* they wrote: "A computer's character influences the nature of a man—that the mere existence of computers will change the nature of man is evident. Just as the automobile redistributed the strength of muscles, so computers gradually grow some, and suppress other, properties in humans. This change may not be so far away—already behind the terminal, you can sometimes see a hobbyist who, by some traits, belongs more to a society of intelligent machines than human society."[422] While this may sound more dystopic than hopeful, it should not be interpreted that way.

To their technologist readers, a society of intelligent machines was above all else a rational society, one to be wished for in distinct contrast to the 'stupidity' and inefficiency of everyday life that seemed an unbearable feature of state socialism to Trojan and others. This ideal of creating a garden from the wilderness was part of an older strain of thinking that dated back to the Enlightenment, but which benefited from potent utopian articulants like the poet and futurist Alexei Gastev in the revolutionary Soviet Union. "In 1918, Gastev envisioned the triumph of the machine throughout the world, the emergence of 'machine cities,' and a culture of 'engineerism' wherein life was run by machines, where workers' rhythms were geared to machine tempos … It was a leveling collectivism, under the authority not of the party but of machinery itself," wrote historian Richard Stites.[423] Utopian thinking on these lines also threads

[422] "Charakter počítače ovlivňuje charakter člověka—Že sama existence počítačů změní charakter člověka, je evidentní. Tak jako auto změnilo rozložení svalové síly, tak počítače u člověka postupně vypěstují jedny a potlačí jiné vlastnosti. Tato změna nemusí být tak vzdálená—již dnes můžete za terminálem občas vidět fandu, který některými povahovými rysy patří spíš do společnosti inteligentních strojů než společnosti lidí." Hořejš and Franěk, "Počítačová Science Fiction (3)," 10.
[423] Richard Stites, *Revolutionary Dreams: Utopian Vision and Experimental Life in the Russian Revolution*, Oxford: Oxford University Press, 1989: 151.

through the science fiction discourse of Hořejš and Franěk, and reflected the aspirations of computer technologists frustrated by the friction of everyday life in normalization Czechoslovakia.

Yet to actually achieve a technocratic utopia geared to scientism in such a way was challenging and demanded a great deal of technicians' engagement with the public in all its inefficiency and irrationality. German sociologist Jürgen Habermas argued that it required technicians to embrace the public sphere and do the hard, perhaps impossible, work of communicating science in such an effective way that it transformed from the closed-off jargon of specialists to a universally understood discourse. "A scientized society," Habermas opined "could constitute itself as a rational one only to the extent that science and technology are mediated with the conduct of life through the minds of its citizens."[424] Technologists in Czechoslovakia instead embraced political indifference, a private citizenship constituted by their wholesale retreat into a closed world of tinkering, convivial conferences like SOFSEM, and spending their poorly supervised time at work to pursue clever 'hacks' of the machines they had access to. This was a world they controlled, and it may explain why so many technologists' memories of late socialism are positive ones. Simultaneously, they were taking part in the construction of a public small group, oriented around a common relationship to the artifact of the computer, intensely interactive and mutually communicative, grist for the mill of civil society formation.[425] Their projects, and the intimate shared life of their profession and hobby, afforded them an outlet for escape and creativity that was not universally enjoyed by their fellow citizens.

[424] Jürgen Habermas, *Toward a Rational Society: Student Protest, Science, and Politics*, Boston, Massachusetts: Beacon Press, 1971: 79-80.
[425] Gary Alan Fine and Brooke Harrington, "Tiny Publics: Small Groups and Civil Society," *Sociological Theory* 22, no. 3 (September 2004): 342-343.

Under the heading of "Golden Czech hands" (alluding to Czechs' renown as greatly skilled artisans and engineers), Eva Dvorníková-Krapková, formerly a punched-tape operator at Baťa in Zlín, remembers the '70s and '80s as a time when the conditions of socialism fostered an environment of experimentation and problem solving. "Socialism taught programmers and technicians an enthusiasm, a burning passion for things, and a lot of DIY—all of which was a necessity. The poor computer technology of the fraternal socialist states forced us to experiment extensively, to invent various non-standard interconnections and emergency solutions."[426] Trojan, in his interview, proudly flourished a jury-rigged modem of his own design, created in the early 1980s from an off-the-shelf Tesla telephone transformer, which allowed him to circumvent standard postal restrictions and connect, through Austria, to his colleagues in Israel and the United States. This effort—obtaining schematics, tracking down components, tinkering with build quality, and ascertaining which connections he had to dial into in order to connect outside Czechoslovakia—represented well over 100 hours of work in his estimation. He did it, he said, strictly because he was interested in keeping up with his colleagues' research in between conferences and formal publications, to exchange poetry, and because the project itself was a source of intense fascination.[427]

It is clear that Czech and Slovak technologists were not the amoral organization men and women that sociologists from Thorstein Veblen onward have typified them.[428] Although Veblen

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[426] "Socialismus vyučil programátory a techniky nadšení, zapálení pro věc a notnou dávku kutilství – to vše byla nutnost. Nekvalitní výpočetní technika socialistických spřátelených států nás nutila značně experimentovat, vymýšlet různá nestandardní propojení a havarijní řešení. Často se v případě havárie muselo do nejbližšího města kde měli stejnou techniku a protože ve dne čas nebyl, zpracování se provádělo po nocích. Později, když už se malinko otevírala vrátka na socialistického sektoru, podařil se nákup 'západní' techniky i když jen formou náhradních dílů. S takovým 'Legem' jsme si pak hráli až počítač začal fungovat a sloužit." Eva Dvorníková-Krapková, "Zlaté české ručičky (a hlavy)" (Golden Czech Hands (and Heads), in "Historie počítačů - a co bylo dál ... aneb co se nezapomnělo a nevyhodilo ...", Personal Blog, Zlín. http://www.dvornikova.cz/pocitace3.html.

[427] Trojan in discussion with the author.

[428] "Thorstein Veblen established the prevailing explanation, arguing that engineers were a 'harmless and docile sort, well fed on the whole, and somewhat placidly content with the 'full dinner-pail' which the lieutenants of the

was describing engineers of the early twentieth century and not computerists specifically, the comparison holds because of how the computer profession emerged, primarily, from the previously established domain of electrical engineering.[429] Indeed computer technologists in Czechoslovakia and globally tended to carry forward much the same masculine biases and utopian aspirations, as reviewed in previous chapters. But even the most politically radical or conscientious individuals found themselves in a bind. By the 1980s, most of them shared a common mind-set of anti-Communism and anti-bureaucratism, decried censorship and politically motivated supervision, and craved an end to the import and travel restrictions that prevented them from engaging fully with the ongoing revolution in computing. However, with notable exceptions, they agreed that direct political action, such as that engaged in by the liberal intelligentsia behind Charter 77, was futile. Within their workplaces—at research institutes, university departments of mathematics and physics, on the tenth floor (calculating machines) of Baťa's building 21C—technologists were ensconced in a predictable world, one that they controlled largely to their satisfaction.

Officially, for example, computer production in Czechoslovakia was a top-down affair run along the same lines as the rest of the command economy. State officials ordered certain production runs from particular factories or industrial concerns intended for pre-determined end users such as schools or agricultural cooperatives. Unofficially, as Studenka recalled, individual enthusiasts at Aritma, INORGA, VÚMS, or other state institutions enjoyed an enormous degree of latitude. "Many, many things, or many, many developments were done by people which are

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Vested Interests habitually allow them.' Sociologists in the 1960s and 1970s added character traits of careerism, adherence to ideals of objectivity, and social conservatism." Wisnioski, *Engineers for Change*, 118.

[429] Although the computer profession always constituted some hybrid mix of mathematicians, physicists and even non-specialized lay persons with scientific aptitude, the example of a founding computer company, ERA in Minneapolis, demonstrates the dominance of those with engineering backgrounds (more than 60 percent) over time. Brent K. Jesiek, "The Origins and Early History of Computer Engineering in the United States," *IEEE Annals of the History of Computing* 35, no. 3 (July 2013): 14.

lovers or … how can I say it? Yeah, enthusiasts. It goes from the heart. It's fine, they will do it, because this [state-mandated production] must be done, but this [other project] can be done."[430] One important way technologists maintained this autonomy was lying to the government. Gruska recounted one key meeting, in the 1970s, at which government officials asked computer specialists how the government could best support their work, where additional funding might be needed, and so forth. While Gruska claims he told the truth and insisted on the necessity of rapid, fundamental change, and that there were no consequences for truth-telling in this situation, every one of his colleagues lied to the government. They insisted that the computing environment in the country was on track and that the only thing they might need from the government was a little extra money for journal subscriptions.[431]

It is just this sort of attitude among Czechs, in particular, that has drawn much criticism from outside observers for decades. According to Vaněk and Mücke:

> Critics pejoratively labeled Czechs and Slovaks who did not resist the regime openly 'little Czechs.' On the one hand, little Czechs are endowed with natural talent, skill, ingenuity, cleverness, and the ability to improvise; on the other hand, they are criticized for not having high goals and for living their lives in the little world of their homes, devoting all their efforts to ensuring comfortable lives for themselves and their families.[432]

Paulina Bren, in turn, described the little Czech as "not motivated by great ideals. His lifeworld is delineated by his family, work, and close friends, and he approaches everything that lies outside it with caution and mistrust."[433] This perspective, especially in comparison with Poland in the 1980s, where a mass movement of millions of ordinary Poles pressured the Communists into, eventually, round-table talks, elections and a peaceful transfer of power, paints a

[430] Studenka in discussion with the author. Emphasis original.
[431] Gruska in discussion with the author.
[432] Vaněk and Mücke, *Velvet Revolutions*, 20.
[433] Bren, *The Greengrocer and His TV*, 149.

particularly unheroic portrait of Czechs and Slovaks, including computer hobbyists and professionals.

Yet this would be a deeply unfair characterization. Certainly, many technologists chose the path of political indifference and taking responsible care of their families, friends and close coworkers under late socialism. Their aims were to accomplish what was practical in what they saw as the operating parameters of normalization-era society. Engineers writ large possess such a common mentality, that of being drawn to what historian Thomas P. Hughes calls 'reverse salients' or in layman's terms, solvable problems.[434] This is one reason that patents for particular innovations—consider the telephone—tend to cluster closely together, sometimes only hours or days apart. "When a reverse salient cannot be corrected within the context of an existing system," Hughes observes, "the problem becomes a radical one, the solution of which may bring a new and competing system."[435] After the tanks of the Warsaw Pact rolled down the streets of Prague and other Czech cities in August 1968, technologists did not view political reform as a solvable problem around which they could organize and lobby to effect change.

Small wonder that technologists were tantalized by the possibility of a third way between conformity and dissidence—political indifference rooted in a sincere belief in the inevitable changes the scientific-technological revolution would wreak. This potentially neutral route between the rocks and shoals of Czechoslovakia's domestic politics mirrored technologists' desire worldwide for a kind of scientific cosmopolitanism, the "algorithmic thinking" of people like themselves who could commune across the Cold War divide.[436] Pinned between a late

[434] Thomas P. Hughes, "The Evolution of Large Technological Systems," in Wiebe E. Bijker, Thomas P. Hughes and Trevor J. Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge: The MIT Press, 1987: 74.
[435] Hughes, "Evolution of Large Technological Systems," 75.
[436] Ksenia Tatarchenko, "Thinking Algorithmically: From Cold War Computer Science to the Socialist Information Culture," *Historical Studies in the Natural Sciences* 49, no. 2 (2019): 209-210.

socialist system in existential crisis, and the harsh penalties and uncertain fruits of dissidence, many technologists escaped by burrowing deeper into a cozy community of mutual interest. Indifference did not simply mean eschewing engagement with civil society or foregoing any dissenting acts. Indifference for Czechoslovak technologists meant committing to the development of their community, participating in and taking care of professional networks like SOFSEM and MFCS, and to the labor of building out the country's computer capacity and maintaining contacts in the international scientific community.

The state socialist government was often perceived by technologists as a source of irrationality and bureaucratic conservatism. Therefore even ordinary, rote work with the computer "provided opportunities to engineer the social and organizational relationships that surrounded it."[437] Chvatík, who worked with a Datasaab computer, proudly recalled the many times he was asked by the StB to bring back industrial secrets from his trips to Sweden, and how he refused each time.[438] Access to the computer made him a person of special interest to the secret police, and gave him the opportunity to engage in repeated, private acts of dissent when he refused to spy for them. It helped reify his identity as a conscientious technologist loyal to an international collective of like-minded experts that straddled both sides of the Cold War political divide.

When Studenka used his spare time at INORGA to design a more efficient, less expensive double interface card to couple analog plotters with ADT computers, and then used his pull with colleagues at the ZPA Čakovice plant to get it mass-produced, it allowed him to contribute to the whole society's benefit while feeling like he was circumventing the system's inefficiency. Decades later, it was a point of pride that his ingenuity had lowered the price of this

[437] Medina, *Cybernetic Revolutionaries*, 95.
[438] Chvatík in discussion with the author.

computer peripheral from 35,000 crowns to only 5,000 crowns.[439] This resolves the apparent contradiction in the memories of many technologists who, when interviewed about the period of *normalizace* in Czechoslovakia, insist they were resolutely anti-Communist but also steadfastly non-political. Petr Pithart, a prominent ex-communist turned dissident, summed up the sentiment: "Sometimes I have the feeling that we would most like to take a well-made product and write on it: Let no one pass by without noticing what a blow the regime has suffered here."[440] Technologists, in accord with Pithart, understood dissidence—marching in the streets, signing petitions, going to prison—as fundamentally different, dangerous and even unnecessary compared to undertaking more private dissenting acts that might achieve immediate, practical results.

The High-Wire Act:
Balancing Ideology, 'Non-Politics' and Community Demands

In this view, anti-Communism was simply zeitgeist, the reality everyone of that time experienced, and so (in the technologists' circle) active dissent seemed both unnecessary and self-defeating. They considered the state socialist system as both permanent in the short- to medium-term—backed by the armed might of the Soviet Union—and porous, full of niches they might exploit to their benefit, e.g. for the security of a prestigious employment at a research institute, or the freedom to pursue their own interests in the bosom of an understanding community. However, political indifference balanced on a knife's edge. Much like the difference between Paulina Bren's *chata* owners and trampers, whose indifference suited the regime differently, the state tolerated some behaviors as in the case of Tomáš Smutný, while delimiting

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[439] Studenka in discussion with the author.
[440] Pithart quoted in: Bolton, *Worlds of Dissent*, 238.

insofar as it could, others. The regime generally preferred to channel, bound and monitor the ways in which technological enthusiasm/political indifference were expressed, whether in the pages of a magazine or on the popular youth program *Televizní klub mladých*.

Mikrobáze is an excellent example of both bounded dissent and a discursive niche that grew into a genuine user community, a grouping of young professionals and enthusiasts who felt *vnye*, who drew on state resources while remaining largely uninterested in open politics and traditional ideology.[441]

As we observed in the reader survey from the last chapter, the editors declined some of the more outré user requests, such as custom-compiled programs catering to their individual desire and delivered to them on tape cassette. However, as they did so the editors of *Mikrobáze* generally expressed eagerness to fulfill users' demands, and a kind of disappointed solidarity when they outlined reasons they could not.[442] Published in early 1986, this kind of empathy for users' desires illustrates how *Mikrobáze* attempted to fulfill its mission as a discursive niche for computer users in Czechoslovakia, and offers a glimpse of a *vnye* grouping virtually *in utero*. Svazarm and other such organizations presented its members many options for acquiring computer skills and working with information technology.

Responding to a cry for more access to software programs and education in writing computer code, *Mikrobáze* recommended that its readers contact their local branch of Svazarm for experts who had experience working with computers and who might be available to teach. "For literature that would lead to mastery of programming in various languages," Svazarm

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[441] Yurchak, *Everything Was Forever,* 146.

[442] "Náš zpravodaj budeme rozvíjet i podle Vašich požadavků, připomínek, námětů a příspěvku." "Our magazine will develop according to your requests, comments, suggestions, and contributions," wrote the executive editor, Eng. Jan Klabal, in the January 1988 issue. "Rádi bychom tomuto požadavku vyhověli. V současných provozních podmínkách se bohužel jedná o zatím nesplnitelné přání." "We would like to meet this requirement [that *Mikrobáze* be printed monthly]. Under current operating conditions, unfortunately, it is an impossible wish," the editors wrote in March 1986. Jan Klabal, "Nový Ročník" (A New Year), *Mikrobáze* 10 (January 1988): 1; "Výsledky ankety Mikrobáze z roku 1985," 12.

provided “program blocks (on tape) and their manuals.” When *Mikrobáze* could not meet readers’ requests, it was usually because such requests were not technically possible to fulfill—for instance, some readers’ demand that “programs be recorded on tapes in blocks and delivered to them, so that they may freely choose individual programs” at their leisure. Quality tape cassettes did not exist in such numbers in Czechoslovakia, and the editors correctly considered the time required for creating custom programs tailored to every individual prohibitive. There was even an “ongoing remote computer science course” for those who had trouble making it to the nearest branch in person.[443] The state played a key role in assisting technologists through state-funded organizations like *Mikrobáze* and Svazarm, both of which provided additional opportunities to obtain practical experience with computers and software. Careful self-interest was at work here.

In the first issue of *Mikrobáze*, the editors did not attempt to disguise the state’s interest in fostering cadres of technically knowledgeable youth and workers: Czechoslovakia was falling further behind in information technology, and policymakers knew that computers would be the key to a modern economy. “It is very difficult to keep up” the first issue’s introduction announced; the editors explicitly framed the creation of *Mikrobáze* as a response to the Czechoslovak Communist Party’s decision, taken at the 16th Party Congress, to thrust “the development and popularization of microelectronics and computer technology” to the top of the country’s agenda.[444] This push from above in Czechoslovakia echoed the similarly keen focus on IT in East Germany, where “information technologies were an important element in the national government’s strategy for economic and political survival and vitality.”[445]

[443] “… probíhajícího dálkového kursu výpočetní techniky.” “Výsledky ankety Mikrobáze z roku 1985,” 11.
[444] “Je velmi těžké udržet krok … Rozvoj a popularizace mikroelektroniky a výpočetní techniky jsou jedním z hlavních úkolů, postavených XVI. sjezdem KSČ.” “Držet krok,” *Mikrobáze* 1 (January - November, 1985): 3.
[445] Cortada, “Information Technologies,” 35.

Memories of state support for computer skills education and access to both hardware and software are not always so rosy, of course. Of the computer clubs sponsored by the state, Švelch writes "Although day-to-day operation of the clubs was apolitical, computer hobby life in the [sic] socialist Czechoslovakia was always subject to the whims of individual state officials—two prominent hobby organizers described their efforts as a never ending struggle against 'bureaucratic supermen' and 'technological conservatism'."[446] However, the very existence of state-sponsored computer clubs gave cover to computer enthusiasts using their skills for money in the dubiously legal 'gray' market. Moreover, clubs sponsored by Svazarm or SSM were sometimes state-supervised or controlled only in the most nominal sense, a scaffolding that created an official permission structure for otherwise unapproved activities.

Fuka, perhaps the most famous individual programmer from the late socialist period, was a teen heavily engaged in video and software piracy during the 1980s. When he joined Svazarm he "never remembered any explicit military participation and the club had quite a bit of freedom to do what it pleased. 'They had two or three very basic computers that were basically smuggled in and one was built by them,' Fuka said with a certain fondness. 'So it was very spartan, very do-it-yourself.'"[447]

While the most frustrating restrictions technologists experienced, such as censorship, choked-off imports and under-production of poor quality equipment and software were largely due to policies put in place by high-level officials in the government, it was the critical middle tier of government—the university departments, research institutes, industrial firms and official clubs and societies that formed the *mesocosm* discussed in chapter one—where technologists found support and protection. As political scientists Marcia Weigle and Jim Butterfield

[446] Jaroslav Švelch, "Say it with a Computer Game."
[447] Jonathan Keshishoglou, "The Programmer Behind the Iron Curtain," *Prague Wandering*, May 18, 2015. https://thepraguewandering.wordpress.com/2015/05/18/the-programmer-behind-the-iron-curtain/.

determined, these mid-tier spaces behaved like protective camouflage, allowing initially small communities of shared interest, such as computerists, to form defensive, avowedly non-political groups during the period of maximum political repression following the end of the Prague Spring. When economic crisis in the CMEA bloc during the 1980s forced the regime to extend political liberalization to most-favored cadres such as technologists and other white-collar workers, these narrowly-defined defensive groups "widened their scope and formed organizational links with one another to act as vehicles for widespread social participation."[448] This phenomenon played out for example in the previously established personal and professional contacts between computer enthusiasts and prominent dissidents in the interlocking web of Svazarm, *Mikrobáze*, SOFSEM, Charter 77 and the software group at VÚMS.[449] Nor was this unique to Czechoslovakia; it seems to have been a common feature of state socialist societies in Europe. In neighboring Poland, for example, mid-level state organizations like the Polish Association of Informatics, the Association of Polish Socialist Youth and journalists at *The Young Technician* magazine lobbied policymakers for increased investment in disseminating and promoting computers to ordinary Poles.[450]

Tomáš Smutný was just such a protected user. His experience in late socialist Czechoslovakia illustrates how the state could foster and support skilled computer users but, frustratingly, also hinder and persecute them. An experienced electrical engineer who graduated from the military college in Brno, Smutný was also a computer enthusiast. Beginning in 1982, he began to repair the kind of arcade game computers (mostly imported from West Germany) that

[448] Marcia A. Weigle and Jim Butterfield, "Civil Society in Reforming Communist Regimes: The Logic of Emergence," *Comparative Politics* 25, no. 1 (October 1992): 12.

[449] Jiří Hořejš, for example, wrote for *Mikrobáze* while using his power as head of the new computer science department to protect a politically active Jiří Zlatuška while he was a student, and co-founded the SOFSEM forum with Josef Gruska which extended community support and funding to Ivan M. Havel while the regime banned his writing and imprisoned his brother.

[450] Wasiak, "Playing and Copying," 129-150.

toured Czechoslovakia in traveling fairs. He gradually began to repair more such machines and produce some of his own for sale. Because Svazarm employed him, he had permission from the competent authorities to conduct his own computer repairs, though he did in fact stretch this permission far outside its intended, limited area of effect around Benešov. Brought into custody, the state began to prosecute Smutný and promptly called as their expert witness … one of Smutný's friends, Vladimír Smejkal, another computer user from his Svazarm organization. "They simply had no one who could understand [about computers]—only the people who were moving around us," he later recalled.[451]

The state's prosecution of Smutný fits a narrative of an ideologically blinkered socialist dinosaur. However, the state sponsored Smutný's technical education, and Svazarm (a state-funded, state-affiliated organization) employed him as a computer expert. The state furnished him with the access to materials and official legal cover he needed to work "on the side" repairing and selling computers for profit. Then they arrested and prosecuted him for it. This relationship between users and the state can be frustratingly unclear to historians because the state was not a monolith. Clearly, computer users and state agents often experienced each other as adversaries. Nevertheless, a relationship of mutual support and need is also evident. Smutný's case reveals elements of both mutualism and antagonism in user/state relations — it complicates a narrative that might stress the opposition between users and the state.

In Dejan Ristanović and Jelica Protić's 2012 article "Once Upon a Pocket: Programmable Calculators from the Late 1970s and Early 1980s and the Social Networks Around Them," a similar dynamic occurs. User communities oriented around shared-interest technologist magazines established software libraries for programmable calculators, as manufacturers like

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[451] "Oni prostě neměli nikoho, kdo by tomu rozuměl, jen lidi, co se pohybovali kolem nás." Bach, "Muž, který bastlil v Československu herní automaty."

Texas Instruments and Hewlett-Packard did not publish enough software to keep up with users' demand.[452] On the other side of the Iron Curtain, Czechoslovak computer enthusiasts pursued a similar course with a program of computer software loaned out to users on cassette tapes. Computer hobbyists in Czechoslovakia relied on *Mikrobáze* and Svazarm for services like this software repository.[453] Typical computer use in late socialist Czechoslovakia was often a private endeavor and constituted a way of withdrawing or "dropping out" from the normative, socialized and (significantly) supervised experience of computer use that the regime encouraged, particularly the hundreds of hours of solo tinkering and self-taught programming that young computerists of the time like Mareš recalled.[454]

However, dropping out usually required "tuning in" first, as it was difficult to acquire hardware, software, peripherals and even the knowledge needed to engage in programming and computer use in the first place without affiliation to a state-sponsored youth or computer club.[455] Youth computerist culture in the 1980s, then, was pulled in separate directions: apathetic about politics and dissent generally, but with heightened interest and attention paid to officials' attitudes toward and treatment of the computer scene. Political indifference and a belief in the inevitable scientific-technological revolution allowed computer users of all ages, not just the youth computing culture, to extract value from the state with a (relatively) clear conscience in the 1970s and 1980s. Open support of the state made little sense given the anti-communist zeitgeist of the period, while open dissent seemed impractical to engineers.

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[452] Dejan Ristanović and Jelica Protić, "Once Upon a Pocket: Programmable Calculators from the Late 1970s and Early 1980s and the Social Networks Around Them," *IEEE Annals of the History of Computing* 34, no. 3 (2012): 58.
[453] "ZO" is an acronym for *základní organizace* or basic organization – in this case, a particular branch of Svazarm, the 602nd ZO, located in the Prague 6 district.
[454] Mareš in discussion with the author.
[455] Patryk Wasiak, "Dropping Out of Socialism with the Commodore 64: Polish Youth, Home Computers, and Social Identities," in Maria Asavei, Irina Costache, Madigan Fichter, et al., *Dropping Out of Socialism: The Creation of Alternative Spheres in the Soviet Bloc*, New York: Rowman & Littlefield, 2016: 162-163.

A better model fits Czechoslovakia's state/user experience. Bohuslav Blažek described state support as "scattershot and uncoordinated," which fits with other contemporary descriptions: A supportive state that sought a mutualistic relationship with technological enthusiasts in its population, groping for the right mix of policies to ensure success.[456] Mutualism problematizes a particular narrative of state socialism's inevitable failure to navigate the personal computer revolution. Elements of the state and user community leaned on one another for support, and in shifting configurations of support and criticism formed a mixed, inclusive community that partook in opportunism and idealism in varying measures.

Science fiction periodicals—ephemeral fanzines, official publications like *Villoidus*, and *samizdat* like *Vega*—provide an illustration of how this mutualism worked in practice to configure belonging and politics among the community of computer technologists. The first dedicated science fiction magazine in Czechoslovakia was *Vega*, published in small circulation, only 20-30 copies of each issue, initially "as a supplement to the newsletter of the Předenice tramp settlement."[457] *Vega* enjoyed a great deal of prestige among the science fiction fan community in the 1980s, both for its prime mover status and because it was "true *samizdat*" in which any material, no matter how salacious or politically challenging, might appear.[458] Then there were a number of ephemeral publications, including newsletters and hobbyist projects of local clubs or groups of friends, such as *Sci-fi Věstník* at the Teplice observatory and *AF 167*, a 1985 one-issue anthology of original Czech science fiction and fantasy stories edited by the circle of science fiction fans at J.E. Purkyně University (today Masaryk University) in Brno. These ephemeral fanzines brought local groups together (the five story contributors, including

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[456] Blažek quoted in Švelch, "Say it with a Computer Game."
[457] Henry Jenkins, "The Czech Zine Scene (Part 2): Science Fiction Fanzines," Personal Web log, *Confessions of an ACA-Fan*, (February 26, 2018). Available from: http://henryjenkins.org/blog/2017/12/26/the-czech-zine-scene-part-2-science-fiction-fanzines.
[458] Holan in discussion with the author.

technologists Hořejš and Franěk, but also Karel Blažek, editor of Blok publishing, and Ivana Holzbachová, an instructor in J.E. Purkyně's philosophical faculty, were all Brno residents).[459] However, for practical reasons of funding, interest and limited access or lack of official permission to use printing facilities, their groups were often ad hoc and uninfluential beyond the confines of a university, a city or a small social group. True *samizdat* like *Vega* and local newsletters and anthologies of work like *AF 167* did not therefore significantly stimulate or organize the Czechoslovak science fiction fandom into a nationwide community.

In comparison, the most successful and influential publication of Czechoslovak science fiction fandom in the early 1980s was *Villoidus*, which conformed to the previously described mutualistic model. Because Holan, one of the magazine's co-founders, sat on the faculty board of the SSM at Charles University, *Villoidus* enjoyed official permission—"of course supervised," Holan noted "We prepared the print masters, put it to them, they reviewed it, and after they did they took it into the faculty printing shop"—to print 300-400 copies of every issue and obtain the funding necessary to distribute copies at the first nationwide fan conventions in Pardubice (1981-1986), conduct interviews with well-known Czech writers like Ondřej Neff and Jaroslav Veis, and hire nationally known graphic artist Kája Saudek for illustrated covers.[460] Holan and the other editors distributed the magazine in separate "channels" to science fiction fan clubs outside Prague through the post, to the annual conventions, and to the students and faculty of Charles University itself.

These outside fan clubs were spread throughout Czechoslovakia: organizations in Teplice, Ústí nad Labem, Pardubice, Brno, České Budějovice, Bratislava, Banská Bystrica and

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[459] The magazine name is homage to *Frankenstein; or, The Modern Prometheus* by Mary Shelley. "AF" stands for "Anno Frankenstein" and "167" refers to the number of years (in 1985) since the book's initial publication in 1818. J. Semrád, E. Fuchs, V. Ševčíková, et al., eds., *AF 167* 1, no. 1, Brno, Czechoslovakia (1985).

[460] Holan in discussion with the author.

Košice all received copies of *Villoidus*.[461] The result, from 1981 onward, was what Holan described as "some form of revolution in the science fiction community, because we met together with so many people, seen together for the very first time. But also we communicated by mail—not e-mail!" Unlike *Vega* and *AF 167* then, the success of *Villoidus* and its co-founder Holan in fostering the creation and rapid growth of a nationwide community of science fiction enthusiasts reveals how Czechs and Slovaks made use of government resources and institutional scaffolding to pursue their own goals and create private groups outside family and state structures.

According to media studies scholar Henry Jenkins: "Official support from the authorities was a significant aid in the practical aspects of fanzine production," yet while "content was most likely regularly checked for subversiveness … no restrictions of content had ever taken place."[462] *Villoidus* and the science fiction fan community that grew up with it in the 1980s, which included a great many computerists such as Holan, Hořejš and Franěk, was not an example of nascent political opposition finding, in Kenney's description, a "space not yet taken over by the communists," such as the environmental movement, but rather a "place for people who wanted to get things done," to achieve their own goals or interests, and did not mind that the government also benefited from this mutualistic paradigm.[463] The SSM grouping at Charles University that Holan helped lead could plausibly claim *Villoidus* represented an important youth activity that fulfilled its mandate, and Charles University administrators saw student activities channeled into ostensibly productive, or at least harmless, apolitical activity they could monitor before printing.

Czechoslovak youth were not the only opportunists to engage with the state in this mutually constructive manner. Even older Czech and Slovak technologists in the 1970s and

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[461] Ibid.
[462] Jenkins, "The Czech Zine Scene (Part 2)."
[463] Kenney, *Carnival of Revolution*, 50, 126.

1980s conformed closely to the generational model Paulina Bren has previously described. “They had grown up in a communist state and yet had had the good fortune to forgo any direct responsibility for Stalinism; consequently, they were at once critical of the regime and loyal to it, ‘enjoying all the advantages’ that communism offered them—‘whether we realized it or not.’”[464] A thoroughly alienated, dissenting user community unwilling to innovate or work with state agencies did not contribute to state socialist Czechoslovakia’s lack of digital success. In the 1980s, the Czechoslovak state offered the burgeoning community of personal computer users important forms of material support, such as software program libraries, technical schematics, access to computer equipment and meeting places—all under the aegis of various state organizations like Svazarm, SSM, university departments and research institutes. Importantly, the state also provided an advocate for users in *Mikrobáze*. This officially state-loyal advocacy was a difficult balancing act for the editors.

There was a growing sense of dissatisfaction among computer users in Czechoslovakia. While this echoed economic malaise throughout the state socialist bloc, the computerist community had its own causes for friction with their government. Imports were unaffordable when they were available. Indeed, the severe shortages noted in *Mikrobáze* occurred as late as mid-1988, after the government’s dramatic attempts to supply the educational and consumer markets for home computers. In 1985, when Svazarm established *Mikrobáze*, there was no legal domestic market for home computers, peripherals or software.[465] Domestic production suffered from faulty components, little access to service and repair, and a paucity of Czech or Slovak-language software. Editors had to address these problems skeptically to maintain rapport with

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[464] Bren, *The Greengrocer and His TV*, 90.

[465] “‘Ano, a co teď právě nabízíte v oblasti malé výpočetní techniky?’ ‘Právě teď nic.’” “‘Yes, what do you offer now in small computing?’ ‘Nothing right now.’” “Na Návštěvě ve Spálené” (On a Visit to Spálená Street), *Mikrobáze* 5 (May 1988): 6.

disenchanted readers in the user community, yet they knew overt criticism of the state or its ideology was out-of-bounds in what was, after all, a publication closely associated with state policies and interests. An examination of the rhetoric addressed to users throughout the four-year (1985-1989) print run of *Mikrobáze* reveals how editors maneuvered in this middle ground between subversion and loyalty to the state.

This was not unique to the realm of personal computers. Socialist regimes' attempts to meet their citizen consumers halfway, acknowledging and attempting to manage their aspirations proved problematic with other technologies and consumer goods as a whole. Bren pointed to the distrusted figure of the *vekslák* (racketeer), who stood outside the closed shops of the Tuzex import/export concern to exchange citizens' hard currency for the *bony* coupons that could buy desired foreign goods, as the symbol of the whole "shared spectrum of of economic behavior that came to define the times."[466] These racketeers were symptomatic of a broken system that required hustling, corruption and unethical transactions—but they were also "vital intermediaries" for the government, which could only provide enough consumer goods to tantalize but not satisfy the public.[467]

In reference to Soviet automobiles, historian Lewis Siegelbaum notes, "The state's attempt to manage desire involved it in a whole series of compromises and concessions, a Faustian bargain with heterodox (if not actually private) economic activity it ultimately could not win."[468] To avoid this and strive for a genuinely mutualistic relationship that might short-circuit any technologist dissent and foster political indifference, elements such as Svazarm and SSM sponsored discursive spaces where two-way communication of limits and demands could occur. *Mikrobáze* was such an interface site where both state and users expressed desire and demand to

[466] Bren, "Tuzex and the Hustler," 45.
[467] Ibid.
[468] Siegelbaum, *Cars for Comrades*, 7.

each other in a supervised and productive manner. Examining changes over time in state-approved rhetoric directed at users, which reflect the influence of user opinion, indicates significant responsiveness and empathy to citizen demands from one of the most hardline Communist regimes in East Central Europe.

In the beginning, the editors of *Mikrobáze* played it safe, erring on the side of ideological orthodoxy. This sometimes led to the adoption of a hectoring tone. In response to readers' complaints of domestic computer shortages, which made it difficult or impossible for them to replace older computers, obtain components for repairs or write software on more capable hardware, the editors launched into a lecture. "Regarding Czechoslovak computers, the survey results show that for members their hobbies are virtually inaccessible. If yes, then thank only the professions at work, where the computer is needed to work, not to engage in leisure activities."[469] This was a preemptive response to criticism.

The rhetoric meant to ground the user community's by-now-familiar complaints of perennial hardware and software shortages. The editors appealed to early computer users' sense of professionalism (many, if not most, older readers had acquired and continued to use their skills in the workplace), their self-importance (as a niche community that casual users could not access) and any remaining ideological sympathies (the computer in a collective work setting helping to build a better tomorrow). As Cortada notes in his review of a similar setting in contemporary East Germany, "user communities admired Western innovations, wanted to use computers more than their economy allowed, and contributed specifically to the discontent exhibited against public policies that attempted to satisfy these wishes."[470] As a state publication

[469] "Pokud jde o čs. mikropočítače, výsledky ankety ukazují [sic], že jsou členům pro jejich zájmovou činnost prakticky nepřístupné. Pokud ano, pak jen díky profesi v zaměstnání, kde je na počítači třeba pracovat, nikoli se zabývat zájmovou činností." "Výsledky ankety Mikrobáze z roku 1985," 11.
[470] Cortada, "Information Technologies," 46.

devoted to these skeptical technologists, editors at *Mikrobáze* were initially in the unenviable position of defending shortages and shifting the blame away from the state policies responsible for them.

The Most Toys:
Games Rhetoric as an Index of Political Shift

Another sign that *Mikrobáze* was initially a defender of state technology policy is the way editors chose to talk about computer games. The user community was unabashedly in favor of them, and so continuing critiques of using computers for games is a reliable indicator of ideological supervision, or at least preemptive self-censorship, of the editors. According to Wasiak, state-directed criticism of using computers for playing games appears to have been a bloc-wide trend as were, of course, the corresponding computer and software shortages. "Officially, computerization in Poland was called 'The game for tomorrow' ... Young people were encouraged to use computers exclusively for 'serious purposes' instead of entertainment. For instance, an editorial in *Bajtek* in 1989 criticized computer entertainment for its failure to increase 'the actual output of [the] national economy.'"[471] In the introduction to the first issue, the editors wrote that their goal (as a magazine but also, presumably, arm-in-arm with state policy) was "a serious and effective use of microcomputers in all areas of our lives. So not only playing various games."[472] Deriding the value of using computers for games was in one sense a way to put the best face on a bad situation—importing foreign computers was an expensive use of limited hard currency, and domestic production continued to suffer serious problems in sourcing components, facilities, technical know-how and quality control.

[471] See survey results for question I. "Výsledky ankety Mikrobáze z roku 1985," 5-8; Wasiak, "Playing and Copying," 129-150.
[472] "A cílem je seriózní a efektivní využívání mikropočítačů ve všech oblastech našeho života. Tedy nikoli pouze hraní nejrůznějších her." "Držet krok," 3.

It was also an ideological reflex. Initial opposition to producing Soviet automobiles, for example, had included accusations that they were bourgeois carriages—akin to the idea that personal computers were not necessary, just bourgeois luxuries to play games on.[473] Mainframe or mini-computers (like Bartošek's beloved PDP 11/34), were limited in number by size and cost and intended for specialized tasks within centralized industry or government work. They were a better fit for a socialist system that demanded centralized control (in form if not in practice) than the image of a lone computer user, hunched over a flickering terminal in the privacy of her apartment, writing her own programs or playing her own games.[474]

Over time, the ideological opposition in *Mikrobáze* to using computers for games softened considerably. One potential reason might have been the belated realization, among certain policymakers, that the lone computer user endlessly tinkering with their ZX Spectrum was not too different in their political apathy from the office worker who dreamed of their countryside *chata* all week long. Government rhetoric against games mellowed in the late 1980s. Taking steps in the direction of opinion in the user community they served, the editors of *Mikrobáze* no longer lectured their readers on the proper way to use the country's limited stock of computers.

No complete *volte face* is evident. Just two years later, however, in the introduction to the March 1987 issue, the editors lamented the inability of the domestic market to support the

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[473] Siegelbaum, *Cars for Comrades*, 38.

[474] Publishing her own *samizdat*? Soviet reluctance toward PCs stemmed in part from this possibility, as Cortada observes. Cortada, *The Digital Flood*, 270. "Program the Future!" an ad for pension insurance from 1988 reveals how the government remained captivated by a future of centralized, not distributed, computing. With digital text and a space background, it is supposed to be optimistic and looking to the future, but at the end of the 1980s they are still portraying computers as large, tape-driven machines like the IBM 729, superseded already at the end of the 1960s by the IBM System/360. "Naprogramujte si budoucnost (1988). Důchodové pojištění, Česká státní pojišťovna. Vizualizace k důchodovému pojištění ukazuje, že i na konci osmdesátých let bylo toto téma spjato se „zářnými" zítřky. Digitální font jako z kalkulačky, počítač a na pozadí pohled do vesmíru – tak nějak vypadala představa moderní budoucnosti." Ondřej Aust, "Historické plakáty České pojišťovny," *Médiář*, January 26, 2013. https://www.mediar.cz/historicke-plakaty-ceske-pojistovny/.

production of even a single delivery's worth of computer games. Noting the failure to deliver 7,000 electronic digital games to the consumer market, they viewed this as a troubling indicator of the overall health of the technology market in Czechoslovakia. "Of course it is just a delivery of micro-computer games. But if because of an insufficient domestic component base even their mini-production is out of the question …"[475] The implication is unspoken. The pregnant pause would not have escaped readers, however, just as it does not escape us. Two years after strongly criticizing games as a waste of time, games became for *Mikrobáze*'s editors (as they already had been for its readers) an index of computer success in the country, a commodity to which it was necessary to produce, consume and pay attention.

Practical experience may also have brought the magazine's rhetoric more in line with its readers in the user community, instead of socialist ideology. Švelch notes "Games attracted hobbyists and would-be amateur programmers [to the field of programming] … who could use them to demonstrate both their own capabilities and those of their machines."[476] The state needed to create new cohorts of technically-skilled users. "It is clear," *Mikrobáze*'s editors wrote in October 1986, "that any device-based computing becomes a solution only if it works with a cadre of engineers and technicians capable of disposition and application in full use."[477] Faced with this need, the state (as evidenced by *Mikrobáze*'s shift in rhetoric in the space of just two years) had become more comfortable with users employing their computers for games, so long as that meant widespread interest in information technology and proficient programmers.

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[475] "Ovšemže jde jen o minidodávku mikrohračky. Ale když z důvodu nedostatečné tuzemské součástkové základny nepřipadá v úvahu ani jejich minivýroba …" "Novinky z novin" (News from the newspaper), *Mikrobáze* 5 (March 1987): 2.

[476] Švelch, "Say it with a Computer Game." See also: Petri Saarikoski and Jaakko Suominen, "Computer Hobbyists and the Gaming Industry in Finland," *IEEE Annals of the History of Computing* 31, no. 3 (2009): 22.

[477] "Je zřejmé, že jakékoli zařízení na bázi výpočetní techniky se stane řešením jen tehdy, bude-li s ní pracovat kádr techniků a inženýrů schopných jeho dispozice v plné míře využít a aplikovat." "Na prahu páté generace," 3.

This changed outlook is perceptible from 1987 onward and tracks with the economy-wide, though half-hearted, government *přestavba* reforms. In October 1987, the editors admitted: "A person becomes a programmer largely on their own, through very time-consuming and intellectually demanding study and extensive experience. The school could give him some basics; clubs and social organizations can help as well. But building capacity and skills must take place in private, continuous contact with the technique itself."[478] Although a collective environment (schools, clubs, organizations) still had an important role to play in educating technically-skilled cadres, the editors had overcome their previous apprehension of the anti-social, bourgeois nature of time spent alone tinkering with hardware, playing games and writing software. Nor was changed rhetoric the only positive nod the magazine directed at the user community—from October 1987, the editors published *Mikrobáze* in color and a few months later, in January 1988, on a monthly basis. Attractive color covers replaced their drab predecessors, and the clarity of the type markedly improved. Clearly *Mikrobáze* was important enough to receive an increase in state funding. Previous editions of the magazine (before January 1988) were quarterly. Color format and more frequent publication had been a reader demand practically since the magazine's launch in 1985.

For the last half of its published life (1987-1989), *Mikrobáze* was unequivocally in the users' corner. Indeed, a publication founded as an interface between the state and the community of computer users began to adopt a strident rhetoric of reform easily interpreted as playfully subversive of official ideology. It seems clear that the tug-and-pull nature of the mutualistic relationship between users and the state had begun to swing, lopsidedly, in users' favor. This was

[478] "Programátorem se člověk stává z velké části svým vlastním, časově i intelektuálně velmi náročným studiem a bohatou praxí. Škola mu může dát určité základy, pomoci mohou i kluby společenských organizací. Rozvíjení schopností a umu ale musí probíhat v osobním, kontinuálním kontaktu s technikou samotnou." Ladislav Zajíček, "Než nám ujede šestnáctka" (Before the [Goals of the] 16th [Party Congress] Expire), *Mikrobáze* 9 (October 1987): 3.

not a simple state retreat, but something more interesting: Svazarm, at the very least the 602nd ZO in Prague, identified with its users and thereby began to articulate *naše zájmy* (our common interests) as a single mixed community. The more formal language and cautious criticism that had characterized earlier issues of the magazine were left behind. Despite continuing to publish under the imprint and supervision of Svazarm, a state agency, articles take on a challenging, sometimes playful but usually critical tone in the last two years of the print run.

For example, in May 1988, the magazine published an interview with František Nevrlý, the owner/operator of the first private computer store on Prague's Spálená ulice (Burnt Street, a famous commercial thoroughfare). After Nevrlý told the interviewer that, unfortunately, he did not have any computers in stock in his (computer) store, the interviewer—instead of commiserating with "Deputy Comrade Head Nevrlý" about the difficulty of keeping up with the fast-paced technology market—asked him, tongue-in-cheek, "Let me jab [at you]. What do you have when you have nothing?"[479] The shift in tone is significant.

There is no longer any pity expressed for failure to keep up, unlike the introduction to the first issue of *Mikrobáze* in 1985, "Držet Krok" or "Keeping in Step," which leads off bemoaning the overly rapid pace of change in the personal computer sector. A cartoon on the same page of the 1988 issue shows a curious consumer looking at a solitary computer on display through the store's glass window, head craning in every direction, fully appreciating the exotic artifact, walking into the store and emerging disappointed with an abacus instead. *Mikrobáze* had moved on to an unsubtle critique of the state's inability to meet consumer demand, a frustration its readers in the user community had expressed for years.

With its advertisements of unobtainable computers, schematics of unbuildable peripherals (no parts!), and interviews with owners of empty shops, *Mikrobáze* might have been a

[479] "Dovolte mi rýpnout. Co máte, když nic nemáte?" "Na Návštěvě ve Spálené," 7.

scintillating but unsatisfying experience for user-readers. The ensuing destabilization, resulting from the growing gap between unfulfilled state production promises and user community demands, inclined the editors of *Mikrobáze* to side with the readership. It diminished some of the earlier promise of a state-loyal, user-friendly publication—*Mikrobáze* was no longer a truly mutual rhetorical interface. State expectations of user behavior and expressions of state policy had dwindled; critical talk of shortages and quality issues increasingly filled that space in the magazine's pages. The community around *Mikrobáze* was still inclusive of elements of the state, such as Svazarm, partly due to material support but also shared outlook and interests: there was no outright divorce of user and state.

Vanguard Off-Guard: How the Velvet Revolution Surprised Technologists

Mikrobáze and its community moved from the middle ground to a decidedly more dissenting and state-skeptical position as the Velvet Revolution of November 1989 approached. Crossing ill-bounded lines of actual dissent, however, still carried risks, enforcing the appeal of at least formal political indifference. Capping the government's decidedly mixed legacy of support and repression vis-à-vis technologists, one of its last acts was to fire Zajíček, *Mikrobáze*'s managing editor and author of one of the key Czech-language guides to programming, *Bity do bytu*. After Zajíček was pronounced an enemy of the state, *Mikrobáze* itself was shut down while the government collapsed and its reading audience scattered to ephemeral, narrow-interest publications like *ZX Magazín* and *Atari FLOP*.[480] Even in the last

[480] "Nejdůležitější ovšem bylo, že Láďa vydával časopis Mikrobáze - to ovšem zdaleka nebyl pouze ryze počítačový časopis. Publikační prostor v něm nakonec dostali i vyslovení odpůrci režimu. I časopis Mikrobáze byl nakonec zaškrcen, přesněji řečeno, Zajíček byl od něj zahnán a osiřelý časopis po jednom "znormalizovaném" čísle zanikl. Ale to už velmi brzo přišel 17. listopad a s ním i konec starého režimu." Zajíček died in 2001, but he was remembered well in this obituary and throughout the larger community of computer enthusiasts in the Czech

days of state socialism, open dissent still carried serious risks and political indifference was the safest, and in many ways the most practically appealing, path for computer technologists. In this respect, Czech and Slovak computerists were more akin to the majority of their fellow citizens, and unlike other communities of common interest in the country—the Independent Peace Association, Slovak Catholics under Ján Čarnogurský, the students of Orange Alternative—all of whom were engaging in open, organized acts of dissent including protest marches by 1988 and 1989.[481] Although individual computerists sometimes took part in these demonstrations or signed petitions like Několik vět, they never publicly organized as a political grouping along the lines of Computer Professionals for Social Responsibility (CPSR), an American white-collar civil society organization that advocated for ethical computing practices (such as refusing to work on Reagan-era missile defense systems).[482]

Personal narratives further bolster this case. Bartošek was still a young man in November 1989 when he returned from a weekend away to find a revolution in progress, one that caught him by surprise. "And now started a lot of discussions; for example, at that student hostel, in which people tried to force the revolution [on] people [who] were afraid of the consequences, and that there would be some bloodshed, and everything."[483] Bartošek, like his parents, was a member of the Communist Party and had spent most of the 1980s utterly engrossed in his work with the DEC PDP 11/34, learning English from its user manual and DECUS (the official PDP newsletter), meanwhile traveling to Britain and Greece to continue his training and complete his Ph.D.

Republic and Slovakia. Jiří Kofránek, "Ladislav Zajíček – Elzet," *Britské listy*, December 14, 2001. https://legacy.blisty.cz/art/9504.html.

[481] Kenney, *Carnival of Revolution*, 215-216, 280-284.

[482] Megan Finn and Quinn DuPont, "From Closed World Discourse to Digital Utopianism: The Changing Face of Responsible Computing at Computer Professionals for Social Responsibility (1981-1992)," *Internet Histories* 4, no. 1 (2020): 10-12.

[483] Bartošek in discussion with the author.

The revolution caught him off-guard in part because, from a technologist's perspective, the government was often the key supportive entity in their lives as professionals and hobbyists. If one wanted to travel abroad, organizations like the ČSVTS (*Československé Vědecko-Technické Společnosti*, the Czechoslovak Scientific-Technical Society) existed to facilitate that. If one needed access to Western publications like *Communications of the ACM* or funding for a two-week conference at a Slovak mountain resort, a sympathetic university department chair would suffice. And as Bartošek said, "on the crucial level, there was an organization called Svazarm … it organized special groups for different areas, and one of them also was for programming and for computers. So, if someone has no contact with computers in his office, or home, probably [they would get it] through this Svazarm or other places," such as the summer computing and mathematics camps run by SSM which Bartošek participated in.[484]

Holan was one of the volunteer adult leaders of those SSM computing camps young men like Bartošek attended in the 1970s and 1980s. Now a software engineer at GoodData, he recounted one of the happiest periods in his life, when he worked—first as a volunteer, then as a paid organizer—of an SSM youth group dedicated to microcomputers, programming and CAD/CAM in the late 1980s and early 1990s. That initiative was only possible because of the extensive funding that the government made available to support youth education in computing at the so-called 'Stations of Young Technicians.' Even in the late 1970s and early 1980s, as a young student at Charles University and co-founder of the underground science fiction magazine *Villoidus*, Holan remembers being an exception to the general anti-communism of scifi and computing enthusiasts. In part this was because his interests materially benefited from state

[484] Bartošek in discussion with the author.

socialism. "We were in a gray zone," he recalled, and "I used my position during studies in SSM to force my hobby."[485]

Bartošek and Holan were members of the post-1968 generation of youth who had never directly experienced the excesses of Stalinism and who might be expected to have more positive memories of the state socialist period. This was especially the case for individuals like Holan and Bartošek because they identified themselves as completely disinterested in politics or ideology—they were interested in the future of Commodore, not Communism. Their embrace of political indifference was both the cause and the result of the opportunistic gray zone they thrived in. For others, especially older technologists, political indifference was more of a survival strategy.

Even those fortunate enough to have families that escaped direct persecution still remember a practical ban on the subject of politics in their home. Trojan, a Charter 77 signatory and a software programmer at VÚMS, reported that his father, the famous composer and a former Communist before the coup of February '48, was very careful not to speak about politics in front of him as a child, even as both his parents continued to follow foreign-language radio broadcasts.[486] Pajas, a physicist and today president emeritus of Anglo-American University in Prague, knew that his father had been a member of the National Socialist Party of Czechoslovakia before the war, but very few other details. "We have never been in deeper discussions about our political situation," he said "because he was afraid that I could be influenced, and he wanted me to be completely independent of that."[487]

Although engaging in political indifference was a choice motivated by different concerns—sometimes a strategy to get by, at other times genuine apathy or ignorance—it would be incorrect to describe Czech and Slovak technologists, like their counterparts elsewhere in the

[485] Holan in discussion with the author.
[486] Trojan in discussion with the author.
[487] Pajas in discussion with the author.

industrialized world, as unmotivated by great ideals. The scientific-technical revolution manifested in the 1970s and 1980s in astonishingly rapid developments in telecommunications, computing and consumer electronics as a whole. As a seemingly unstoppable secular force, it united technologists in Czechoslovakia with their counterparts in the socialist and capitalist camps, most of whom believed fervently in the forward march of progress embodied in Gordon Moore rather than Vladimir Lenin.

The ideology of technological change, in turn, arose from a fundamental dispute about the nature and future of computing itself. In the 1950s, two of the field's founding figures, John von Neumann and Norbert Weiner, disagreed vehemently as to whether computing should be highly centralized (the IBM mainframe) or de-centralized (the personal computer). As Ron Eglash observed in 2000:

> It was von Neumann's centralized computing camp who won the power of mainstream support, while Wiener's decentralists were marginalized as cranks or mystics. ... The essential claim of Wiener and his followers—that political progress could be achieved from the resonance between decentralized computing and decentralized social authority—was fundamentally flawed. Flexibility is not inherently subversive; the chaos, complexity and fractal nonlinearity of Wiener's neural nets are just as easily put to the service of postmodernity's global capitalism as they are to any counter-hegemonic resistance.[488]

However, this was by no means clear to technologists at the time. In the late 1960s and early 1970s, at the genesis of the ideology of technological change, the notion of putting better and more powerful tools in the hands of the public, rather than governments and large corporations, seemed to be a win-win proposition that embraced the best elements of democracy and technological progress. This framework of understanding was deeply hazardous, as it shifted the onus of responsibility for social change to an artifact (the computer) rather than its users. It was

[488] Ron Eglash, "Cultural Cybernetics: The Mutual Construction of People and Machines," presented at the Society for Social Studies of Science, Vienna, 2000. Rensselaer Polytechnic Institute. http://homepages.rpi.edu/~eglash/eglash.dir/cyb/cultcyb.dir/cultcyb.htm.

nevertheless an ideal: non-violent, incrementalist, meritocratic and originating in the pedigree of Western positivists' view of history as ultimately progressive and evermore enlightened.

Ultimately, political indifference did not represent "a flight from politics," as a whole, even if it stretches normal ideas of dissent beyond their breaking point. Conscientious technologists "cast humane technology as a middle way that transcended partisan politics … ideology and identity were entangled in their conceptions of what it meant to be human. Iconoclasts and dropouts self-consciously defined technological selves outside the framework of standardized education and hierarchical labor."[489] Technologists engaged in dedicated maintenance of international connections in a closed world, a stubborn defense of apolitical spaces in everyday life for individual creativity, and the daily labor of making a broken system work at least a little better for its citizens. Their politics challenges us to think, as Paulina Bren put it, of "the ways in which narratives of dissent, collaboration, and collusion were all closely bound together during the 1970s and 1980s."[490]

If computer technologists in late socialist Czechoslovakia ran the gamut from the freewheeling, almost openly dissident Zlatuška to the card-carrying Communist naïveté of Bartošek, then clearly it is difficult to pin technologist politics securely on the traditional spectrum of collaboration and opposition. Instead, theirs was an artifactual, technocratic politics that, as Theodore Roszak and others astutely claimed, might have fit comfortably on either side of the Cold War divide.[491] Czechoslovakia was not California; Brno was not the Bay Area. No

[489] Wisnioski, *Engineers for Change*, 145.
[490] Bren, *The Greengrocer and His TV*, 158.
[491] Theodore Roszak, *From Satori to Silicon Valley*, 1986; This is not to suggest a "hard determinism" for technological artifacts like the computer. It is, rather, in accordance with Paul Ceruzzi's suggestion to recognize that with Moore's Law and the integration of digital electronics into many facets of everyday life, it may be best to "step back from a social constructionist view of technology and consider that, in at least one instance, raw technological determinism is at work" in the sphere of computing. It is also a recognition of the reality that human-artifact

ragtag army of computer hobbyists, armed with the countercultural gospel of Brand and Nelson, ever materialized on the Smetana embankment in Prague. Nevertheless, there was an international zeitgeist of computing. Czech scientists followed the *Communications of the ACM*, of course, as several interview subjects reported, but they also read *Byte*, *Computer World*, and *National Geographic*.[492]

Even during the repressive height of *normalizace*, Czech and Slovak computer technologists occasionally traveled abroad for conferences and education. Havel went to California; Zlatuška spent over a year in Delaware; Gruska had the substantial resources of a UN computing center at his fingertips in Bratislava; Pajas spent significant time working in Trieste and Oxford; and Mannová studied and worked in Sudan and Canada.[493] From outside they brought back to Czechoslovakia enhanced awareness and increased expectations of information technology.

Perhaps the best example of a politics—one might say a 'non-politics' or an 'anti-politics'—organized around technocratic ideals and the dominating object of the computer, was the annual SOFSEM (software seminar), founded by Gruska in 1974. It was, interview subjects universally agreed, an idyllic time. For nearly two weeks at the end of November and beginning of December, the invitation-only conference hosted the leading lights of Czechoslovak mathematics, programming and computer hardware design. Participants knew the secret police closely monitored them. They do not appear to have cared.

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interactions are complex, that artifacts often suggest particular uses to end users, and that things like the computer can "structure people's perceptions of the world, thereby changing that world," as Leora Auslander observed. Paul E. Ceruzzi, "Moore's Law and Technological Determinism: Reflections on the History of Technology," *Technology and Culture* 46, no. 3 (2005): 593; Leora Auslander, "Beyond Words," *The American Historical Review* 110, no. 4 (2005): 1018-1019.

[492] Beneš in discussion with the author; Studenka in discussion with the author.

[493] Zlatuška in discussion with the author; Gruska in discussion with the author; Pajas in discussion with the author, and; Mannová in discussion with the author; Havel in discussion with the author.

When Havel showed a portion of his (lengthy) StB file to Mannová shortly after the revolution, they both laughed at one hapless secret policeman, who reported that he could not find Dr. Havel at the conference.[494] Open dissidents attended SOFSEM, like Havel and Sokol, but there were also at least nominal Communists, members of the party alongside the majority who insisted, like Trojan, that they were not interested in politics.[495] "Surely," Gruska was asked, "a gathering of more than one hundred of the country's top technical intelligentsia resulted in some political discussion, some frank exchange of views." But Gruska was vehement:

> No, that was a completely different time. Many such things, most people didn't care. I don't remember, say, during my high school studies that I would care about something like that. That was there, this was here, and the basic idea [of socialism] was nice, yeah? The basic idea was nice. So I had some small problems because of my father, but finally it became OK [when he was rehabilitated]. You didn't have much choice, so I was interested in sports. And this fight for freedom … it was a couple people, only that.[496]

Havel's memory of SOFSEM and other such technologist gatherings was somewhat different. "What I can definitely say," he recalled, "is that I never noticed that somebody would not fit into the collective atmosphere which was quite open and anti-Communist."[497]

A general distrust in ideology, a focus on logic and results (Trojan's chief frustration under Communism, according to him, was the inefficiency and stupidity of the system), a joy in technical competence and clever 'hacks' of the system: these were characteristic of the ethos that Steven Levy identified among American computer technologists in his seminal 1985 book *Hackers*.[498] They also described Czech and Slovak computer technologists who bypassed their mandatory exams on Marxism-Leninism, set up an illegal TV to watch the first space shuttle launch in America, or worked as a spare-time hobby with ZPA Čakovice to produce

[494] Mannová in discussion with the author; Havel in discussion with the author.
[495] "I never was and I am still not politically active. It's not politics. By politics I mean the politics of political parties. It's for me a problem to accept any kind of ideology." Trojan in discussion with the author.
[496] Gruska in discussion with the author.
[497] Havel in discussion with the author.
[498] Trojan in discussion with the author.

digital/analog plotter interfaces for hybrid computers at only one-seventh the cost (5,000 crowns compared to 35,000 crowns) of the official units developed at VÚMS.[499]

Conclusion: No Simple Binary on the Digital Frontier

After the collapse of state socialist governments in Central and Eastern Europe in the late 1980s and early 1990s, Western historians of technology felt reasonably sure that CEE governments' collective failure to manage properly the telecommunications and electronics revolutions was partly responsible. "The trilogy of an ecosystem that proved unable to collaborate effectively to the extent that occurred in the West, reluctance in allowing free flow of information and knowledge, and reliance on continuously uncompetitive technologies," writes James Cortada "put the entire region on a path to slower diffusion of IT."[500] At least two of state socialism's failures, according to Cortada, related directly to how the government interacted with citizens interested in or knowledgeable about technology. User communities living with incessant hardware shortages, strict import controls and faulty equipment could hardly "collaborate effectively" in producing, say, the next Microsoft. Nor could they even communicate their ideas and innovations to one another, or provide constructive criticism on technology policy—computer users were muzzled, the state was deaf, and a tense, frustrated silence cast a pall over technologists in 1980s' Czechoslovakia.

That judgment is premature, however appealing at first glance. The introduction and adoption of computers was a joint project of Czechs and Slovaks in state and society. The state allocated substantial resources, material and rhetorical, to this project—Czechoslovak

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[499] Zlatuška in discussion with the author; Beneš in discussion with the author; Studenka in discussion with the author.
[500] Cortada, *The Digital Flood*, 305.

policymakers, like their neighbors in East Germany, understood that their economies needed to modernize to both compete with the West and meet rising consumer expectations.[501] The personal computer became a symbol and instrument of progress toward that goal. State-supported communities of computer users would in turn, policymakers expected, generate technical innovation to the benefit of all society. This system—which birthed both Svazarm's computer-related activities and *Mikrobáze*—does not mesh with the interpretation that socialist policymakers "shrank from the logic of reform and sought to reaffirm the principles that had guided the Soviet Union since the 1930s."[502] Czechoslovakia had a native legacy of innovation and scrappy tinkering that had helped the country navigate previous technological and economic crises. To an extent, it was re-running models that had worked before—not in the Stalinist '30s but, as we saw in chapter one's description of the computer crisis following Svoboda's 1964 emigration, as recently as 1969 in Czechoslovakia.[503]

In the course of its relatively short four-year publication life, *Mikrobáze* played a valuable role as a forum for the exchange of desires and demands between computer users and the government in late socialist Czechoslovakia. Its longer-term impact is more difficult to assess, but there are contemporary indications that the *Mikrobáze* readership inspired a significant part of the technical community in today's Czech Republic. Recalling that the 602nd branch of Svazarm in the Prague 6 district published *Mikrobáze*, today there is a software company in Prague—Software602—whose name reflects its foundation by subscribers. One of

[501] That support extended, as in Poland, to the establishment of computer science departments, institutes for the study of electronics and computing, factories for computer production and prizes awarded for innovation in IT. Łukaszewicz, "On the Beginnings of Computer Development in Poland," 107.
[502] Maier, *Dissolution*, 81-82, 105. Quoted in: Siegelbaum, *Cars for Comrades*, 72.
[503] See: Durnová, "Sovietization of Czechoslovakian Computing," 21-31 which discusses the Czechoslovak pioneer of digital computers, Svoboda, *and*: Karen Johnson Freeze, "Innovation and technology transfer during the cold war: the case of the open-end spinning machine from communist Czechoslovakia," *Technology and Culture* 48, no. 2 (2007): 249-285, for an examination of Czechoslovak innovation in textile factories that diffused out of Czechoslovakia to the West in the late 1960s.

the infant company's earliest successes was the production of a Czech-language text editor, T602, the first word processor many Czechs ever encountered. Ivan and Václav Havel wrote *samizdat* with it, and Beneš learned to type with it in the 1990s.[504]

While evidence supports the concept that the socialist state and its computer user community were frequently at odds with one another over basic questions of censorship, material shortages, expensive equipment and inadequate education, both sets of actors relied upon one another, supported each other and often acted in mutually beneficial ways. The Czechoslovak computer user community did not exclude, indeed called out for, state support and organization. Elements of the state, such as Svazarm, fought for the users. Far from hostile blocs, state agents and everyday users interacted in complicated and often opportunistic ways to form an integral community of personal computing enthusiasts.

As we have seen, the practice of dissent did not occur uniformly across that integrated community of technologists. Rather, individuals like Chvatík, Havel and Zlatuška were typically motivated to dissent for personal reasons rooted in their biographies and their relationships to other prominent dissident intellectuals such as Patočka, Vaculík or Václav Havel. Chvatík, for example, who later played an important role in the dissident movement by archiving and reproducing Patočka's writings, initially grew embittered due to the government's persecution of Svoboda, the father of Czechoslovak computing, whom they hounded out of the country in 1964. His hopes of studying under Svoboda dashed, Chvatík began work at Aritma in 1964 in order to produce some of Svoboda's designs for a small computer.[505]

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[504] "To have your own computer … I think only after the Velvet Revolution it started, the period when people could have their own. I know that my brother had a computer which was supplied through the Charter 77 Foundation and was smuggled here somewhat. … And I, actually yes, I was doing some writing on that in text editor, which was Czech-specific text editor, T602." Havel in discussion with the author; Beneš in discussion with the author.
[505] Chvatík in discussion with the author.

Indeed, while nearly every memory of that period includes some anecdote of "getting one over" on the Communist regime, it is best to consider these as largely covert and highly individualized dissenting acts, rather than any consistent engagement in a lifestyle or organization of open opposition. This should not surprise us when we consider how limited technologist dissent was even in more permissive political environments such as the United States. According to Wisnioski, "Dissent among engineers often amounted to furtive acts of individual resistance — wearing an antiwar armband at work or penning an invective letter to the editor of a technical journal," rather than running for office or taking part in a sit-in.[506] By comparison, in normalization-era Czechoslovakia, whole families were subject to punishment for subversive political activity or simply suspicion of such, as we saw in the case of Mannová, Pajas and Trojan.

While it is clear that technologists shared a particular, technocratic vision of political reform, as articulated in the lightly coded discourse of Hořejš and Franěk's science fiction articles published in Mikrobáze, it is equally clear that most technologists saw no conflict between general agreement with these principles and their particular mix of collaboration, dissent and indifference towards politics. This helps to explain the otherwise puzzling interpretive split on the events of 1989 between technologists with similar backgrounds, educations and careers. When Dolores Augustine interviewed East German engineers who had worked in technical fields, some remembered "disappointment and fear. For one, the opening of the Wall meant 'the total breakdown of everything that I had done up until then ... It was tough.' Another reacted similarly: 'It was clear to me that it would destroy my work ... For me personally, it was a day of mourning.'"[507]

[506] Wisnioski, *Engineers for Change*, 25.
[507] Augustine, *Red Prometheus*, 294.

Those technologists had lived in a system that was sufficiently prone to error and oversight that they could safely engage in small acts of dissent, such as smuggling a computer into the country for relatives, or reading *samizdat* science fiction, without serious repercussion, but which also afforded them sufficient leisure time and funding to pursue the projects which most interested them. Such was the case with Bartošek, who was unaware of the brewing revolution in 1989 in part because he was in the middle of a two year long, highly-involved quest to upgrade the memory on his DEC PDP 11/34, which he was able to recount in much richer detail than the events of the Velvet Revolution.[508] Ironically, technologists like Trojan claimed to hate the same systemic inefficiency, personal favoritism and chaotic, informal networks that afforded them a greater degree of privilege and workplace autonomy than most of their fellow citizens. They dreamed of a fully rational, technocratic system—of themselves at the top of the heap, finally free to program an orderly and humane Czechoslovakia.

Thus, many technologists welcomed the revolution, when it came, with open arms. Mannová professed to remember "every minute" of the moment, and participated on November 17th in the students' march to lay flowers on poet Karel Mácha's grave and then into the center of Prague.

> So I went from here with the students to Albertov, and we stayed close together, and then we went with students on a march on Vyšehrad, on the cemetery, to give some flowers to Mácha, because he has a gravesite there. And when we were walking through the streets, it was for me very strange, because it was a lot of students, a lot of people, but the windows were closed and everything was just silent, nothing was happening. We came to Vyšehrad, and some delegation went to the cemetery. We stayed at the first entrance and we sang some song, I don't remember, and then when they returned somebody was talking all the time [about] something, and then we went down to Železniční most Smíchov [a bridge over the Vltava river] and we came and in front of us were the police. We were not allowed to go there. So we turned back and we started to be a little mixed up, what we should do, so one part went on the bank of the river, one went another way,

[508] Bartošek in discussion with the author.

> and we go around the National Theater to Národní Třída, and stopped there. That's the end. It was very cold, so I went home.[509]

Mannová's actions of protest were increasingly shared by other technologists across Czechoslovakia and the region as a whole. Dolores Augustine interviewed a male engineer who attended a November 4th, 1989 mass demonstration on East Berlin's Alexanderplatz. "'I am among the people who welcome it [the end of Communism] unconditionally,'" he said "'found it bitterly necessary, but never expected it to happen.'"[510] Far more commonly, however, the sudden arrival of a political revolution took technologists by surprise.

Change from that direction was unexpected, and the social upheaval it caused was often unwelcome. Holan remembered the period as particularly bleak. He attempted to continue the computing activities of his SSM youth group, but funding dried up and he was thrown into unemployment for years.[511] Meanwhile collaborators, including employees of the secret police (StB) like Jan Mühlfeit, quickly found lucrative work with Western companies like Microsoft, which only cared about one's skills, not politics.[512] To many disoriented Czechs and Slovaks, the arrival of a market economy that had no interest in rewarding individuals on the "right side of history" must have seemed like the revenge of political indifference. In any case, after 1989 Czech and Slovak technologists found themselves living in a world of dizzying pitfalls and

[509] Mannová in discussion with the author.
[510] Augustine, *Red Prometheus*, 294.
[511] Holan in discussion with the author.
[512] "Když se podíváte zpětně, rozhodl byste se stejně?" "Kdybych věděl, co vím dneska, nejspíš bych na ministerstvo vnitra v roce 1987 pracovat nešel. Jenže tehdy mi bylo pětadvacet let, měli tam technologie a já jsem zrovna řešil bytovou otázku. A upřímně, nikdy jsem si nehrál na žádného hrdinu. Navíc jsem věřil, že existuje třetí cesta." Aleš Vojíř and Pavel Hejkrlík, "Pracoval pro StB i Microsoft. Zpověď manažera Mühlfeita," *Týden*, November 9, 2014. https://www.tyden.cz/rubriky/byznys/cesko/pracoval-pro-stb-i-microsoft-zpoved-manazera-muhlfeita_323556.html. See also the case of Vladimír Vaněk in: Vaněk and Mücke, *Velvet Revolutions*, 84-85.

opportunities with one constant: the inevitability of technological change and their role in taming it.

Chapter 5
Socialist Silicon:
The Embryonic Emergence of Czechoslovakia's Alternate Modernity

In May 1884, the great nationalist romantic composer Bedřich Smetana lay dying in a hospital bed at the Kateřinky asylum for lunatics in Prague. Although always among the most prominent artistic exponents of the 19th century's Czech national awakening, Smetana's career had begun to slip downward in his later years. The catalyst was a bitter professional dispute over his *avant garde* opera *Dalibor*, which premiered May 16, 1868 at Prague's New Town Theater. Rivals like František Rieger, director of the Provisional Theater (the home of Czech nationalist music until the later construction of the National Theater) eagerly seized upon critics' hostile reviews of the opera. Considered excessively Germanic or 'Wagnerian,' *Dalibor* became *casus belli* in an all-out war to question Smetana's loyalty to the Czech nation and remove him from the conductorship. The coup briefly succeeded, and was only reversed by the timely intervention of Antonín Dvořák and other Czech musical luminaries. Smetana soon however demonstrated symptoms of a sickness, possibly syphilis, that degraded his ability to compose and, eventually, led his family to commit him to the care of the Kateřinky asylum a month before his 1884 death. Sixteen years after its debut, Smetana considered *Dalibor* among his life's great failures.[513]

Had he lived just two years more, Smetana would have observed the successful revival of *Dalibor* on the stage in 1886; by the 1970s, it was "regarded in Czechoslovakia as Smetana's most important opera," a work of nationalist excellence that extolled the virtues of a 15th century Czech knight, Dalibor of Kozojedy, struggling heroically against foreign overlords.[514] Moreover, Dalibor was a Renaissance hero with peculiarly contemporary Czech characteristics—kept

[513] George Jellinek, "Dalibor," *The Opera Quarterly* 14, no. 1, (Autumn 1997), 174-176.
[514] Harold C. Schonberg, "Opera: Smetana's *'Dalibor*'," *The New York Times*, (January 10, 1977), 20; Flora Pauline Wilson Kopta, "Dalibor: A Bohemian Legend of the Fifteenth Century," in *Bohemian Legends and Other Poems*, edited by F.P. Kopta, 16-20, New York: William R. Jenkins, 1896.

imprisoned in an isolated tower, his soul suffered from a lack of music. Thus he craftily fashioned a violin from the jailer's spare match sticks, teaching himself to play so beautifully it engendered the sympathy of the townsfolk, who rallied in a revolt to free him.[515] Bohemia as "a musical nation" was a well-established trope already by the 19th century, and we have already touched on craft skill—*zlaté české ruce* or golden Czech hands as an indelible, widely presumed aspect of 'Czech-ness'—in reference to Dvorníková-Krapková's memoir of her life as a punched-tape computer operator at the Baťa plant in Zlín.[516] Dalibor was an exemplary, and emphatically Czech, folk hero.

Yet despite all his bravery, his native musical talent and his craftiness in fashioning complex instruments from simple splinters of wood, the tragedy of Dalibor is that he never escaped the prison tower. The town that rallied to his liberty was brutally suppressed by the king's forces. They slew Dalibor in his jail cell. Sticking one's neck out for someone's freedom, for beauty, for culture—it could all lead to savage reprisals. During the 1980s in Czechoslovakia, particularly following the regime's crackdown on Charter 77 signatories, this cautious sentiment was typically expressed by the phrase "We cannot all be dissidents," even though, ironically, the contemporaneous Solidarity movement in neighboring Poland seemed to indicate otherwise.[517]

It is this image of the legendary hero, trapped in a tower despite all his brain power, to which Zajíček referred his *Mikrobáze* computer technologist readership in an April 1987 editorial entitled "Dalibor of Information Technology." In it, Zajíček referred to the technologist community in Czechoslovakia as the "Dalibors of computing," and lamented that a kind of

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[515] Magdalena Wagnerová, *Pověsti staré Prahy* (Legends of Old Prague), Prague: Nakladatelství Plot, 2014.
[516] Franz H.H. Valentin, Graf von Lützow, *The Story of Prague*, London: J.M. Dent & Co., 1902: 136; Dvorníková-Krapková, "Zlaté české ručičky (a hlavy)."
[517] Ladislav Holý, *The Little Czech and the Great Czech Nation: National Identity and the Post-Communist Social Transformation*, Cambridge Studies in Social and Cultural Anthropology, Cambridge: Cambridge University Press, 1996: 32.

mystical cult had formed around the idea of "do-it-yourself" (DIY) culture—everywhere he went, in answer to every complaint about shoddy hardware and empty store shelves, he was haunted by the refrain "DODO" (***DO**dělej* ***DO**ma*, do it at home).[518] This approach was flawed, Zajíček argued. The computerist community was accustomed to solving the problems of scarcity through individual ingenuity and ad hoc community mobilization. Yet these patchwork solutions were an inadequate response to the systemic problems of the microelectronics crisis in Czechoslovakia. It also ignored hard truths, such as that not everyone would, or could, partake in DIY culture, and that the pressure to share one's work with others in a close-knit community—for free, made well, and quickly—led to Dalibor programmers besieged in their own homes, phones ringing constantly, stalked by inquiries at work and the club.[519]

From 1987 to 1989, the technologist milieu in Czechoslovakia was driven by scarcity and dashed expectations of progress to mobilize politically. As previous chapters have demonstrated, they were already united through similar social and family backgrounds, shared professional organizations and publications, common interests and the same privileged access and knowledge of computers. Unable to obtain formal political power given the official leading role of the Communist party, and incapable of financial prowess in the command economy of a small market, technicians' power lay in their relationship to the computer, which in those heady days of the PC revolution made them the vanguard of the "civilizational phenomenon of our epoch," in the words of Vlastimil Homolka, director of the Computing and Organizational Service in Prague.[520] This concluding chapter provides a final look at the tactics and frustrations of the

[518] That the "DODO" was also a species of bird that infamously went extinct through an inability to face reality and change its behavior was an irony not lost on Zajíček.
[519] Ladislav Zajíček, "Dalibor výpočetní techniky" (Dalibor of Computers), *Mikrobáze* 6 (April 1987): 2.
[520] Vlastimil Homolka, "V záloze 100 počítačů: Potenciál překážek pro lepší využití výpočetní techniky" (In Reserve, 100 Computers: Potential of the Barriers to Improved Use of Computer Technology), *Hospodářské noviny* (August 25, 1983): 4.

scarcity scene in late 1980s' Czechoslovakia, the result of a microelectronics crisis that had once again set off a scramble for computers among government institutions, universities, ministries and enterprises reminiscent of the mid-1960s. This crisis, however, unfolded differently. The tensions of the mid-1960s had resolved in the stable system of the 1970s, wherein heterarchical competition between mesocosmic institutions had helped slow technological diffusion to a more manageable pace, protected technologist employment and workplace autonomy, and established their relatively privileged status as cadres with additional opportunities for travel, well-funded conference vacations and a degree of protection from political pressure.

By the late 1980s, a growing youth contingent clamored for computers in numbers that outstripped the system's capacity to provide or import. Older technologists such as Zajíček, Hořejš and Franěk argued that the government's continued pursuit of centralized computing on the lines of mainframes and minicomputers, and laggardly steps toward integrating microcomputers and automation in schools, offices and industry, failed to deliver a viable future for the country and proved an impossible burden to shoulder for the country's valiant, long-suffering 'Dalibors'. Between 1987 and 1989, when the outbreak of the Velvet Revolution caught technologists by surprise, the community had begun to move toward a kind of technicians' syndicalism—communal ownership and management of computers, software and peripherals as shared goods for the benefit of the community. This was an evolutionary outgrowth of previously well-established practices under state socialism, using (borrowing, as well as stealing) government resources for private projects. As we have seen in previous chapters, this included the use of youth club (SSM) money by Holan and others for their own science fiction fanzines; the seizure of *Mikrobáze* to become a more authentic nationwide organ for the computerist community; using the computer clubs as hubs of gray market software exchange, and even as *de facto* legal defense in the case of Smutný.

Therefore this chapter makes a synthetic argument, one that builds upon the observations of the previous four chapters and integrates them with one final view of the late '80s scarcity computing scene and its political fallout. Czechoslovak computing in the late socialist period constituted an example of silicon's second world, one defined by a long period of material scarcity extending into the years of political and economic transition during the 1990s. Scarcity shaped not just the values and politics of the community from indifference into syndicalism and in ways that made it resemble strongly the earliest PC users of the American 1970s' counterculture; it also constrained and contoured the ultimate landscape of computer use and innovation in the contemporary Czech and Slovak republics. Framing a history of computing in Czechoslovakia and its successor states by examining material scarcity and its contingent effects on the community of Czech and Slovak computer technologists is an opportunity to reassess the success of the IT economy in East Central Europe as a whole as an unexpected legacy of state socialism.

Emblematic both of the wider state socialist bloc—the political 'second world'—and, in important ways, of technological diffusion, adoption and innovation in so-called peripheral or emerging countries today, the case of Czechoslovakia represents an alternate or "distinctive" modernity. To use S.N. Eisenstadt's term, this alternate modernity reflected "novel patterns of institutional life, with new self-conceptions and new forms of collective consciousness."[521] While Czechoslovakia was an outlier within the CMEA bloc in terms of its more extensive pre-World War II industrial development, making it most akin to the GDR, it shared similar

[521] S.N. Eisenstadt, "Multiple Modernities," *Daedalus* 129, (Winter 2000): 13.

ideological, economic and social approaches to computing in the late twentieth century that make its experience a useful, if inexact, analogy to other state socialist countries such as Poland and Hungary.[522] To the extent that we can recover this piece of technological, social and political alterity, the "semi-peripherality" of Czechoslovakia's computing scene in the crucial transition of the 1980s, we contribute to the larger ongoing rescue of what Martin Müller calls the "Global East," which possessed a significant "diversity that is not just ethnic … but political, cultural and economic."[523] The emergence of Czechoslovakia's alternate modernity was rooted in its identity as a socialist state, and all the formal ideological and informal practical freight this entailed.

Czechoslovakia in the late 1980s was a time and a place that provided nearly irreproducible circumstances for the emergence of an alternative to computers-as-commodities and the surveillance capitalism they engendered. It was also a contingent phenomenon related to Czech and Slovak culture, gendered interpretations of labor, international influence and all the mixed *lebenswelt* of two generations of computer technologists—those who had experienced 1968, and those who came of age in the aftermath. Nor was the alternate modernity represented by Czechoslovak computing universally accessible or relevant to every Czech and Slovak in the 1980s. However, to paraphrase novelist William Gibson's aphorism: A future was already there, if never evenly distributed.

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[522] Although development and policy choices varied among the CMEA bloc countries, it is possible to speak of a "socialist system" with common ideological, political and economic approaches to technological development and to treat carefully individual case studies from the region as useful illuminations of those bloc-wide trends. Kornai, *The Socialist System*, 53, 297-301.

[523] Martin Müller, "In Search of the Global East: Thinking Between North and South," *Geopolitics* (2018): 9.

Flight of the DODOs:
Tacit Knowledge, the Scarcity Scene and Global Scrounging

Computer enthusiasts in late socialist Czechoslovakia, DODOs or not, like their counterparts in other so-called "Second World" countries, were the middle children of the 20th century modern. On one end of a spectrum sat wealthy Western economies with satiated consumers of computers-as-commodities, even toys (think of the Commodore 64's multi-million selling success). On the other sat still-poor economies in Latin America, Africa and Asia. These might feature a small cluster of computer technologists at a major university or research institution, but without yet a sufficiently developed base of technically skilled professionals and hobbyists with access to leisure and materials (technical manuals, television monitors, journal subscriptions) to practice and transmit computing culture at a significant scale.[524] Czechoslovakia stood in the center.

As Karen Johnson Freeze has shown in the case of the BD 200 open-ended spinning machine, which became a global standard in the textile industry, Czechoslovakia occupied a technological middle ground. A rare instance of East-to-West technology transfer, the BD 200 case also demonstrates how Czechoslovakia benefited from its political and technological position, able to leverage Soviet investments, Czech craft traditions and precision mechanics, and Western customers into "hundreds of millions of dollars in hard currency through sales of machines and licenses."[525] Müller argues that this was also the catbird seat in studying worldwide exchange and development. Understanding the phenomena of globalization, including the production, diffusion and adoption of information technology, requires integrating the

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[524] The latter end here might be represented by, *pace* earlier description, India, Brazil, Mexico or even South Korea which remained quite poor in the 1970s compared to its contemporary highly-developed status. Langer, "Generations of Scientists and Engineers," 97; Bassett, "Aligning India in the Cold War Era," 794; Bátiz-Lazo and Haigh, "Engineering Change," 28; DiMoia, "Atoms for Sale?" 596-597.
[525] Freeze, "Innovation and Technology Transfer During the Cold War," 251-252.

historical narratives not just of the "Global North" and "Global South" but also liminal spaces like former Czechoslovakia: "Neither North nor South, it helps us avoid hemispheric binaries of rich and poor, powerful and powerless when thinking of the global."[526] During the Cold War, the Soviet Union and its allies were not simply also-rans in the field of science and technology, but determined and capable competitors.

As Švelch notes, it can be reductive and misleading to consider second world countries with a developed industrial base, established hobbyist life and good technical education through the lens of backwardness. Such a focus erases the labor that went into adaptive appropriation of technology. Czechs who sliced into the CPU of a Soviet Minsk mainframe found "an Intel chip inside, covered by such a thick layer of some other materials, packing material. So it was stolen," Pajas recounted "everything was stolen from the West, installed into the machine."[527] Yet this was not a straightforward case of importing technology; technicians had to make the Intel chip work with every other component and software program, often with an imperfect knowledge of how the chip was originally designed and fabricated, and what might be its working parameters. "But they were clever enough," Pajas conceded "these Belarussians in Minsk, they must have been clever, the guys there, to produce computers which were quite happily working.[528] But the components were from the outside. They were not original components." A cultural priority of invention gives well-deserved credit, but as seen here successful technological diffusion also requires clever technicians to innovate and adapt artifacts to local circumstances.

In the process, users can direct technologies along different evolutionary paths, can assign them new meanings and novel uses outside their first habitats. "Czechoslovakia—and

[526] Müller, "In Search of the Global East," 16.
[527] Pajas in discussion with the author.
[528] Ibid.

arguably the rest of the Soviet bloc," Švelch points out "was not simply *delayed*, but created its own, independent timeline," in part because the CoCom embargo and hard currency shortage meant that software, and the latest ideas (such as programming languages) could pass through the Iron Curtain's bottleneck more easily than hardware. This forced adaptive innovations that were unnecessary in wealthier Western countries or impossible in poorer developing nations.[529] In addition, a Czech or Slovak computer technologist could rarely, if ever, simply consume the experience of computer use. Like many of the early American enthusiasts, though for an extended period lasting well into the 1990s, they engaged in a more active, creative identity as users, not consumers. Frustrating technological problems such as a faulty disk drive or a game without Czech-language subtitles were often reinterpreted as challenges. In turn, these challenges became a form of play that led to the acquisition of tacit knowledge and prestige within the community.[530]

In the previous chapter, we saw how Trojan proudly flourished his jury-rigged modem made from a Tesla telephone transformer in 1981 and hand-wired into a ZX Spectrum never designed for such an interface as an example of Czech technical know-how, adversity in the face of shortage, and "getting one over" on the government's communication restrictions.[531] As Paulina Bren pointed out in *The Greengrocer and His TV*, Czechs and Slovaks under late socialism were still *bricoleurs*, but had also become progressively canny consumers of leisure

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[529] The rapid adoption of the ALGOL 60 programming language in Czechoslovakia in the early 1960s, touched upon previously in the first chapter, is an excellent example of this phenomenon of scientific transmission across the Iron Curtain. Durnová, "Embracing the ALGOL Effort in Czechoslovakia," 26. Švelch, *Gaming the Iron Curtain*, 223. Emphasis original.

[530] Describing an engineer at Data General in Massachusetts in 1980, Tracy Kidder noted "the joy derived from mastering machines, both building and repairing them" an impulse held in common with Czechoslovak users like Eduard Smutný: "playing with computers at home was a joyful and stimulating activity, and an essential prerequisite for further creative work with computers." Tracy Kidder, *The Soul of a New Machine*, New York: Back Bay Books, 1981: 180; Švelch, *Gaming the Iron Curtain*, 31.

[531] Trojan in discussion with the author.

and commodities.[532] Computer technologists in the 1980s had become particularly active consumers as well, of necessity and in their own niche, recognizing inferior goods for what they were. Many of them tried to address the country's endemic quality and shortage problems on their own or in small cooperatives with friends and colleagues. This yielded some important material results during the decade. The 1980s witnessed a proliferation of limited-run, often hand-assembled and modular (designed for additional RAM or storage to be added later by the end user) machines like the MAŤO, or the Tesla Logitronik 01 kit. These were labors of love just as much as they were playful acts.

Eduard Smutný's Ondra microcomputer was a prominent example of this trend, from its promising early days in 1985 when Smutný, already a national engineering figure for his work on the first Czechoslovak microcomputer, the Tesla SAPI 1, named it after his young son. In a special feature entitled "Looking Back After 10 Days that Shook Prague," *Technický Magazín* reported on the success of the Ondra and its creator at the capital city's exhibition on electronics in the fall of 1985. What proved particularly exciting to many observers at the exhibition was the novel programming language KAREL, created at Tesla in order to make learning to program in Czech easier on microcomputers:

> The increasingly popular microcomputer program Karel is an ideal addition to this simple computer [Ondra] and has a lot of identical features with it. In fact, Karel is a precursor to the Pascal language and represents a solid and illustrative teaching aid, a fun game and a versatile means for the early stages of modern programming. [...] And in addition, Karel understands Czech and even on Ondra's four-row keyboard you will not find a single English expression—they are replaced by easy-to-understand symbols.[533]

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[532] Bren, *The Greengrocer and His TV*, 190.

[533] "Stále populárnější mikropočítačový program Karel je ideálním doplňkem tohoto jednoduchého počítače a má s ním spoustu shodných vlastností. Karel je vlastně předstupeň jazyka Pascal a představuje solidní a názornou učební pomůcku, zábavnou hru a zároveň univerzální prostředek pro počáteční fáze výuky moderního programování. […] A navíc, Karel rozumí česky a i na čtyřřadé Ondrově klávesnici nenajdete jediný anglický

In addition to designing Ondra to be a particularly Czech-friendly and youth-friendly microcomputer, Smutný had made extra modifications to the hardware. According to Czech programmer Martin Malý, Smutný "designed all these functions like RAM refresh or display timing as very clever hardware hacks, based on 8253 timers/counters and other parts, available in Comecon."[534] This was on top of the imported East German U880 CPU at Ondra's core, based on the Zilog Z80 chip (1976) and much more powerful than the only comparable Czechoslovak 8-bit microprocessor, the Tesla MHB8080A, which had lower clock speeds and an older, less capable instruction set based around Intel's 8080 chip from 1974.

Finally, Smutný had carefully ensured that his computer was software-compatible with the popular line of Sinclair ZX 81 and ZX Spectrum computers, so that imported and copied software might be in copious supply and that any Czech-developed software could be easily converted for a potentially international market. Yet it all went wrong. Zajíček offered the Ondra a swan-song obituary only two years after its debut, ruefully noting in April 1987 that Smutný's machine should have been the basis for successful microcomputer adoption in the country—"the day before yesterday in black-and-white, yesterday already [in] color."[535] Tesla Elstroj, which had manufactured an initial run of 1,000 units, had fallen into a series of unresolved disputes with the enterprise's other production facilities as it attempted to shift and expand production of Ondra in 1986.

výraz—jsou nahrazeny lehce pochopitelnými symboly." Luboš Horčic, "Ohlédnutí po deseti dnech, které otřásly Prahou" (Looking Back After 10 Days that Shook Prague), *Technický Magazín* 29, no. 6 (June 1986): 24-25.

[534] Martin Malý, "Home Computers Behind the Iron Curtain," *Hackaday* (December 15, 2014). Available from: https://hackaday.com/2014/12/15/home-computers-behind-the-iron-curtain/.

[535] "Tím základem se mohl stát ONDRA – předevčírem černobílý, včera už barevný. Není žádný." Zajíček, "Dalibor výpočetní techniky," 3.

Parallel Ports:
How Technologist Autonomy Impeded Microcomputing

The trouble lay in the autonomy of enterprises and research institutes within the federal state. Each seemed to have a talented and popular engineer or small cooperative of programmers at their heart with their own ambitions and ideas about the future of microcomputers in Czechoslovakia. In the Czech lands, the Smutný brothers were pre-eminent but in Slovakia, where much of the country's microelectronics production capacity was located in Bratislava, Banská Bystrica, Piešťany and Žilina, Roman Kišš (the designer of the PMD 85) ruled the roost. Their personal preferences, political connections and design idiosyncracies resulted in a chaotic welter of innovative but never broadly adopted machines. Disagreements abounded. Should home computers be designed for cost or power? How closely should successful Western models like the ZX Spectrum or the IBM PC be copied? How should software compatibility be handled? Teacher training? The inadequate implementation of instructor training initially envisioned by the government's Long Term Complex Program of Electronization was to a limited extent ameliorated by bottom-up initiatives like the small programming classes that mathematician Alena Šolcová taught in Prague in the mid-1980s, but the scale of nationwide demand generally swamped and obscured the productive efforts of amateurs.[536] The microelectronics crisis of the 1980s was in large part a crisis of speed and scarcity in the face of change so rapid it overloaded the decision circuits of not just the Central Committee and State Planning Commission, but divided and confused expert computerists themselves about the best path forward.

The government's decision in 1985 to tie the country's home computer production to the 8-bit architecture of the reverse-engineered MHB8080A microprocessor seemed reasonable at

[536] Švelch, *Gaming the Iron Curtain*, 70-71.

the time on the basis of cost, material availability and anticipated demand. Rudolf Pecinovský, a software programmer at Tesla Elstroj from 1985 to 1990 (when the Ondra was produced), defended the decision in June 1985, noting that the computers only had to be powerful enough to run the Basic programming language: "After all, the simplest applications, such as [on] the Sinclair ZX 80 or [with] the Basic configuration of Tesla SAPI 1, take less memory than two pages of typescript would take. What does it matter that [these computers are] not suitable for solving complex programs ... users of personal computers mostly program games on them and for those Basic is enough!"[537] Other technologists disagreed bitterly, noting that committing substantial state resources to computers that were little better than toys only exacerbated long-standing inefficiencies of heterarchical competition.

Homolka, director of the Computing and Organizational Service in Prague, argued that amassing computers in large centers, programmed and maintained by responsive experts, was the only way for the Czechoslovak economy to efficiently integrate the new computers into the economy. "The application of computer technology, just as [in] other fields, must be carried out at a high professional level if it is to be successful," Homolka claimed. "The number of disruptions and amount of down time is significantly less in the network of computing organizations than at individual enterprise computing centers," he pointed out, noting also that common problems such as inter-enterprise competition for capable programmers, the hunt for

[537] "Vždyť v nejjednodušších aplikacích (například Sinclair ZX 80 nebo základní konfigurace počítače Tesla SAPI 1) zabere méně paměti, než by zabraly dvě stránky strojopisu. Co na tom, že není vhodný pro řešení složitějších programů ... Vždyť uživatelé osobních počítačů na nich stejně většinou programují hry, a na ty basic stačí!" Rudolf Pecinovský, "Z historie výpočetní techniky /10/" (From the History of Computers #10), *Technický Magazín* 28, no. 6 (June 1985): 62.

spare parts, confusion over booking maintenance and installation service—all could be more easily resolved when computing was vertically organized under one roof, or in one combine.[538]

He noted, however, that his proposition was an unpopular one. Describing his enterprise's offer to perform contract data processing for an unnamed third party, Homolka asserted: "Almost immediately they lost interest in any further cooperation. They wanted their own computing center."[539] The new scramble for computers threatened to overwhelm a whole system—of industrial production, cooperative software programming and trained maintenance, repair and installation personnel—that had gradually cohered over the course of the long 1970s and was now unprepared to convert over assembly lines, generate software for schools or re-train across a breadth of different, incompatible imported and domestic computers. Individual industrial enterprises competed with one another for scarce parts and funding. The Federal Ministry of Electrotechnical Industry (FMEP) had laid down broad guidelines (the Czech-made IQ 151 should be supplied to Czech schools, the Slovak-made PMD 85 to Slovak schools) but in practice these rules were immediately violated as the PMD 85 quickly proved to be a better-quality microcomputer and Czech schools and youth clubs snapped them up.

As we have seen, Czechoslovak microcomputer production volumes were also typically too low to recoup the cost of their design and construction. They were frequently the effort of solo designers or small groups working with a combination of their spare time and, on an *ad hoc* basis where it could be negotiated, with the scattershot resources of state enterprises. The MAŤO, for example, was only produced from 1989 to 1992 at Štátny majetok (State enterprise) Závadka; Slovak workers assembled 5,500 of the machines. Many Czechs and Slovaks first

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[538] Homolka, "V záloze 100 počítačů," 4.
[539] Ibid.

encountered it only when it was on display at the 2017 Game On! Exhibition in Prague.[540] The otherwise robust collection of Czechoslovak computers at the Czech Republic's main repository of computer history, the Brno Technical Museum, did not include a single MAŤO on display in that same year.[541]

Ivan Urda, who designed the MAŤO's hardware at home over the course of three months, was a jack-of-all-trades who also rewrote its software—both the operating system and a BASIC-G interpreter. His day job was as an engineer working on computer-controlled washing machines in the Strojsmalt state enterprise in Banská Bystrica, Slovakia.[542] Even his talent ran up against insuperable obstacles, however. The CPU that ran MAŤO from 1989 to 1992, and which bottlenecked its capabilities as a home computer, was the same Tesla MHB8080A microprocessor that Czechoslovakia had reverse-engineered (in 1980) from the venerable Intel 8080, first released in April 1974. There were no alternatives, even for an intrepid DODO like Urda. As Zajíček noted sadly "No matter how much I endeavored [to find someone], no one can build a VLSI (very large-scale integrated) integrated circuit for me at home," a manufacturing process described as "dauntingly complex" that demands precision control instruments in an industrial setting for wafer processing, photolithography and circuit etching on delicate silicon crystal.[543] Indeed, successful silicon-gate MOS manufacturing demanded such a tight integration

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[540] [Figure 4], Appendix A. Photos of the Game On! Exhibition in Prague, November 3, 2017, courtesy of the author.
[541] Appendix B. Photos of the Brno Technical Museum, October 5, 2017, courtesy of the author.
[542] "Tesla MAŤO," Old-Computers.com: On-Line Museum since 1995, available from: https://www.old-computers.com/museum/computer.asp?st=1&c=943.
[543] "Kdybych se sebevíc snažil, doma mi integrovaný obvod VLSI nevykouzlí nikdo." Zajíček, "Dalibor," 2; "Almost any type of component can be built well or badly, except a microprocessor. If a microprocessor isn't perfect, it won't work. … The countries of the Eastern bloc do not have the plants, machinery, or labor skills to manufacture microprocessors of any design less than 15 or so years old." Colin Barker, "Personal Computing in Eastern Europe," *Byte* 15, no. 9, (September 1990): 404; David C. Brock and Christophe Lécuyer, "Digital Foundations: The Making of Silicon-Gate Manufacturing Technology," *Technology and Culture* 53, no. 3, (2012): 584.

of tacit knowledge and the materials involved that it formed a kind of craft, a trade secret of Intel's that even enormous rivals such as Fairchild Semiconductor failed to crack in the 1970s.[544]

While the DIY (or DODO) mentality was prevalent among the Czechoslovak computer community—frustratingly so for Zajíček—there was also a persistently expressed preference for computers, software and peripherals from the West and Japan. At their 1986 annual SOFSEM conference, the Czechoslovak programmers and engineers in attendance broke into song, to the tune of "To Ta Heľpa," a traditional Slovak Čardáš dance:

> Here is Heľpa/
> This is a nice town/
> And in this Heľpa/
> Hundreds of computers there are/
> But for whom is this hundred, what is this hundred, if they are not to my choosing/
> Only for one/
> My heart aches.
>
> For an IQ [151], for a [Tesla] SAPI I would not take a step/
> For an HP, for a PC, I would leap the Danube.
> Danube, Danube, Danube, Danube ah that wide water/
> ZX Spectrum/
> Tomorrow you'll be mine![545]

The technologists' song riffs on the traditional lyrics of "To Ta Heľpa," which express the refusal of a country girl to settle for the hundred otherwise adequate boys in her hometown when her sole beloved lies across the Danube river. It is also an oblique reference ("hundreds of computers") to Slovakia's prominent role in computer production within the CSSR federal state. Extensive industry-related manufacturing was centered in Tesla and ZÁVT enterprises in

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[544] Brock and Lécuyer, "Digital Foundations," 586.

[545] 1. To ta Helpa/to je pekné mesto/a v tej Helpe/počítačov je sto. Koho je sto, toho je sto, ne po mojej voli/len za jedním/srdečko ma bolí.
2. Za IQčkom za SAPIčkom krok bych nespravila/za HPéčkom za PíSíčkom Dunaj preskočila.
Dunaj, Dunaj, Dunaj, Dunaj aj to širé móre/ZX Spectrum/zajtra bude moje! "ZX Spectrum," Nápěv*: To ta Helpa (slovenská lidová)*, Moravské trio, SOFSEM 1986. Found on "30 Let Sofsemu," a CD-ROM containing most of the conference's history from 1974 to 2003, provided by Miroslav Bartošek and in the author's possession.

Bratislava, Piešťany and Banská Bystrica. These lyrics are possibly also a tongue-in-cheek description of one of the major smuggling routes for software and computers into Czechoslovakia, which required "leaping the Danube" border controls from Slovakia into Austria, and back again.[546] Finally, we also see longing expressed here, however jestingly, for a romance with technology instead of a human heart. Where that longing look elsewhere might lead already troubled state officials and nationalist Czechs like Eduard Smutný, the designer of the Czech ONDRA microcomputer whom we encountered in chapter three, who justifiably feared this could lead to the destruction of Czechoslovak distinctiveness in computing for his children and grandchildren's generations.[547]

Overcoming this cultural preference for Western computers required Czech and Slovak policymakers to master the unwieldy, opaque world of of computer and software production in their own country. So long as the system had maintained a relatively stable equilibrium of slow but adequate production and implementation during the long 1970s, this had been unnecessary. The microelectronics crisis of the 1980s made change an urgent imperative. Heterarchical competition between enterprises had slowed production, distribution and adoption too much in a world where the scale and pace of technological change seemed newly overwhelming. In a prescient 1981 article entitled "Less Would Mean More: The Experience and Views of a Computer Technology User," hardware engineer Jindřich Katscher decried "ill-considered innovation drives … the underestimation of the importance of production traditions … insufficient cooperation—bordering on rivalry—between research, development, production, service and user organizations," some of which (insufficient mesocosmic cooperation) had

[546] Travel, and hence smuggling, was however much more frequently practiced between fraternal socialist states, especially Poland and Yugoslavia. Švelch, "Building a Lightning-Fast Sneakernet."
[547] Dawisha, *Eastern Europe, Gorbachev, and Reform*, 127.

previously guaranteed technologist autonomy and privileges from top-down political meddling and quota-setting.[548]

However, a decentralized system that afforded maximum leeway to professional hardware engineers like Katscher, Smutný and Kišš was also a system that catered to their hobbyist interests rather than the overall health of the computing milieu in Czechoslovakia. They were interested in hardware, particularly in microprocessors, and the result in Katscher's words was that "We have reduced the computer technology production sector virtually to the production of processors, that is to the computers' central units. While doing so we did not consider that processors without peripheral equipment and materials enabling operation are incapable of proper functioning."[549] Ironically state socialism, stereotypically associated with excessive centralization and top-down control, was here a victim of the excessive latitude enjoyed by individual technologists.

Yet the occasional and scattershot efforts by the State Planning Commission and party leaders to bend this process to their will, to rationalize and do away with heterogenous engineering and heterarchical competition via directives and quotas, constituted an unsuccessful form of social engineering. As anthropologist James C. Scott observed, such social engineering's "efficiency depends on the response and cooperation of real human subjects. If people find the new arrangement, however efficient in principle, to be hostile to their dignity, their plans, and their tastes, they can *make* it an inefficient arrangement."[550] Gruska, a prominent Slovak

[548] Jindřich Katscher, "Méně by znamenalo více: Zkušenosti a názory uživatele výpočetní techniky" (Less Would Mean More: The Experience and Views of a Computer Technology User), *Rudé právo* (December 21, 1981): 5.
[549] Katscher, "Méně by znamenalo vice," 5.
[550] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*, New Haven, Connecticut: Yale University Press, 1999: 224-225. Emphasis original.

computer scientist, recalled a particular scheme by Jozef Lenárt, First Secretary of the Slovak Communist Party, to obtain more understanding and control of computer production in Slovakia:

> Some [JSEP] hardware was developed in Bratislava and also in Žilina and leaders of those facilities had direct contact with the first party secretary, who seemed to have an interest in supporting the development of computing technology. These two powerful men I mentioned did not like each other, to say it politely, and the first party secretary knew that. It seems that he hoped to make use of it to get real information about the overall state of development, but he was deeply wrong.[551]

Information asymmetry and fierce mid-tier institutional strength helped to safeguard local prerogatives against political interference (or leadership). Traditional management techniques, such as replacing the top brass with new faces or fostering socialist competition between enterprises, did not effectively bring to rein autonomous technicians. Precisely because of the unwieldy nature of the command economy, workers who wanted idle time on the job to pursue their own hobbies or to take an early getaway to the family's weekend *chata* were able to do so.[552] The same technologist workers might very well proceed to castigate the lack of up-to-date software or working peripherals, but those ripples in the economy felt distant from the pebbles they had each tossed.

None of these were failures of state socialism *per se* systemically but rather of particular and contingent personal, political, economic and cultural choices by those who held the reins of political power in the Communist party. Western computers, for example, were consistently used as the standard and copied, thus discouraging homegrown innovation. These were often choices made by policymakers who had deeply internalized a dichotomy of backwardness and

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[551] Gruska in discussion with the author.

[552] "*Chata* culture further overlapped with the already pressing problem of labour discipline. On Friday afternoons, Czechoslovakia's roads were congested with traffic as everyone made their way to their *chata*. … The working week shrank to little more than three full days of work." Paulina Bren, "Weekend Getaways: The *Chata*, the *Tramp* and the Politics of Private Life in Post-1968 Czechoslovakia," in David Crowley and Susan E. Reid, *Socialist Spaces: Sites of Everyday Life in the Eastern Bloc*, Oxford: Berg, 2002: 134.

development between Eastern and Western Europe that originated in the Enlightenment.[553] Frustratingly for many technologists like Trojan, they were choices not rooted entirely in material reality—Czechoslovak and Soviet scientists were capable of keeping pace and leading the way in international scientific development.

Trojan remembered one encounter with Soviet scientists from a Yerevan research institute in the late 1970s where he was shown what may have been a Soviet evolution of the Williams-Kilburn tube, an early type of computer memory developed shortly after World War II. Trojan saw this tube, shrunk to a size little bigger than a pencil, laser-readable and capable of holding 600 megabytes of memory, in 1978 when enormous magnetic hard drives typically held no more than 1 gigabyte.[554] But to Trojan's chagrin it was never commercialized. This was a regional trend that cut across technologies, something that Scott Palmer has identified in the early Soviet aviation industry of the 1920s and that Helena Durnová pointed out in the case of Svoboda's work on the SAPO-1 digital computer in the 1950s. Overcoming a complex of cultural inferiority to the West in East Central Europe was a problem in many cultural arenas throughout the 20th century. Nor were shortsighted bureaucrats, always a common complaint, unique to socialism.

Slow Down, You Move Too Fast: Czechoslovakia as Craft Knowledge Reservoir

Indeed, state socialism offered two advantages to computer enthusiasts: one intentional and one accidental. The primary intentional advantage was the excellent system of technical education, a topic examined in-depth in chapter two. If, as David E. Nye observes, "technologies

[553] Larry Wolff, *Inventing Eastern Europe: The Map of Civilization on the Mind of the Enlightenment*, Stanford, California: Stanford University Press, 1994: 9-10.
[554] Trojan in discussion with the author.

are not just objects but also the skills needed to use them," then state socialist societies, which prized engineering and the sciences, laid the scholastic foundation in the 1970s and 1980s for the widespread technical competence in computing that characterized the emerging economies of East Central Europe after 1989.[555] The unappreciated advantage of state socialism was scarcity and slowed diffusion. Expensive, unavailable computers prolonged the period when users needed to interact intimately with their machines. Users repaired them when they broke, wrote their own computer games and maintained close-knit social networks to trade information or illicitly copied programs on tape. Scarcity was to some degree a result of the well-known inefficiencies of a command economy, especially in distribution and timely provision of consumer goods; however, it was to a significant extent also *epiphenomenal* to state socialism.

The Western CoCom technology embargo, for example, was a hindrance to the adoption and diffusion of computers in Czechoslovakia and other CMEA bloc countries. While there were ways around the embargo, it nonetheless proved largely effective at preventing or dramatically slowing technology transfer from west to east. According to Mirosław Sikora, "In the following decade [the 1960s] it [the CoCom embargo] caused permanent scarcity of semiconductors and integrated circuits of small, medium and then large scale of integration behind the Iron Curtain." This shortage, which struck literally at the heart (the CPU) of state socialist microcomputing production and diffusion efforts, resulted from a contingent political choice by the United States and its allies, not a structural failure inherent to state socialist economies.[556]

The unanticipated result of state socialist scarcity was to slow machine diffusion and extend the period of time in which computers might be *curios*, objects of technological

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[555] David E. Nye, *Technology Matters: Questions to Live With*, Cambridge, Massachusetts: The MIT Press, 2007: 4.
[556] Mirosław Sikora, "Clandestine Acquisition of Microelectronics and Information Technology by the Scientific-Technical Intelligence of Polish People's Republic in 1970–1990," In *2017 Fourth International Conference on Computer Technology in Russia and in the Former Soviet Union (SORUCOM)*, IEEE, 2017, 204.

exploration and wonderment. Again, David E. Nye: "As they become 'normal,' technical systems disappear into 'black boxes' whose inner workings we neither think about nor understand. People accept automatic technical control, and the opacity of the machine becomes 'natural.'"[557] Computers became commodities in Japan and the West by the late 1980s, a process delayed in East Central Europe until the mid-to-late 1990s. While young Californians ran to a store for the latest computer game, Yugoslav enthusiasts had to develop a clever system of software programs broadcast over Radio Belgrade 202, carefully recording each program on cassette tape at home or in their clubs.[558]

Most of those software programs were games. However, this does not signify that computer enthusiasts' pursuit of them was frivolous—computer games in the 1980s, especially in state socialist societies, had not yet become products solely of entertainment value. Instead, as Frank Veraart argues in the case of the Netherlands, "games served as a means to test and improve programming skills … [and] games were used as tools to tempt new—predominantly lay—audiences and to demystify computer operation." Only as the market for home computing expanded dramatically in the 1980s and 1990s as more of the public, enrolled by virtue of the efforts of early computer enthusiasts, brought one home for themselves did games become "the main application of their personal computer."[559] Unlike their counterparts in the West, young computer game players in Czechoslovakia also stayed loyal to their 8-bit and, much less frequently, 16-bit home computers well into the 1990s.

Pricing data, coupled with advertisements and classified listings from youth magazine *ABC Mladých Techníků a Přírodovědců* tell us why: In the autumn of 1994, *ABC* ran an ad for

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[557] Nye, *Technology Matters*, 200.
[558] Kristian Benic, *Geeks Behind the Iron Curtain*.
[559] Veraart, "Losing Meanings," 53, 58.

VABO, an electronics shop on Tashkent Street in Prague that offered the Sega Megadrive home console for 3,990 crowns, over half a month's average salary (7,004 crowns). Individual games, such as *Sonic III*, which was not the most expensive listed game, cost 1,790 crowns—about $64 dollars given the exchange rate at the time; well out of reach for the average Czech or Slovak child or teenager. Meanwhile, on the same page as the VABO ad, a classified listing from Martin Ščerba of Stráž pod Ralskem, a tiny town of 4,000 inhabitants near Liberec, offered ZX Spectrum-compatible games for 20 crowns each, a whopping one percent of the price of a new home console game.[560]

Formal and informal networks of exchange such as these, rooted in the adaptive tactics that Czech and Slovak computer users employed to navigate the scarcity of late socialism, endured until the end of the 1990s. They were a powerful and lasting influence on computing culture. Rather than a case of industrial production and commodity consumption, Švelch argues that Czechoslovakia in the 1980s had become, by virtue of its peculiar circumstances, a kind of "reservation where this preindustrial logic [of homebrew craft production, tinkering and informal exchange] was maintained longer than in market-driven contexts."[561] However, this was not by choice—such a reservation was formed by the contingent confluence of feckless government policy, inadequate market provision, necessity and long-standing craft traditions in the Czech lands. Many users yearned to be consumers. To them, the computer scarcity of the 1980s was not

[560] VABO Advertisement, "Sega: 16 Bit Televizní Hry," and "Čtenářská burza," *ABC Mladých Techníků a Přírodovědců* 39, no. 5 (Autumn 1994). Not counting the collection *52 Games in 1*, which sold in the United States as the now rare but subpar quality *Action 52*, and that retailed for 2,130 crowns, the most expensive single game on offer was the brand new *World Cup USA '94* at 1,880 crowns.
[561] Švelch, *Gaming the Iron Curtain*, 220-221.

an opportunity to acquire hands-on skill that would serve them well in a later career—it was a barren "wasteland," (*pustina*) as Zajíček put it in April 1989.[562]

That same year, Franěk wrote a humorous advice column "How (Not) to Buy a Computer," in the pages of *Počítačové Hry* (Computer Games), one of many ephemeral computerist newsletters and magazines of the time. It reflected frustrations about inept and ignorant bureaucrats, restricted imports, shortages and corruption that had become common critiques in the emerging political consensus of the computerist community. However, his column also reveals lingering suspicions about market capitalism: Manufacturers abruptly discontinued unprofitable products with little consumer protection or went out of business entirely; small companies one preferred to support often operated only by mail, and their products were hard to find in major stores; computers, software and peripherals were incompatible with the products of other companies, and one had to make expensive, ignorant gambles about the viability of entire operating systems and computer lines.[563]

Such uncertainty seemed crippling. Confronted with too many choices obscured by too much ignorance of the market made Czechs' hunt for the right computer just as challenging as it had been in the wasteland of empty shelves. "It might appear," Franěk demurred "that I'm trying to say that buying nothing is the best option. I only want to point out the dangers of buying a computer abroad."[564] The frustration of being caught between Scylla and Charybdis, a market too expensive, confusing and inaccessible to supply the country's computer needs and a government that had proven incapable of implementing a top-down national reform strategy, transformed many Czechs and Slovaks by necessity in the late 1980s into heroic "Dalibors of

[562] Ladislav Zajíček, "Počítač z Tuzexu," *Mikrobáze* 5 (April 1989): 23.
[563] Jiří Franěk, "Jak si nekoupit počítač" (How [Not] to Buy a Computer), *Počítačové Hry* 1, (January 1989): 3.
[564] Ibid.

computing," DODOist jacks-of-all-trades. Yet in the face of a breakdown in the previously stable system of computing during the microelectronics crisis, DODOism was a short-term solution stretched increasingly thin, leaving a restive, growing and well-organized community to contemplate a new kind of politics.

Tomorrow is Yesterday: The Limits of Political Indifference and Promise of Technical Syndicalism

The story of computer technologists' politics in late socialist Czechoslovakia, one of tactical alliance, occasional repression and eventual disenchantment, repeats familiar themes from the lives of engineers and technicians from other fields, other times, and other socialist states. In *The Ghost of the Executed Engineer* Loren Graham wrote compellingly of the early 20th century Soviet engineer Peter Palchinsky, whose life and beliefs anticipated the experience and ethos of Czechoslovakia's computerist community half a century later. Palchinsky, Graham observed, wanted "to unite his ideas about industrial planning with Bolshevik aspirations. He was particularly excited by the plan to electrify all of Russia in a few years … [He] was eager to work with the Soviet authorities and the Communist Party in planning industry and increasing the strength of Russia, but he stoutly resisted the takeover by the Party of any organization of which he was a member."[565] Palchinsky stood against arbitrary commands from the center, organized and protected a voluntary club of fellow technicians and took advantage of state funding to expand the scope and power of institutional, expert authority, as represented by his Institute of the Surface and Depths of the Earth.[566]

This should sound familiar. It represents a mode of thinking, a pattern of behavior that ran through the heart of Czechoslovakia's computer community in the 1970s and 1980s. Chapter

[565] Graham, *The Ghost of the Executed Engineer*, 29-31.
[566] Ibid, 34.

two demonstrated that, despite diverse social origins and the mixture of two generations of computer technologists (the generation of ’68 and the youth of *normalizace*) Czechs and Slovaks formed a coherent identity with regards to the artifact of the computer and in relationship to one another. They expressed a consistent set of community values, which included efficiency, unimpeded access to tools (especially the computer and its ecology of peripherals, software, manuals, newsletters, etc), and meritocracy. Those values had political import.

The defining incident that drove Pospišíl into open dissent (signing the reform petition “Několik vět”) in the spring of 1989 was an offense against meritocracy. As he recalled: “One scientist came to our department as a Communist (there were only three in our institute [of atmospheric physics]), and he was a con man (a closed thesis, no peer review). The communists had their own team in our institute—this con man was from the military, and he worked on something, organized by the Academy of Sciences, he wrote a small booklet with a nonsense theory in meteorology, [and] received a prize.” Pospišíl refused to accept this, and wrote a paper refuting it at length after he had studied this con man’s paper. When Ivan, a colleague’s friend from the Geophysical Institute came round with “Několik vět” later that spring, Pospišíl signed it along with two of his women colleagues, Pretlová and Čechová, over the objections of the institute’s director.

For Czech and Slovak computer technologists in the 1980s, community values and underlying political feelings were both broader than, and inclusive of, the “hacker ethic” defined by Levy. The computer was truth in a system sustained by lies.[567] For older computer technologists, as we have seen, community values and political beliefs were shaped to a

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[567] Sherry Turkle, *The Second Self: Computers and the Human Spirit*, 20th Anniversary Edition, Cambridge, Massachusetts: The MIT Press, 2005: 164. “The computer is a magic box. It’s a tool. It’s an art form. It’s the ultimate martial art . . . There’s no bullshit in there. Without truth, the computer won’t work. You can’t bullshit a computer, God damn it, the bit is there or the bit ain’t there.” Les Solomon quoted in Levy, *Hackers*, 189.

significant degree by mutual interaction in relatively autonomous discursive spaces such as the research institute and invitation-only conferences like SOFSEM and MFCS. After Sokol signed Charter 77 alongside Trojan, Benda, Sedláček and Žák at VÚMS, he was officially targeted for political reprisals by the government and the Communist party. Despite the risks of associating with him—recall Pajas' earlier warning that for politically suspect individuals like himself "to have many friends was dangerous to the friends"—the SOFSEM community never abandoned Sokol; he continues to appear in photos of practically every annual conference from 1978 on.[568]

This community embrace of the politically suspect extended even to those with the most famous (or infamous) surnames. Ivan Havel was brother and close collaborator to the Communist Party's most prominent domestic critic. Despite this, Gruska and the organizing committee of SOFSEM ensured they were both invited to the conference year-after-year. They insisted on the unimpeachable scientific credentials of Sokol and Havel, made successful appeals to sympathetic institute directors, and even played rival secret police commanders in Bratislava and Prague off each other to keep their dissenting colleagues in the fold.[569] The community managed to sustain this solidarity against state power even when subtext strayed dangerously close to the surface during the relaxed atmosphere of the conference—Havel at one point attended a masked ball dressed as a prisoner while his brother languished behind bars.[570]

The social lives of younger members, in turn, often revolved around the state-sponsored youth club, whether explicitly focused on computing as 602 Svazarm was, or clubs of radio amateurs, science fiction enthusiasts or brand loyalists (Speccies, Atari-heads). Everyday club

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[568] Pajas in discussion with the author; Appendix D: Photos of Principal Interview Figures from SOFSEM and the Archives of Czechoslovak Television, [Figure 15].
[569] Gruska in discussion with the author; Prof. Jan Sokol, Ph.D., CSc., (Professor—Faculty of Humanities, Charles University), in discussion with the author. June 12, 2018.
[570] Gruska in discussion with the author; Havel in discussion with the author.

life was largely regarded as apolitical, in part because many of the older volunteers and staffers responsible for organizing activities, corralling computers with state funds and hosting summer programming camps were, at least formally, members of the Communist party like Holan and Bartošek.[571]

Many of the younger members, too, may have fallen within this category. Owning a home computer in the 1980s was still an unusual and privileged position, and those fortunate enough to have one were often the children of loyal party members who had more access to international travel and could bring back machines and software from abroad.[572] Even those computer enthusiasts, however, still needed access to repair services, new games, user manuals and peripherals. The clubs served not just as educational and computer access centers, but as we observed in chapter two, also as hubs in an informal network of software exchange and cultural transmission that spanned the country. As Švelch has demonstrated, the clubs were also termini and depots for international distribution networks that cut across the borders of the Cold War world, bringing in Western software and publications (magazines, manuals, newsletters like DECUS for PDP 11 users).[573]

The general anti-communist zeitgeist was, during the brief efflorescence of these clubs in the late 1980s, also present among young people. Traditional expressions of open dissent, such as signing reform petitions, were uncommon among them and might have derailed scholastic opportunities. Nevertheless, home-grown computer games critical of the regime did begin to circulate in the same informal economy of software exchange the government relied on. Schools that managed to obtain rare shipments of computers, for example, often found they arrived

[571] Švelch, “Say it with a Computer Game.” Holan in discussion with the author; Bartošek in discussion with the author.
[572] Beneš in discussion with the author.
[573] Švelch, “Building a Lightning-Fast Sneakernet.”

without any useful educational software, and depended on students to furnish these through connections with local computing clubs.[574] These youth critiques included games like the text adventure *Přestavba* (Reconstruction) from 1988, which ironically displayed the regime's empty slogans as distractions along the bottom and sides of the screen, and *Nechceme násilí* (We Don't Want Violence), a crude game whipped up and published within two days of the November 17, 1989 student protests and police beatings which sparked the Velvet Revolution.[575]

From Dissatisfaction to Dissent: The Syndicalist Politics of 'Computers for the Community'

As we observed in chapters three and four, computer technologists were, like Palchinsky, not natural-born dissidents. They were typically imbricated in the structures of technological, social and political power that sustained the daily operations of the communist state. While the political views of computer technologists were never as sharply defined or publicly articulated as those of the humanist intelligentsia who formed the core of active dissent in Czechoslovakia's Charter 77 movement, those views are nevertheless possible to discern and were widely held. Anti-communism was the leitmotif of technologist politics throughout the 1970s and 1980s, usually expressed privately in person, couched in coded discourse in publication, or expressed more openly at invite-only gatherings like SOFSEM. Common critiques included officials' "stupidity" (usually in reference to their comparative, perceived technological illiteracy); "bureaucratic backwardness" when travel visas were not issued or planning directives made no sense; and "reactionary conservatism" which appropriated official rhetoric to describe

[574] Fuka in discussion with the author.
[575] Švelch, *Gaming the Iron Curtain*, 204-206, 210-211.

recalcitrant workers and managers, as well as members of the public, who failed to appreciate the technologists' vanguard role in carrying out the processes of the scientific and technological revolution.[576]

Zajíček heaped scornful adjectives on a system that prevented technologists—and thus the country—from achieving their full potential. "Indifference, irresponsibility, laxity, rigidity, bureaucratic procedures, limiting the sphere of action for inventiveness—[all] this causes the dysfunction of what otherwise might be functional, evolutionary social benefits" of computing he proclaimed.[577] Persisting in this direction instead of undertaking necessary structural reforms, he warned, meant continuing to rely on makeshift "DODOism" at home and in the workplace, stalling the entire country's progress and imperiling its future. What gave him hope were Svazarm's continued support of technologists' efforts and the cautiously growing chorus of voices for reform among Czech and Slovak computer enthusiasts.[578]

In this sense, computer technologists were not remarkably different from their fellow citizens in late socialist Czechoslovakia who, at least according to their majority accounts after the Velvet Revolution in 1989, had engaged in numerous private or small-scale dissenting actions without crossing an invisible but actively patrolled boundary into dissidence, e.g. as much as a third of the entire population tuning into Radio Free Europe or the BBC at home.[579] Czech and Slovak computer technologists warmed to dissent slowly over time, and began to adopt a more openly subversive rather than state-loyal stance around 1987.

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[576] Švelch, "Say it with a Computer Game."

[577] "Netečnost, nezodpovědnost, laxnost, zkostnatělost, byrokratická procedurálnost, omezování akčního rádiusu invence – příčiny disfunkce toho, co by v opačném případě mohlo být funkční, společensky přínosné, evoluční." Zajíček, "Dalibor," 3.

[578] Zajíček, "Dalibor," 3.

[579] Vaněk and Mücke, *Velvet Revolutions*, 32-33.

Much of the evidence for this shift in tone manifests itself in written sources from the brief 1987-1989 period of *přestavba*, or Soviet-inspired openness and reconstruction. Nevertheless, there is reason to believe that technologist disenchantment with the state reflected material realities specifically founded in computing. Their collective expectations of progress were not being met by virtually every metric, including new computer imports, hardware pricing, software availability and provision of computers to schools.

It is challenging and likely impossible to disentangle how much the expressed change in computer technologists' willingness to engage in dissent was rooted in a lessened fear of government reprisal from an actual loss of patience and faith in the government's ability to navigate the microelectronics crisis. However, as we observed in chapters one and two, managers and technicians had been ringing alarm bells throughout the early 1980s in criticism of the government's slowness to embrace microelectronics. These warnings popped up even in the middle of otherwise dry technical progress reports in limited-circulation professional journals.

In 1982 Rudolf Sorm, an electronics engineer at the A.S. Popov Research Institute of Communications Technology defended government policy favoring hybrid integrated circuit technology by referring to their application flexibility and relatively low cost, but confessed that "our slow response to worldwide developments" in microelectronics had also delayed the institute's research and production.[580] This building pressure eventually led the Central Committee to issue sweeping plans for reform in 1984 and 1985. Periodicals, oral recounting, and contemporary television programs indicate that in 1987, even older computer technologists who inhabited a stable *modus vivendi* with normalization-era socialism had run out of patience.

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[580] Rudolf Sorm, "Vývoj komponentních technologií pro komunikaci" (Development of Component Technologies for Communications), *Telekomunikace* no. 8 (1982): 125-127.

When Eduard Smutný appeared on the January 25, 1987 broadcast of the popular television program *Televizní klub mladých* (Youth's Television Club), he was visibly distressed and uncomfortable. The inventor of the ONDRA microcomputer and one of the most prominent exponents of computers in Czechoslovakia, he had come before a mass audience to argue for a radical overhaul of the country's approach to microelectronics production, distribution and adoption, especially for schools. "Unless we manufacture twenty thousand machines," he claimed, "it makes no sense to write programs for it, it makes no sense to write manuals for it, it makes no sense to teach people how to use it, to put it into schools."[581] Smutný kept a copy of the ONDRA on the table in front of him that he kept touching, as if for reassurance and emphasis.[582] Momentarily losing his train of thought, he looked to it for inspiration before continuing: "It really must be our goal to have these computers—the goal [is] to give cheap Czechoslovak computers to people."[583] The government's entire purpose (*cíl*, a word he stressed again and again) should be to fulfill this goal. The moderator, after hearing Smutný's speech, gently touched him on the arm and remonstrated with him, lightly referring to him seeming like "a sad, angry man." Smutný flinched away.[584]

In a *Mikrobáze* editorial that April, Zajíček castigated the interview. "We learned once more how to make sense of the stupidity, the ignorance and the social apathy backed by the reigning bureaucracy," he fumed.[585] The treatment of Smutný, along with his brother Tomáš, a well-known and much-liked figure, rankled Zajíček and confirmed many of the community's

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[581] Švelch, *Gaming the Iron Curtain*, 28.
[582] Antonín Vomáčka, "Televizní klub mladých 1/1987," *Televizní klub mladých*, Prague: Československá televise, January 25, 1987.
[583] Švelch, *Gaming the Iron Curtain*, 28.
[584] Vomáčka, "Televizní klub mladých 1/1987."
[585] "Není to tak dlouho, co se v pražském TKM ze své bolesti vyznal Eda Smutný, autor mikropočítačě ONDRA. Dozvěděli jsme se o tom, jak si zase jednou smlsla hloupá, ignorancí a společenskou netečností zaštítěná byrokracie." Zajíček, "Dalibor výpočetní techniky," 3.

worst suspicions about the lack of any serious, speedy government reform to address the needs and desires of computer technologists and the country as a whole. For decades, the government had engaged stridently and repeatedly in the rhetoric of reform, of addressing errors and moving onward in the spirit of the scientific and technological revolution.

In chapter one we saw this exemplified in the pronouncements of Kubát, who spent years calling for an acceleration of technical progress without ever addressing the shaky, fissured foundation from which that progress was meant to launch. Yet here was Smutný, one of the foremost computer technologists in the country, pouring out his heart on national television in the cause of reform, treated with laughing scorn. By mid-1987, even many of the older and traditionally more politically cautious computer technologists like Zajíček had publicly lost patience with the government.

Years had passed since the two "long term complex electronization" plans the Central Committee of the Communist party promulgated in 1984 and 1985 to reform and computerize education and the economy. For Zlatuška's two daughters, born in 1981 and 1983, there were no computers at school. In Zlatuška's memory, as late as 1989 no such computer-equipped school existed in Brno, the country's third-largest city.[586] "Where are the promises" of these government computerization plans, Zajíček asked rhetorically, before answering for his readers: "Where last year's snows are!"[587] While Czech and Slovak DODOs would soon form a savvy, entrepreneurial basis for a transition into a market economy stuffed with computers in the 1990s, that future was still difficult to envision from the vantage of 1987. In that year DODOism, or leaving the digital future of Czechoslovakia in the hands of enthusiastic tinkerers starved of the

[586] Zlatuška in discussion with the author.
[587] "Kdeže sliby, kdeže loňské sněhy jsou!" Zajíček, "Dalibor výpočetní techniky," 3.

material fundaments of their craft, seemed the only future the government was capable of offering.

Putting into perspective just how radical a break Zajíček was making from the official state-loyal stance of computer technologists is the editorial that appeared in *Mikrobáze* just one month prior, in March 1987 by 'kš,' a pseudonymous editor of the magazine. In "Novinky z novin" (News from Newspapers), he conducted a rough survey of computer accounts appearing in the mainstream press—*Rudé právo* (Red Justice) and *Svobodné slovo* (Free Word). He concluded that the mainstream communist press was covering the problems and challenges of computerization in Czechoslovakia relatively openly and fairly.

The press truthfully addressed the gap between the number of computers in Czechoslovak schools as compared to the United States, interviewed a Prague retail goods worker who criticized the unrealistic and insufficient domestic production of electronics, and soberly assessed the slipshod implementation of computers in Czech agriculture, often deployed without necessary software or technicians to install and set up the machines. All this, he concluded, constituted: "Evidence that the [government's] program of development and use of electronics is not an empty phrase, but really is the center of social concern."[588] However, as discussed in chapter four, this kind of patient support for the regime was fast becoming a minority opinion, and from 1987 to its last issue in the midst of the Velvet Revolution in 1989, Czechoslovakia's only nationwide magazine for computer enthusiasts had shifted into an oppositional stance toward the government.

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[588] "Vidíte? Docela obyčejné noviny z tak krátkého časového úseku, a tolik podnětů k zamyšlení jen z jedné, jediné oblasti lidského konání." 'kš' (pseudonym), "Novinky z novin" (News from Newspapers), *Mikrobáze* 5 (March 1987): 2-3.

In this way, the shift from a state-loyal to state-skeptical position among the computer technologist community in Czechoslovakia, its sole organ (*Mikrobáze*), and within the centers of its organizational life (conferences like SOFSEM, within the research institutes, the youth clubs) mirrored an important socio-political trend across the entire bloc of socialist states. Lewin referred to this phenomenon unfolding in parallel inside the Soviet Union:

> Through persistent and confidential formal, semiformal, and informal contacts, the formal and informal structures exchange information and opinions. Exchanges occur among workers and technicians, inside economic and political administrations, and in offices, think tanks, and institutes. … New professional and interprofessional associations are appearing, and older official organizations are acquiring a new identity, shedding to some extent, at least, their official tutelage and expressing their own opinions.[589]

What Lewin describes here was ironically both a sign of exhaustion and a surge of vitality. Technologists and other members of the intelligentsia were re-coding the old institutional parameters of state socialism to run new programs. It was their belated collective response to the crisis in microelectronics during the 1980s, which had really been a crisis of mismanaged expectations. For decades under the stable system that had cohered during the long 1970s, computer technologists' had held to explicitly state-loyal, if muted, political beliefs. Many saw themselves, like their cohorts abroad, as largely apolitical technocrats or as reformers who understood that life under capitalism simply meant a different set of problems and not a panacea to cure all ills.[590] When political reforms seemed most hopeless, in the aftermath of the Prague Spring, Czech and Slovak computerists held on to the belief that changes were coming, and that they had the knowledge of computers to master the inevitable upheaval, to create technology with a human face.

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[589] Lewin, *The Gorbachev Phenomenon*, 75, 79.
[590] Gruska in discussion with the author.

Conclusion: System Crash 1989

What ensued was a series of cascading errors that ultimately led to government crashes throughout East Central Europe from 1989 to 1991. These political changes, and the rapid introduction of a market economy in the 1990s, elided an emerging technicians' syndicalism in Czechoslovakia and its former fraternal socialist partners.[591] Material conditions for computing in the state socialist bloc looked very different both from those prevailing in the United States and in the world's poorest countries by the end of the '80s.[592] There were far fewer computers in general, and an insignificant number of those were under private, individual ownership. Technologists previously scattered among numerous state enterprises, research institutions and universities had defined the discipline and laid down its educational curricula in the 1970s, formed conferences, maintained networks of social support and rapport and were groping toward consensus reform political views based on shared community values.[593]

They were united by a vision of a dynamic technological future, with the liberating potential of the personal computer at its center, which would have been familiar to Whole Earth Catalog subscribers.[594] Yet because commoditization of computing had not already taken place

[591] These particular socialist spaces anticipated, by some two decades, the current trend of so-called "maker-spaces" which provide means of technical production, such as 3D printers, along with skilled instructors, to the community at large. Kimberly M. Sheridan, Erica R. Halverson, Breanne K. Litts, et al., "Learning in the Making: A Comparative Case Study of Three Makerspaces," *Harvard Educational Review* 84, no. 4 (Winter 2014): 505-531. Švelch refers to the proto-syndicalist arrangement of computerist life at the end of the '80s as "*vnye*-style environments that are controlled neither by state power nor by commercial companies." Švelch, *Gaming the Iron Curtain*, 221.

[592] The Czech Republic was able, for example, to reach rough parity with the United States in average computers per household by 2007, despite relative poverty during the 1990s as the country adjusted to the introduction of a market economy. See Appendix E: Graphs, Maps and Tables, [Figure 29] and [Figure 30] for the OECD's data on the growth curve in computer acquisition in the Czech Republic. Direct comparisons of Czech computer acquisition to specific poorer countries in the world may not be helpful, as from 1990 onward Czechs and Slovaks benefitted from high rates of foreign investment, particularly from Germany, and lower security costs from post-Cold War demobilization, circumstances which make close contemporary analogies to other peripheral countries like India or Mexico challenging.

[593] Pospíšil in discussion with the author; Bartošek in discussion with the author;

[594] Wisnioski, *Engineers for Change*, 175-179.

in this semi-periphery, the syndicalist potential of computer technologists at the very end of the 1980s lay in their combination of state-skeptical and capital-skeptical positions, a reflexive consolidation around principles of DIY hands-on knowledge, local control, unmitigated access to the means of production (the computer), tactical sharing and recycling/re-purposing to overcome scarcity, and an egalitarian, meritocratic ethos. Countercultural dreams of computing did not simply die out from the popularization and mass adoption of computers as business machines in the office and toys at home. Programmers were also seduced into entrepreneurship by a different, and as it turned out incompatible, dream—the accumulation of wealth that transformed the hippie haven of the California Bay area into a repository of vast fortunes, centralized technological power and libertarian politics.

More than forty years have passed since the onset of the PC revolution at the West Coast Computer Faire in 1977. The networked microcomputer and its direct descendants, "smart" cellular phones and speakers, tablet-sized devices, video gaming consoles and even many televisions, are daily pecked at, stroked, squeezed, swiped, thumped, talked to and shown off. It is difficult to conceive of a technology more intimately tied to our everyday lives. The early computer enthusiasts, most of them, have lived to see a future of ubiquitous computing.

Yet the PC revolution's material success undermined its cultural aims. We previously encountered the disappointment of Western hobbyists and enthusiasts like the Welshes, who felt that the TRS-80 and other micros like it contained great potential for social and economic change by putting powerful means of technical and creative production and communication in the hands of ordinary people. Richta described in his 1966 collection of forward-looking intellectuals' essays *Civilizace na rozcestí* a vision of the scientific and technological revolution to come. He argued that a fundamental social re-ordering would be necessary to replace a hierarchy of management and control that stultified technologists and could not keep pace with change:

> Development of social relations which not only do away with the narrow confines of antagonistic interests but which also readily react to the new aspects of civilisation, to the dynamic potential of the scientific and technological revolution, is a condition for the triumph of socialism. This revolution is not a short-lived upheaval to be carried out by directives issued at the top. It is a prolonged universal process of structural change which greatly enhances the dynamics of growth. Only a flexible economic system of management extending to all areas of social labor and possessing an adequate system of reciprocal interconnections can ensure intensive growth. Man's interest structure itself must be dynamic.[595]

We have already seen a manifestation of this kind of "flexible economic system of management" in the making and, frankly, in a defensive and reactive posture. Through the 1970s and 1980s, the *mesocosm* of research institutes, universities, government ministries and large state enterprises constituted the employment backbone of the Czechoslovak computing community. A gradually equilibrated product of heterarchical competition, it proved frustratingly masterless for party leaders and central planners, but a source of patronage, political protection, creative outlet and cultural safe space for Czechs and Slovaks who spent their days designing, building, maintaining and operating computers.

A closer union between this flexible economic system, a heterarchy which afforded technicians a great deal of control over the means of production, and the formal and informal structures of social life (the clubs, black and gray market exchange networks, periodicals) into a kind of bottom-up syndicalism seemed to promise the kind of rich "reciprocal interconnections" Richta believed were a necessary prerequisite to a fully realized revolution in science and technology. This is difficult to conceive precisely because, first, it failed and, second, it would undermine our intuitive historical biases that liminal spaces and communities are and ought to be

[595] Radovan Richta, "The Scientific & Technological Revolution," *Australian Left Review* 1, no .7 (1967): 66.

in transition to a given destination—"slipping" into backwardness, or "catching up" to become modern on Western terms.[596] The emergence of computer syndicalism in late socialist Czechoslovakia would have been an undeniably altered modernity, one in which ironically a technocracy could not exist, since technicians would continue to inhabit a formally subordinate position with local autonomy and be incapable of accumulating substantial capital.[597]

Continuing conditions of material scarcity under state socialism would likely have promoted an intensive engagement with computers. More akin to crafted objects, technologists would have treated computers with more care, with planning undertaken to integrate relatively few machines into settings of social use, to strengthen informal networks of exchange, to prioritize maintenance and their environmental and capital cost. This is a markedly different cultural choice than the extension of computers as more powerful, flexible tools slotted into the same framework of market capitalism and aimed at the same profitable ends. This is informed speculation, since we can observe a similar process ongoing in Cuba. There local owners of networked personal computers can connect to each other and the outside world through "SNET" or the street-net. As it developed in the late 1990s and early 2000s, users themselves had to repair network nodes, replace wiring, invent governance structures, distribute IP addresses, and disseminate user etiquette through online forums and in-person meetings. Access to SNET is scarce and highly valued—everyone needs each other to help maintain the network and therefore

[596] "The traditional response has been to think of this interstitial position as something to get rid of or transition from, in the move from periphery to core. But why do we not think of this liminality as a strength? Why do we not utilise the resources it offers to address uncertainties, unpredictabilities and improvisational tactics?" Müller, "In Search of the Global East," 16.
[597] Larson, "Notes on Technocracy," 29.

"Everyone respects each other. I have never had an offensive discussion in the four years I've been a member," said one user named Alejandro.[598]

Although the late socialist roots of Czechoslovak computing culture remain an important influence on users today, there are at least three reasons why an alternate model of computing such as in Cuba failed to emerge in Czechoslovakia. The first is time. Much as Smetana died two years too early to witness the revival of *Dalibor* on the stage, the collapse of the state socialist regime in the Velvet Revolution of 1989 ended formal practices of autarky, the country's participation in CMEA's Unified System of Electronic Computing and any reason for the Western powers to continue the CoCom blockade of technology imports. In state socialist regimes elsewhere around the world that survived, such as Cuba, Vietnam and China, the adoption and diffusion of computing continued under state direction, to varying speed and results.

Second, while scarcity proved an important motivator for long-held traditions of Czech tinkering, repair and tacit knowledge innovation, it was a disliked and extrinsic motivation that disappeared as incomes gradually rose in the 1990s and market capitalism rushed in to address distribution and consumption. No one wanted to be poor. Computers were now on the shelves, even if they were initially unaffordable. There was a palpable sense of relief among the community when the wall fell, a sense that everything had changed overnight and that now their creative and constructive horizons were virtually limitless. Pajas developed a scheme, inspired by Brussels, to automate and otherwise computerize all of Prague's city services; Zlatuška set to work organizing a cohort of young faculty members to back his successful 1994 proposal to

[598] Dye, Nemer, Kumar, et al., "If it Rains, Ask Grandma to Disconnect the Nano," 11.

found a new Faculty of Informatics at Masaryk University.[599] The "Dalibors of computing" were no longer trapped in the tower, improvising violins from match sticks.

Finally, cultural preference played a role, as it always had, and proceeded to assert its influence on the Czechoslovak computing scene. The rhetorical and cultural transition took place with ruthless speed. In 1989, the pages of *Věda a Technika Mladeži* (Youth Science and Technics) are filled with news articles and even advertisements for the computers produced by Tesla Eltos, the PMD-85, the IQ-151, keyboards from the Slušovice cooperative farm. By 1991, the magazine had undergone a name change (to *Věda, Technika a My*, or Science, Technology and Us) and was stuffed with reporting and advertisements on Apple Macintosh, Atari, Sharp and IBM PCs.[600] Western computers, though often out of reach for most Czechs and Slovaks in the early 1990s, quickly supplanted domestic models in their imagination and focus, even if practical necessity dictated delaying consumer bliss. Czechs and Slovaks had to move forward as self-reliant users, DODOs on Didaktiks, just a while longer.

[599] Pajas in discussion with the author; Zlatuška in discussion with the author.
[600] *Věda a Technika Mladeži* 43, no. 1-24, (1989) and *Věda, Technika a My* 45, no. 1-12, (1991).

Epilogue: The Spirit of Radio

All this machinery/
Making modern music/
Can still be open-hearted/
Not so coldly charted/
It's really just a question/
Of your honesty, yeah, your honesty/

One likes to believe/
In the freedom of music/
But glittering prizes/
And endless compromises/
Shatter the illusion/
Of integrity …[601]

Where the commoditization of computing in the West, and the powerlessness of consumers rather than users, might lead was evident in a *Motherboard* report published in 2017, entitled "Why American Farmers are Hacking Their Tractors with Ukrainian Firmware." Farmers in Nebraska were in an open state of rebellion against a company they had relied upon for generations—the $60 billion colossus John Deere. Newly embedded software prevented anyone besides authorized John Deere technicians, who charged fees of hundreds of dollars an hour, from repairing their latest tractors and combine harvesters. Nebraska farmer Kevin Kenney complained that the only people he could turn to for help were "technicians running around here with cracked Ukrainian John Deere software that they bought off the black market."[602] Consumers habituated to computer powerlessness, without tacit knowledge or control over the machines integrated into every aspect of their lives, rely increasingly on technically skilled users.

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[601] Rush, "The Spirit of Radio," recorded 1979, track 1 on *Permanent Waves,* Mercury Records, March 1980, vinyl record.

[602] Jason Koebler, "Why Americans are Hacking Their Tractors with Ukrainian Firmware," *Motherboard*, (March 21, 2017). Available from: https://motherboard.vice.com/en_us/article/why-american-farmers-are-hacking-their-tractors-with-ukrainian-firmware. Accessed March 26, 2017.

In Ukraine and elsewhere around the world, these users emerge from shifting liminal societies characterized by material scarcity and the tinkering, repair and machine mastery that scarcity by necessity engenders. As Erin McElroy points out in the case of Romania, the growing market share, customer services and reliable stockholder dividends that Western companies such as Microsoft, Oracle and IBM generate depend on exploiting the moving frontier of low-wage, highly skilled users from recent or contemporary scarcity societies in East Central Europe and elsewhere (India, the Philippines). What McElroy refers to as "Silicon Valley imperialism," is ironically built on an unintentionally successful legacy of state socialist societies: their citizens.[603] Transitioning from the margins to the center, Czechs, Slovaks and their post-communist neighbors in East Central Europe have a recent past, which we have examined here, that includes these elements of scarcity, a flourishing hobbyist life and advanced technical education, and which continues to foster innovation in permitted and illicit engineering, programming and services.

One way to distinguish between markets where innovation has reached a plateau and ones where it continues to occur is how opaque a technology has become for everyday users. The first generation of personal computer owners assembled hobbyist kits, and later microcomputers such as the TRS-80 relied on an enthusiast community that wrote early software "on the metal" in machine code. As historian Melanie Swalwell noted in the case of Australia, early microcomputers were mostly only useful for playing games, but to become a consumer of computer games was to transform into a user. "Users typically learnt some simple programming

[603] McElroy defines Silicon Valley imperialism as "the global condition in which Silicon Valley's existence is necessitated by its unending growth, in which, zombie-like, it penetrates and devours people's intimate lives and personal data while also consuming global and even outer space imaginaries in novel ways." Erin McElroy, "Unbecoming Silicon Valley: Techno Imaginaries and Materialities in Postsocialist Romania," PhD dissertation, UC Santa Cruz, 2019: 5; Erin McElroy, "'The Most Dangerous Town on the Internet': And the Cold War 2.0," *Obieg* 13 (2019). Available from: https://obieg.u-jazdowski.pl/en/numery/the-speed-of-guccifer/-the-most-dangerous-town-on-the-internet-and-the-cold-war-2-0.

while playing games, especially in the early days, as in order to play a game you either had to type in the source code, or type commands to load and run it. Many hobbyists began to write games," which "marked the beginning of an Australian software industry."[604] Users understood their machines inside and out. They had to. Throughout the 1970s in America and elsewhere, microcomputer hardware was expensive and underpowered. Computers at that time were "a technology in search of a use," as Swalwell observed.[605] Users began pushing limits immediately, adding in RAM chips that allowed them to play more complex games and writing simple word processing and spreadsheet programs. Scarcity drove isolated enthusiasts toward one another in clubs, magazines and infant business ventures like Ed Roberts' MITS in New Mexico in the 1970s, or the tiny software cooperative that Eduard Kučera and Pavel Baudiš formed from their collaboration at VÚMS in 1988, which would become Avast Antivirus, the world's largest contemporary network security provider.

Subsequently, the geeks-to-riches stories of Bill Gates and Steve Jobs convinced many that American success with personal computers was inevitable, the product of risk-taking entrepreneurialism. "No one had realized just how primed the market was for a personal computer," Freiberger and Swaine observe. "The [MITS] Altair was the fruit of a technological revolution that dropped straight into the hands of a hungry population."[606] User clubs, magazines and self-published books like Nelson's *Computer Lib/Dream Machines* were largely forgotten by the public. Yet the computer counterculture of the 1970s designed their values into the earliest personal computers and their eventual inter-network, the Internet. Hobbyist enthusiasm in the counterculture, and their embedded values, established an early foothold for microcomputers at a

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[604] Melanie Swalwell, "Questions about the Usefulness of Microcomputers in 1980s Australia," *Media International Australia* 143, no. 1 (2012): 69.
[605] Swalwell, "1980s Home Coding," 194.
[606] Freiberger and Swaine, *Fire in the Valley: The Making of the Personal Computer*, 2nd ed. New York: McGraw-Hill, 2000: 50-51.

time when they lacked an otherwise compelling use case. The truly personal computer was supposed to vanquish what Nelson called "the peon/executive dichotomy" that was "a traditional aspect of IBM products," and strongly associated with the centralized mainframe computing of the military, the government and big corporations.[607] Levy (*Hackers*) argues that early computer users had in common "a philosophy of sharing, openness, decentralization, and getting your hands on machines at any cost to improve the machines and to improve the world."[608] To paraphrase Zajíček, these hobbyists were a flock of DODOs.

Making money came second to them. A number of writers, including Fred Turner, John Markoff and Katie Hafner assert that this computer counterculture was the key to silicon success in the 1970s and 1980s.[609] These hobbyist beliefs and actions stood in stark contrast to the resigned fatalism of Langdon Winner, who declared in his 1978 work *Autonomous Technology* that "no matter who is in a position of control, no matter what their class origins or interests, they will be forced to take approximately the same steps with regard to the maintenance and growth of technological means."[610] Nevertheless, for a time before and shortly concurrent to their adoption as business machines (Freiberger and Swaine date their commoditization to the end of

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[607] Ted Nelson, "What Will IBM Do Next?" *Computer Lib/Dream Machines*, South Bend, Indiana: Self Published, 1974.

[608] Levy, *Hackers*, vii.

[609] "While the acousticians usually came to work in jackets and ties, the atmosphere on the computer side was decidedly more relaxed. 'When we got into the computer business we had the strangest people working for us,' said Beranek. He appreciated the brilliance of the people [Licklider] hired but seldom felt comfortable around them. He recalled being invited to a New Years' Eve party at the home of a computer engineer around 1965. 'It was like going to the Addams Family house,' Beranek said. 'They were all in bare feet. The women were wearing tight-fitting clothing. I showed up with a tie on and had to take it off.'" Hafner and Lyon, *Where Wizards Stay Up Late*, 87; "Forgotten among the thousands of great fortunes since made from the personal-computing industry is the simple fact that the foundation for the industry was laid not by entrepreneurs but rather by a political activist and a group of hobbyists whose original motivation was sharing information." Markoff, *What the Dormouse Said*, 192.

[610] Langdon Winner, *Autonomous Technology: Technics-Out-of-Control as a Theme in Political Thought*, Cambridge, Massachusetts: The MIT Press, 1978: 263-264.

the 1980s in the United States) microcomputers for early adopter hobbyists were a radically open platform for experimentation, creativity and forms of play.[611]

As Christina Lindsay notes, microcomputers were far more open to new forms of use and cultural meaning for hobbyists around the world in the 1970s and 1980s because there were no settled scripts yet defining for what these machine were useful and for whom they should be used. The TRS-80 (Tandy Radio Shack) microcomputer, for example, was the creation of hardware engineers—much like the Ondra and Maťo in Czechoslovakia—who were uncertain what the market of end users might look like, if not themselves. Meanwhile the CEO of Tandy thought perhaps business owners might adopt it for office work.[612] The result of an open-ended machine was an international burst of creativity, and a rapid growth in communities of technical enthusiasts and hobbyists who organized around computers into networks of cultural, social, economic and political exchange.

In Czechoslovakia, computer enthusiasts embraced micros. "The computer offered a seemingly infinite space for exploration and self-realization in a society that tended to close off opportunities rather than open them. … In computer clubs and at homes, thousands of people were left alone with their computers—presumably to train for their industry and military jobs—and in the process co-created a grassroots communication network that allowed them to address thousands of others," in *zines*, newsletters, virtual *samizdat* and coding acts like games, hacks and manifestos.[613] In Britain, the hobbyist community that coalesced around the BBC Micro engaged in an unprecedently large scale effort, called the Domesday Project, to map "life in the

[611] Freiberger and Swaine, *Fire in the Valley*, 360-361.
[612] Christina Lindsay, "From the Shadows: Users as Designers, Producers, Marketers, Distributors, and Technical Support," in Nelly Oudshoorn and Trevor Pinch, eds., *How Users Matter: The Co-Construction of Users and Technologies*, Cambridge, Massachusetts: The MIT Press, 2003: 36-37.
[613] Švelch, *Gaming the Iron Curtain*, 185-187.

UK in 1986, from the everyday to national treasures such as artifacts in museums and art galleries."[614] Although far too ambitious for the technology of the time (it relied on early hypertext encoded on specially prepared laser discs typically too expensive for most schools to purchase the necessary equipment) it was an indication of the kinds of creative projects that flourished in the hobbyist user scene in the 1980s.

PCs owe their ubiquity today to that early and creative community of hobbyists. Or, as Brand put it in a 1995 *Time Magazine* essay: "We owe it all to the hippies."[615] Underpowered toy microcomputers had no utility for businesses, the military or bureaucracies—the classic computer customers. Meanwhile, inventors never profitably commercialized groundbreaking innovations—the graphic user interface, the computer mouse, the WYSIWYG text editor or Ethernet. Those became industry standards when early users appropriated and shared them in line with the "hacker" ethos. As Hafner and Lyon pointed out in the case of the community embracing the TCP/IP protocol compared to its rivals: "Perhaps what TCP/IP had to recommend it most was the fact that it was unerringly 'open.' Its entire design was an open process, following a path first blazed by Steve Crocker and the Network Working Group and continuing into the Internet. The ARPANET, and later the Internet, grew as much from the free availability of software and documentation as from anything else."[616] Openness, efficiency, utility and displays of craft skill were what mattered far more than profitability to the computer user community both in Czechoslovakia and the West.

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[614] Gazzard, *Now the Chips Are Down*, 146.

[615] "Most of our generation scorned computers as the embodiment of centralized control. But a tiny contingent - later called 'hackers' - embraced computers and set about transforming them into tools of liberation. That turned out to be the true royal road to the future." Stewart Brand, "We Owe it All to the Hippies," *Time Magazine* 145, no. 12 (March 1, 1995).

[616] Hafner and Lyon, *Where Wizards Stay Up Late*, 251.

As we saw in earlier chapters, Czech and Slovak computer users shared many elements of the hacker ethos with their counterparts abroad since scarcity, craft traditions and technical enthusiasm for the machine and its possibilities tended to attract similar groups of young male technophiles who were connected to one another across borders by the circulation and consumption of ideas in the popular and professional technical press (newsletters like DECUS, in the case of Bartošek, the *Communications of the ACM*, the *Byte* magazine Fuka's uncle in America sent him).[617] These users and their communities, organized around a technical artifact (the computer), had in turn grown out of the older and well-established amateur radio community from the mid-century—the spirit of radio often passing from father to son. Ham radio enthusiasts had a similar demographic and values profile, as Kristen Haring and Lécuyer have shown, a largely masculine community that emphasized open standards, education, and prestige through demonstration of technical competency.[618]

That ethos in turn nestled comfortably alongside the "socialist sharing" of computer enthusiasts in 1980s' Czechoslovakia, where the shelves were bare but the tape drives were busy making software copies for one's friends, family and colleagues. Just how extensive a phenomenon socialist sharing was can be tricky to reconstruct quantitatively from oral interviews and ephemeral documents. The computing scene was certainly highly active, and produced more computer games in Czechoslovakia for the popular ZX Spectrum platform (92) than any other country in the CMEA bloc, including more populous Poland (53 games) and the USSR (7).[619] Interviews with subjects like Beneš and Fuka, a customer and a black/gray marketer, lend the impression that such sharing of domestic and imported software took place on a continuous small

[617] Bartošek in discussion with the author; Fuka in discussion with the author.
[618] Haring, *Ham Radio's Technical Culture*, 17.
[619] Švelch, *Gaming the Iron Curtain*, 163.

scale among friends, club members and social acquaintances in the towns and villages of the country, supplemented by occasional trips to the big city (in Beneš' case, from Rakovník to Prague by bus, a comparatively short hour long journey).[620] Users like Petr Geža in Zlín seem to have been an outlier, offering in 1989 to swap or sell their list of "circa 600 programs and games" for the Sinclair ZX Spectrum and Spectrum 128.[621] However, it is clear that abundance (for some) was one possible outcome of the informal economy of computing in Czechoslovakia.

Market failures like software copying led inevitably to some monetary losses in the short run, difficult to assess, but also to early personal computers spreading more quickly, without each separate innovation gated behind patents and license fees. Bill Gates complained to hobbyists in the 1970s that his Microsoft BASIC language was copied and disseminated for free, leading to widespread derision of Gates in a community that prided itself on sharing. Ironically, as '70s hobbyist Steve Dampier noted, widespread piracy of BASIC meant that everyone was familiar with it. Later on, it became a profitable worldwide standard for Microsoft.[622] In Czechoslovakia, widespread computer adoption by thousands of users would not have occurred as successfully prior to 1989 if the government had not funded—in howsoever scattershot and uncoordinated a fashion—the batch production of thousands of domestic microcomputers like the PMD 85, IQ 151 and Didaktik machines, and then distributed those to clubs and schools. Additionally, for those Czechs and Slovaks who spent small fortunes acquiring micros on the foreign market or through Tuzex, the availability of free or inexpensive software hacked, translated and distributed by the clubs made the financial burden of early adoption palatable.[623]

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[620] Beneš in discussion with the author; Fuka in discussion with the author.
[621] "Petr Geža" in "Redakční oznamovatel" (Editorial Notification), *ABC Mladých Techníků a Přírodovědců* 34, no. 6 (1989).
[622] Levy, *Hackers*, 234.
[623] Švelch, *Gaming the Iron Curtain*, 152.

From the beginning home computers were a potentially uncomfortable fit for traditional capitalism, *tout court*, not only for Bill Gates' Microsoft. Scholars such as David Farber and Raymond Williams have rightly identified capitalism's amoeba-like quality of adapting to and profiting from the counterculture's every effort to transform or escape from it. Williams noted the difficulty, in his 1977 work *Marxism and Literature*, of even distinguishing what elements of the counterculture "are substantially alternative or oppositional to it [the dominant, capitalist culture]" as opposed to simply a natural outgrowth.[624] However, it is important to read against the grain of a history of computing focused on innovation and the accumulation of wealth in Silicon Valley.

The computer represented, for the slice of counterculture that embraced it, not just a "right livelihood" to balance personal profit with social desire, as the Grateful Dead aimed for in the 1960s, but a powerful open-ended tool in their hands that might change all livelihoods: might extend the mind, alleviate alienation from technology and foster an explosion in the personal, unmediated creation and distribution of arts and letters.[625] As Nelson pointed out in his article "No More Teacher's Dirty Looks," integrating computers into American classrooms held the potential of revolutionizing instruction and learning. Yet "what happens?" Nelson asked "Many of the inhumanities of the existing system, no less wrong for being unintentional, are being continued into computer-assisted teaching," because administrators, teachers and school board officials gave little to no systemic thought to the computer-as-ecology, and simply inserted the machine into classrooms.[626] That personal computers were adopted into capitalist societies primarily as consumer commodities and business machines should not diminish the challenge

[624] Raymond Williams, *Marxism and Literature*, Oxford: Oxford University Press, 1977: 123.
[625] David Farber, "Moral Capitalism in the Age of Great Dreams: The Grateful Dead's Struggle to Craft Right Livelihoods," *The Sixties: A Journal of History, Politics and Culture* 10, no. 1 (2017): 67.
[626] Ted Nelson, "No More Teacher's Dirty Looks," *Computer Lib/Dream Machines*, South Bend, Indiana: Self Published, 1974.

they initially represented. This tension ran in parallel to the many observers who argued state socialist societies struggled with their subversive ideological potential and could not adequately replicate or understand the individualist spirit, entrepreneurship and embrace of risk that successful computer companies displayed. Christophe Lécuyer refers to the "meritocratic and resolutely capitalistic" semiconductor community at Intel and Fairchild which in the '70s spawned "Innovator-entrepreneurs … [who] developed unusual financial incentives for their work force: profit-sharing programs, stock ownership, and stock option plans."[627] Computers in this view were yet another "new frontier" to be explored and conquered by these "cowboy capitalists" from California.

In comparison, the most socialist managers could offer their computerist employees in the research institutes and large enterprises was guaranteed employment and plenty of downtime for their own projects. It suited many, as we saw in the case of Trojan and Chvatík, but it was also an economic inefficiency, a sore spot for the government. According to a report in *Tribuna*, in the city of Prague alone in 1985 one government commission found 90 different *types* of computers, many obsolescent and incompatible, too "difficult to complement with necessary peripheral equipment" for them to function. "Many reliably functioning systems from socialist states thus have to be equipped with peripheral devices from nonsocialist countries, especially disk units, printers and terminals." Making square pegs fit into round holes was a time-consuming craft process unique to each individual machine's use case and need, and waiting for the right parts could stretch into months or years. Czech and Slovak technicians were often left in the odd limbo of being simultaneously swamped with work while apparently idle.[628]

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[627] Lécuyer, *Making Silicon Valley*, 296, 299.
[628] Jan Belda, "Výpočetní Techniky v Praze" (Computers in Prague), *Tribuna* no. 15 (April 10, 1985) and no. 19 (May 15, 1985).

Cortada's retrospective assessment of computerization in societies like Czechoslovakia in *The Digital Flood* (2012) was damning. "The centralized approach to managing technology and the economy simply did not work as effectively as the more decentralized ways common in market-driven economies of the pan-Atlantic community and other non-Communist states."[629] Yet pioneering firms like MITS Altair, Commodore Business Machines and Tandy died or dwindled. Innovations at research centers like Xerox's PARC were successfully commercialized, but by other companies, later, in what would amount today to blatant intellectual property theft.[630] Innovators and inventors themselves received little, sometimes nothing, of the great accumulation of wealth. IBM's beige box business triumphed. Personal computers introduced into the workplace as "business machines" by employers failed to spark significant productivity gains and undermined enthusiasts' vision of the computer's liberating potential.

In *Priming the Pump*, hobbyist programmers David and Theresa Welsh noted that businesses in the West locked down their computers, disabling certain features, monitoring employees' activities extensively, and turning machines of manifold possibilities into glorified typewriters. This killed the spirit of tinkering and openness central to the early leaps made by the community in the 1970s and 1980s.[631] In 2020, in the midst of a global pandemic that has forced many workers to retreat from the office into their homes, concerns abound over the loss of privacy from intrusive corporate spyware inserted into workers' computers by managers worried about excessive leisure and loss of productivity.

The most commonly used tool for video-conferencing was the ubiquitous Zoom, but like most enterprise software it was riddled with security vulnerabilities, unpatched and exploitable

[629] Cortada, *The Digital Flood*, 303.
[630] Ceruzzi, *A History of Modern Computing*, 261.
[631] David Welsh and Theresa Welsh, *Priming the Pump: How TRS-80 Enthusiasts Helped Spark the PC Revolution*, Ferndale, Michigan: The Seeker Books, 2011: 350-351.

backdoors, and significant privacy and consent problems that made deploying it at scale a disaster for workers' rights and personal privacy.[632] Cryptographer Bruce Schneier commented: "Zoom spies on its users for personal profit. It seems to have cleaned this up somewhat since everyone started paying attention, but it still does it. … Zoom's security is at best sloppy, and malicious at worst."[633] The common theme present in narratives of locked-down John Deere tractors, PCs turned into "business machines" and intrusive enterprise spyware is a closed culture of mistrust and abusive monetization directed at users by private companies that seek to maintain control of these means of production. As centralized computing re-emerges as an oligopolistic Internet of vertically-integrated "stacks" like Amazon, Microsoft, Facebook, Google, Apple and Baidu, users lose local, tactile control of their own letters, maps, home videos, recipes and intimate moments, which become commoditized as data to be repackaged and sold beyond the user's ken.[634] When Ed Fredkin, the inventor of reversible computing at MIT, traveled to the Soviet Union in the early 1990s, he presciently told colleagues there that in some respects socialism might have suited personal computing just as well if not better than capitalism.[635]

This was far from the conventional view. As noted, state socialist societies did not produce or otherwise diffuse (including imports) computers in the same numbers, or even approaching the scale, of Japan and most Western countries. According to contemporary reports,

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[632] Drew Harwell, "Thousands of Zoom video calls left exposed on open Web," *The Washington Post* (April 3, 2020). Available from: https://www.washingtonpost.com/technology/2020/04/03/thousands-zoom-video-calls-left-exposed-open-web/; Mark Hachman, "Update: Zoom issues fix for UNC vulnerability that lets hackers steal Windows credentials via chat," *PC World* (April 2, 2020). Available from: https://www.pcworld.com/article/3535373/report-hackers-can-steal-windows-credentials-via-links-in-zoom-chat.html.

[633] Bruce Schneier, "Security and Privacy Implications of Zoom," Personal Web Log *Schneier on Security*, (April 3, 2020). Available from: https://www.schneier.com/blog/archives/2020/04/security_and_pr_1.html.

[634] Bruce Sterling, "Bruce Sterling, Cory Doctorow & Jon Lebkowsky: State of the World 2015," *The WELL* (January 5, 2015). Available from: https://people.well.com/conf/inkwell.vue/topics/478/Bruce-Sterling-Cory-Doctorow-Jon-page01.html#post6.

[635] Andrei Soldatov and Irina Borogan, *The Red Web: The Struggle Between Russia's Digital Dictators and the New Online Revolutionaries*, New York: Public Affairs, 2015: 20.

Czechoslovakia in 1980 possessed fewer than 1,500 computers countrywide.[636] That same year, the Commodore VIC-20 alone surpassed one million units sold. Even after the Velvet Revolution in 1989, Czech households did not catch up to American households in average computer ownership until 2007.[637] And it is this marker—how many computers does a society have access to, and how advanced are they?—that has predominated in histories of computing undertaken from the high vantage points offered by the global success of Silicon Valley.

One prominent example is Paul Freiberger and Michael Swaine's *Fire in the Valley*, originally published in 1984, re-issued again in 2000, and then re-issued a third time in 2014 with a title change proclaiming the death of the personal computer.[638] This triumphalist history has all but erased the views of computer technologists like Fredkin, who believed that there were aspects of socialist ideology, in particular a focus on youth programming instruction and public ownership, which meshed promisingly with the personal computer revolution. He was particularly enthusiastic for the approach championed by academician and computer scientist Andrei Ershov in the Soviet Union: Programming and computer science instruction would be oriented toward mathematics and elegantly sparse programming practice (rather than relying upon increasingly powerful hardware to disguise sloppy craft work).[639] Histories of computing

[636] František Marek, "The Principles for Proper Management of Electrical Power are Also True for Computer Technology," *Energetika* 31, no. 7 (1981): 301-305; "1000 komputerów w Czechosłowacji," *Przegląd Mechaniczny* 37, no. 11 (1978): 2.
[637] Organization for Economic Cooperation and Development, "Data on Computer Ownership in the Czech Republic, 1990-2015," OECD Data on Czech Republic, 2016.
[638] Paul Freiberger and Michael Swaine, *Fire in the Valley: The Making of the Personal Computer*, New York: Osborne/McGraw-Hill, 1984, 2000; Paul Freiberger and Michael Swaine, *Fire in the Valley: The Birth and Death of the Personal Computer*, Raleigh, North Carolina: The Pragmatic Bookshelf, 2014.
[639] Paul R. Josephson, *New Atlantis Revisited: Akademgorodok, the Siberian City of Science*, Princeton, New Jersey: Princeton University Press, 1997: 138, 145-146. "As historian of Soviet science Greg Crowe points out, in many respects Soviets were far more computer literate than many Americans. The average computer science student at the university was a much better programmer and engineer than his American counterpart. One man Crowe met spent a month reducing the size of a layover program for Microsoft Word that would produce Cyrillic so that it would fit into 17K instead of about 60K [of memory]. Why the emphasis on program size? Because he did not have enough twenty-five-cent floppy discs to hold the bigger version."

like *Fire in the Valley*, focused only on the richest and first, also perpetuate damaging myths about the "right path" of technological innovation which obscure the environmental damage, labor exploitation, industrial espionage, bankruptcies, patent wars and government subsidies that contributed to that success, as W. Patrick McCray recently (2019) pointed out in *The Los Angeles Review of Books*.[640]

Fredkin discerned something important about the capacity for computing to be adopted by socialist and capitalist systems alike. Masked by the ideological propaganda of the Cold War, societies on both sides of the Iron Curtain were essentially technocracies. Socialists and capitalists alike subscribed to social progress measured by technological prowess. In an October 1987 editorial in *Mikrobáze*, for example, Zajíček compared Czechoslovakia unfavorably to the more open markets of Hungary and Poland, which allowed programmers to organize and earn money as software cooperatives and abolished imports on foreign computers to increase access to the machines. "The responsible institutions of these countries do not put administrative obstacles in the way of development, because they understand that their implementation would go against the needs of society," he argued.[641] In the mind of Zajíček and his readers, both "development" and "the needs of society" could only be met in one way—through more computers, and catering to technicians' desires for craft autonomy and fiscal livelihoods.

Theodore Roszak agreed, arguing that behind nominal Cold War divisions, certain shared assumptions, such as the valorization, even fetishization, of "industrial efficiency, rationality,

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[640] W. Patrick McCray, "Silicon Valley: A Region High on Historical Amnesia," *The Los Angeles Review of Books* (September 19, 2019). Available from: https://lareviewofbooks.org/article/silicon-valley-a-region-high-on-historical-amnesia/.

[641] "Odpovědné instituce těchto zemí nekladou rozvoji do cesty administrativní překážky, protože chápou, že jejich uplatňováním by šly proti společenským potřebám." Zajíček, "Než nám ujede šestnáctka," 3.

and necessity," drove state and corporate policies.[642] The computer embodied those values. Whether pictured as electronic brains or cybernetic servants, computers fascinated engineers in the free world and the socialist camp for their potential to guide missiles, store records and better organize production. Paul R. Josephson observed "computer science and technology were seen in the USSR as a panacea for a whole range of social and economic problems."[643] Contemporary historians are increasingly discovering that cultural differences and policy decisions played a larger role in creating societies of minimal computer diffusion than the nature of the system itself.

In *How Not to Network a Nation*, Peters builds on the earlier work of Slava Gerovitch to point out that the creation and eventual success of the Internet in the United States is owed to intelligent top-down government management, extensive subsidies and scientists' mutual collaboration. In the USSR, meanwhile, he argues that work on a similar system floundered as bureaucracies competed with one another for scarce funding absent any firm coordinating hand.[644] In chapter one, we observed this kind of process in the computer chaos of 1960s' Czechoslovakia: A heterarchical balance between mid-tier institutions such as large state enterprises, government ministries, universities and research institutes which constitute the *mesocosm*. Although retrograde, chaotic and frustratingly opaque to state planners, heterarchical competition (between mesocosmic institutions) and heterogeneous engineering (the microcosmic bricolage and negotiation of technologists' everyday lives) formed an adaptive set of tactics that slowed down the unmanageable pace of technological change.

[642] Roszak quoted in Magali Sarfatti Larson, "Notes on Technocracy: Some Problems of Theory, Ideology and Power," *Berkeley Journal of Sociology* 17 (1972-73): 6.
[643] Josephson, *New Atlantis Revisited*, 122.
[644] Peters, *How Not to Network a Nation*, 193; Slava Gerovitch, "InterNyet: Why the Soviet Union did not build a nationwide computer network," *History and Technology* 24, no. 4 (December 2008): 340.

This bought time, status and autonomous niches for computer technologists in state socialist societies. However, in the midst of the microelectronics crisis of the 1980s, this stable system of computing proved insufficiently responsive to top-down government initiatives in computer production and distribution and excessively dismissive toward bottom-up efforts at introducing microcomputers to Czechs and Slovaks through youth clubs and schools. “I had no need for doing that [taking part in education or software creation/exchange in the clubs],” Gruska remarked. “Actually, I never heard of them.”[645] Older professionals like Gruska frequently already enjoyed satisfactory, privileged access to much more powerful mainframe and mini-computers at their workplace, a generational cleavage that may have also slowed computer adoption in Czechoslovakia.

The community values and political aspirations of the computerist community, however, largely united Czechs and Slovaks across demarcations of age and professional employment. They were often articulated by prominent figures in the field, such as Zajíček, Hořejš, Havel and Franěk, who circulated their ideas—informed by an international countercultural and ideological discourse among engineers and other technicians—in forums like SOFSEM, the youth clubs, and the pages of the popular and professional technical press. Science fiction too, as observed in chapter three, was both a common interest and a *lingua franca* for computer enthusiasts everywhere to hash out technological, moral and political visions of the future. This often played out as a countercultural or dissenting act, whether promoting ideas of political reform coded in sci-fi discourse, or fighting a blinkered university bureaucracy at MIT.[646] When this global computer counterculture of the 1970s and ‘80s was accidentally creating a world-dominating

[645] Gruska in discussion with the author.
[646] “The university administration required that all rooms in the facility be numbered, but the SAIL researchers supplied the school with a detailed map in which each office was named after a place in Tolkien's Middle Earth. The whimsy was lost on the university's bureaucrats, who came out and placed conventional numbers throughout the building.” Markoff, *What the Dormouse Said*, 107.

industry, they never dreamed that corporate titans like John Deere would abuse intellectual property laws to bleed farmers dry. Most of them would have laughed at the concept of exclusively monetized intellectual property. They would have been horrified to own a machine they could not totally open up, thoroughly understand and freely modify or improve. The networked personal computer was initially a reflection of its creators' values: An open architecture, free information, unlimited access to the machine, and a mistrust of authority.

The capitalist solution to this technology's possibilities—to books, films, music and ideas that have virtually no marginal cost to copy and share—has been to insert ever-more intrusive DRM, or digital rights management, software in order to restrict users from their own media and leash them tightly to a pre-digital model of dumb consumption. When users buy electronic books from Amazon and others, they are only purchasing licenses that companies may revoke at any time.[647] In order to discourage repairs, electronics companies such as Apple solder parts to the motherboard, making them difficult or impossible to replace when they break down or wear out.

This was one of the factors that led to the creation of an entire technical community, so-called "Hackintosh" users "technical enough to jump through numerous hoops, that loves a company's product so much that they're willing to subvert it to get that product in its unvarnished form, because the company's growth [or anti-consumer practices] has left them behind."[648] The entire commercial underpinning of the World Wide Web is intrusive advertising that spies on its users and is notoriously insecure, open to state-sponsored or cowboy hackers

[647] Martin Koksrud Bekkelund, "Outlawed by Amazon DRM," Bekkelund.net, October 22, 2012. Available from: https://www.bekkelund.net/2012/10/22/outlawed-by-amazon-drm/. Accessed March 23, 2017; James Pinkstone, "Apple Stole My Music. No, Seriously." *Vellum Atlanta*, (May 4, 2016). Available from: https://blog.vellumatlanta.com/2016/05/04/apple-stole-my-music-no-seriously/. Accessed March 23, 2017; Aaron Gordon, "People are Jailbreaking Used Teslas to Get the Features They Expect," *Motherboard* (February 11, 2020). Available from: https://www.vice.com/en_us/article/y3mb3w/people-are-jailbreaking-used-teslas-to-get-the-features-they-expect/.

[648] Ernie Smith, "I Hack Because I Love," Tedium.co, (February 12, 2019). Available from: www.tedium.co/2019/02/12/hackintosh-cultural-trend/.

who use the data to target political propaganda and spear-phishing commercial schemes with pinpoint accuracy. Aware of the danger, increasingly savvy users have tried to block these ads with their own free, open source software in an endless arms race, leading *MIT Technology Review* to question the viability of the Internet itself as advertisers realize they are not reaching consumers.[649]

Two decades into the 21st century, we live in a world where computers are more widespread than ever, but where technical expertise and therefore control lies in ever-fewer hands. The United States, where commoditization of computing occurred earliest, is in contrast to Europe (especially the post-communist East), where so-called "demoscenes" of hacking, cracking, coding and sharing software thrived throughout the 1990s in communities linked by "diskmags" like Atari *FLOP* distributed hand-to-hand in Czechoslovakia.[650] Throughout the most developed countries, the scarcity and the computer counterculture that drove the mainline innovations of the 1970s and led to the explosive growth of personal computers in the 1980s are no longer present.

According to Richard Greenblatt, one of the two founders of the American hacker community alongside Bill Gosper, "The real problem … is that business interests have intruded on a culture that was built on the ideals of openness and creativity. … There's a dynamic now that says, 'Let's format our web page so people have to push the button a lot so that they'll see

[649] Emerging Technology from the arXiv, "Connectivity: How Ad Blockers Have Triggered an Arms Race on the Web," *MIT Technology Review* (May 26, 2016). Available from: https://www.technologyreview.com/s/601581/how-ad-blockers-have-triggered-an-arms-race-on-the-web/. Accessed March 25, 2017.

[650] Jimmy Maher, *The Future Was Here: The Commodore Amiga*, Cambridge, Massachusetts: The MIT Press, 2012: 181-184; "*FLOP*: Disketový Atari Magazín" (*FLOP:* Atari Disk Magazine). Available from: http://flop.atariportal.cz/index.php.

lots of ads.'"[651] In an illustration of globalization and Alexander Gerschenkron's "advantages of backwardness," Czech antivirus companies like Avast now protect American computer users from Russian botnets while Ukrainian hackers help Nebraskan farmers circumvent corporate controls. Whether resisting the imposition of state censorship, influencing an election or cracking DRM on films, the digital frontier looks most open and innovative in contemporary East Central Europe. Ershov's dream of what Tatarchenko calls the "digital socialist society" was "imperfectly realized" by the end of communism, but its forked evolution from state socialist origins has nevertheless led to a kind of alternate modernity in which the personal computer and many of the cultural ideals it represented might survive and even prosper.[652]

The promise of that forked modernity, an alternative to the present reality of a centralized, aggressively monetized and diminishingly free computing environment, is well represented by the kind of technicians' syndicalism that was beginning to take shape in Czechoslovakia at the end of the 1980s. It was not the first, or the last, of its kind in the world. As Thomas J. Misa's and Joy Rankin's work on the Minnesota Educational Computing Consortium (MECC), or Stefan Verhaegh and Ellen van Oost on communal wireless infrastructure maintenance in Leiden have shown, computer technologists continue to find means and methods of enlisting themselves, governments, universities, enterprises and the public in ad hoc syndicates that reflect their values and goals.[653] Those cases represent a healthier, more

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[651] Levy, *Hackers*, 454.

[652] Ksenia Tatarchenko, "The Great Soviet Calculator Hack: Programmable Calculators and a Sci-Fi Story Brought Soviet Teens into the Digital Age," *IEEE Spectrum* 55, no. 10 (October 2018): 46-47.

[653] Thomas J. Misa, *Digital State: The Story of Minnesota's Computing Industry*, Minneapolis: University of Minnesota Press, 2013: 202-211; Joy L. Rankin, "How Minnesota Teachers Invented a Proto-Internet More Centered on Community than Commerce," *Zócalo Public Square*, Los Angeles, California: Arizona State University, (February 21, 2019). Available from: https://www.zocalopublicsquare.org/2019/02/21/minnesota-teachers-invented-proto-internet-centered-community-commerce/ideas/essay/; Stefan Verhaegh and Ellen van Oost, "Who Cares? The Maintenance of a Wi-Fi Community Infrastructure," in Tineke M. Egyedi and Donna C. Mehos, eds., *Inverse Infrastructures: Disrupting Networks from Below*, Cheltenham, UK: Edward Elgar Publishing Limited, 2012: 141-160.

sustainable, open and democratic mode of engagement with an important technology that is imbricated ever more intimately into our homes, businesses and bodies.

The lasting influence of the late socialist Czechoslovak computing scene, a technicians' community organized into spontaneous, informal networks around values like openness, public ownership, free or low-cost access to information and technology, can be seen in turn-of-the-millenium DIY networking projects like the Ronja wireless optical data project. Their values and politics were formed more easily by their similar backgrounds, but computer enthusiasts in Czechoslovakia, from scarcity's sake, also shared everyday experiences of use that were "neither socialist nor Western, but rather a deterritorialized mixture of both."[654] While countercultural ideas relating to computer use certainly flowed across the Iron Curtain, Czech and Slovak computer culture was not derivative of the West, but represented rather an evolution, preservation and local appropriation that reflected the reality of a smaller, poorer and non-Anglophone country. Scarcity made computer use a privilege in Czechoslovakia. Scarcity bound users more closely to one another in socio-technical networks and inculcated a respect for the machine, for its full potential and gamut of use. Finally it was scarcity, rooted in the material realities of late socialism, which helped Czechs and Slovaks resist computer commodification into the 1990s and helped transmit traditions of craft, tinkering and maintenance into the twenty-first century.

[654] Švelch, *Gaming the Iron Curtain*, 59-60.

Appendix A: Photos from the 2017 Game On! Exhibition in Prague

Figure 1: The Didaktik Alfa, a clone of the PMD 85-1 produced in Skalica, Slovakia in 1986 and intended for schools. It used Tesla's reverse-engineered MHB8080A microprocessor and had 48 kB of RAM and 4 kB of ROM.

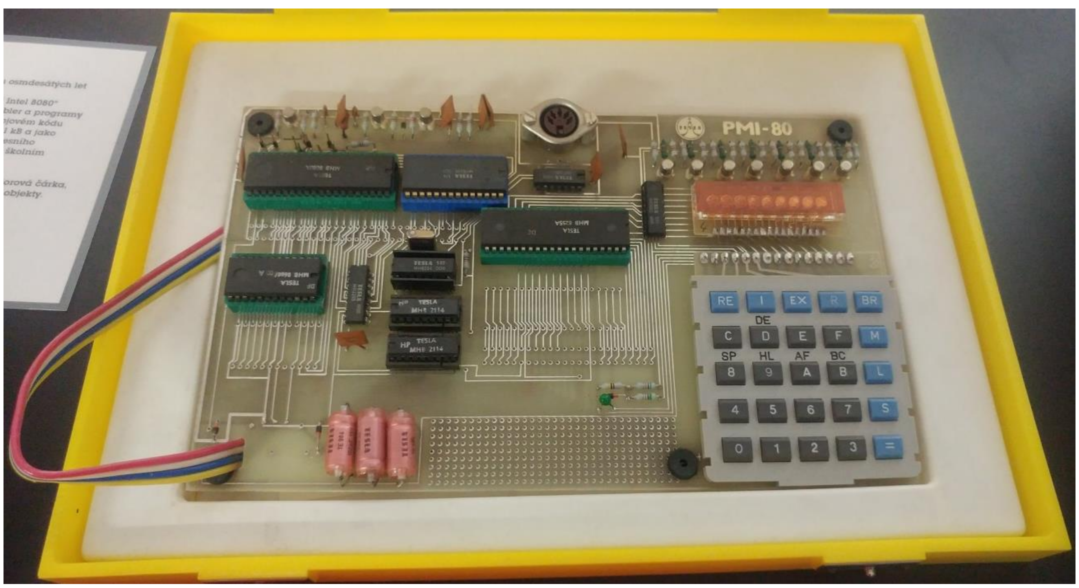

Figure 2: The Tesla PMI-80 (Piešťanský Mikropočítač Intel 8080, referring to its construction at the Piešťany factory in Slovakia in 1982) was an early computer similar in performance to the hobbyist kit machines of the mid-1970s in the United States like the MITS Altair 8800. However, it ran on an underclocked 1.111 MHz Tesla MHB8080A microprocessor, lacked a higher-level programming language (Assembler was used instead), and featured only 1 KB of RAM and 1 KB of ROM.

Figure 3: The Didaktik Gama, a clone of the Sinclair ZX Spectrum and the most commercially successful Czechoslovak computer. Mass production began in Skalica, Slovakia in 1987 and continued until 1992. Unlike other Czechoslovak clone computers, the Didaktik ran on an authentic imported Zilog Z80 microprocessor (not the Tesla MHB8080A), 80 kB of RAM and 16 kB of ROM, and thus featured full software compatibility with the extensive library of the British ZX Spectrum.

Figure 4: The Maťo, a home computer designed by Ivan Urda and produced at State Enterprise Závadka nad Hronom in Slovakia in 1989. A clone of another Czechoslovak computer, the PMD 85, it included a version of BASIC in ROM, ran on an upclocked-but-venerable 2.048 MHz Tesla MHB8080A microprocessor and came with 48 kB of RAM and 16 kB of ROM. Half as expensive as the more popular and powerful Didaktik Gama, it still cost a month's average salary (3,000 crowns).

Figure 5: The IQ 151 was inspired by one of the first commercially successful home computers, the Apple II (1977). Production began at ZPA Nový Bor in 1985, intended to supply Czech schools and using the reverse-engineered Tesla MHB8080A microprocessor. However, the IQ 151 was plagued with quality problems, including overheating, a notoriously difficult-to-use keyboard and components so badly fitted to the motherboard that integrated circuits would regularly detach during normal percussive use, i.e. typing.

Appendix B: Photos from the Brno Technical Museum, 2017

Figure 6: The Consul 2715, produced by Zbrojovka Brno arsenal and office equipment combine in 1983, was a data entry workstation compatible with the IBM 5280 (from 1980). Its CPU was the Tesla MHB 3000, a reverse-engineered clone of the Intel 3000 line of microprocessors from 1974. System RAM varied from 128-512 kB, while initial ROM was limited to 64 kB.

Figure 7: The Consul 2717, otherwise known as the 'Zbrojováček,' was a microcomputer designed for the educational market by the Zbrojovka Brno arsenal and office equipment combine in 1989. While it featured an unusually powerful 64 kB of video RAM, allowing it to support up to a 384 x 256 graphics resolution on an attached display, it remained bottlenecked by its 2 MHz Tesla MHB8080A microprocessor and its operating system, a local instance of Gary Kildall's CP/M from 1974.

Figure 8: The TNS (Ten Náš Systém) SL-64 workstation, designed and produced in 1986 at the JZD Agrokombinát Slušovice in Moravia. Equipped with a built-in mechanical 5.25" disk drive and typically hooked up to a Tesla Merkur television display as shown here, the agricultural cooperative near Zlín produced and sold several hundred units of this computer inside Czechoslovakia in the late 1980s. Advertisements are a large-scale placard (undated) and full-page print ad from the March 1988 issue of *Mikrobáze*.

Figure 9: The PP-06 personal computer, modeled after the IBM PC XT line of computers from 1983 but with a slightly different serial bus configuration, entered production at ZÁVT's Banská Bystrica facility in Slovakia in 1989. Running on an imported Intel 8088 CPU from 1979 and with separate RAM cartridges up to 640 kB, the PP-06 was also one of the last in the SMEP series of small computers produced under the direction of the Soviet-led Unified System of Computers project.

Appendix C: Photos from interview with collector Karel Buďa

Figure 10: From the late 1980s into the early 1990s, many Czechs and Slovaks owned inexpensive imported home computers such as the Commodore 64 and Atari 800. However, software such as games normally circulated on inexpensive but slow-loading cassette tapes, a problem that was addressed by custom after-market homebrew cartridges such as these Expert C 401 (for the Commodore 64) and Turbo 2000 (for the Atari) tape loaders produced by the JRC and RICO collectives in the late 1980s. Homebrew cartridges extended the useful lifetime of these early home computers, even allowing operating systems and user productivity software like Milan Dadok's version of DOS, that would normally only have run on more expensive PCs.

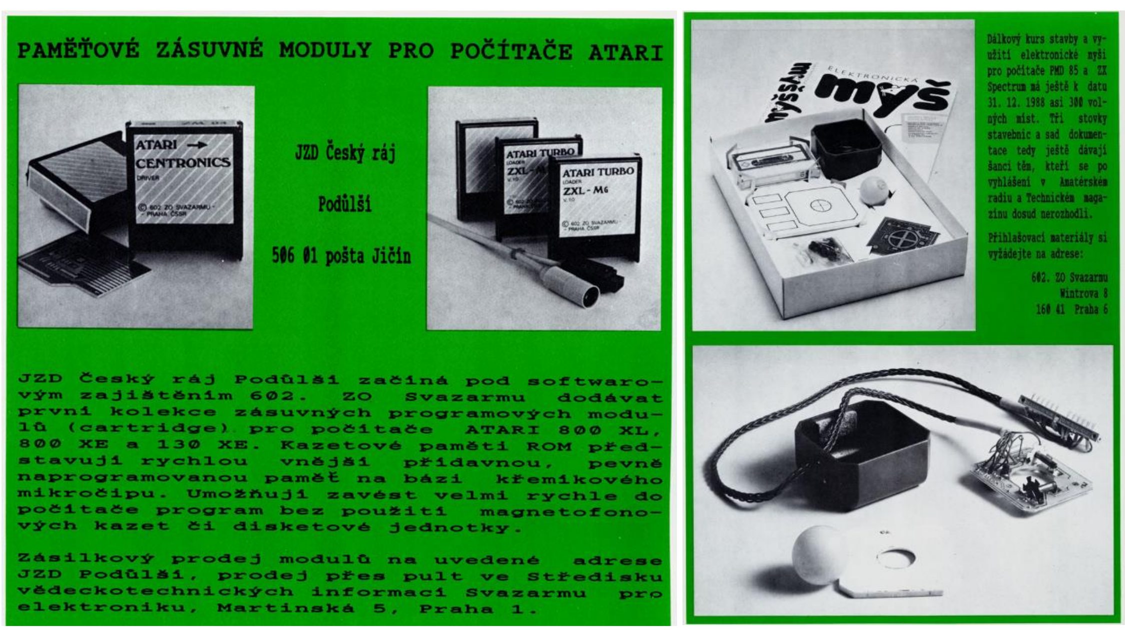

Figure 11: While hacked hardware and homebrew software circulated hand-to-hand in an informal economy, advertisements such as these for tape loaders from JZD Český ráj Podůlší in the October 1988 issue of *Mikrobáze*, and for a September 1988 300-student course in building a computer mouse from available parts, indicate the interconnectedness of a nationwide network of small clubs and cooperatives, the high level of

demand for Czechoslovak-made peripherals and software, and users' efforts to create more formal, transparent spaces for education and transactions within a state socialist environment.

Figure 12: As custom after-market 'hacks' of the hardware, the Czech-made add-on tape loader cartridges had to be hand-wired by users into the cassette drives' serial cables as seen above with a Commodore 64 tape drive from the mid-1980s.

Appendix D: Photos of Principal Interview Figures from SOFSEM

Figure 13: Božena Mannová (left) attends the masked ball at SOFSEM 1983; she (right) listens to a lecture alongside Gruska. All SOFSEM photos courtesy of Miroslav Bartošek.

Figure 14: Jozef Gruska (left), co-founder of SOFSEM and Slovak computer scientist, with two other attendees (Markusová, Lampert), at Sliezský dom, a hotel in the High Tatra mountains in 1974.

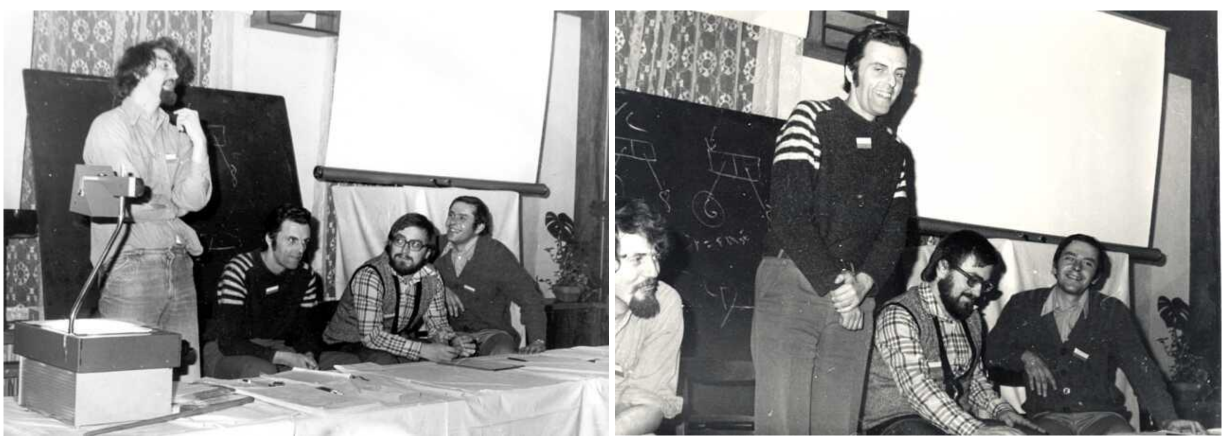

Figure 15: Jan Sokol, second from left, takes part in a panel presentation at SOFSEM 1977 at Pomezní Boudy, a ski resort in the Czech Krkonoše mountains bordering Poland.

Figure 16: A young Jiří Zlatuška (standing, center-left) alongside his mentor, the Czech logician, political dissident and underground educator Pavel Materna (standing, center-right), at SOFSEM 1979 in Labská bouda along the Polish border.

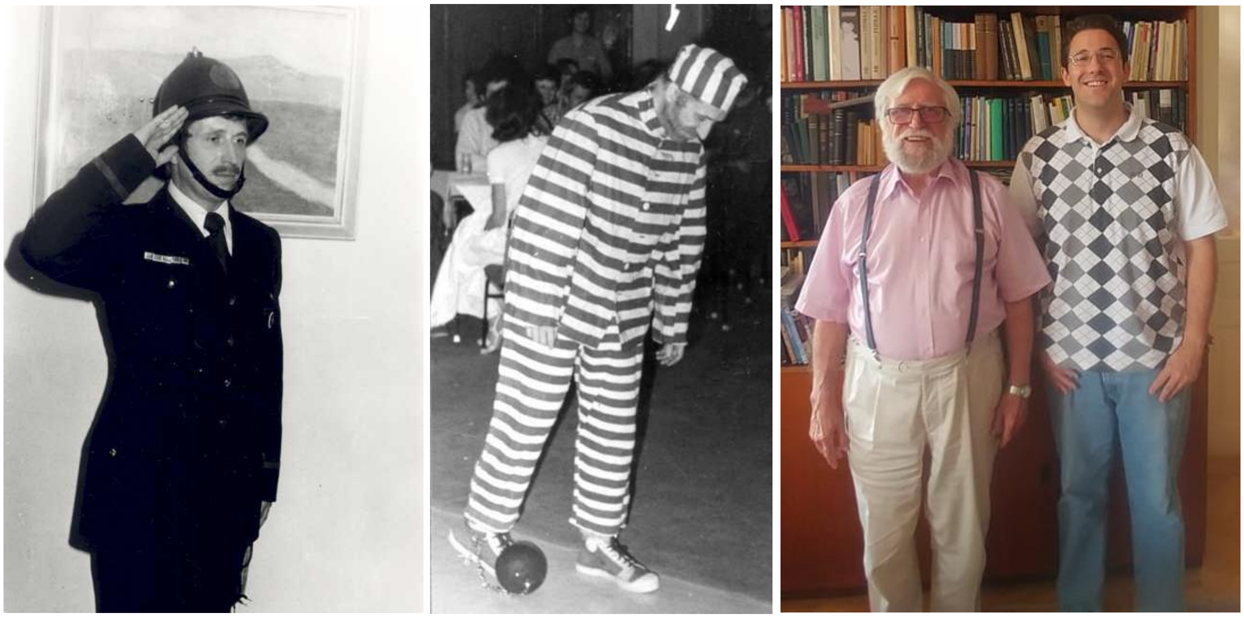

Figure 17: Ivan M. Havel, artificial intelligence expert, stands at attention as part of the masked ball at SOFSEM 1979, as a prisoner in 1981, and in his family home (left) after an interview with the author (right) in June 2018.

Figure 18: Vladimír Smejkal (standing, left), fellow member of the Benešov computer club who testified on Tomáš Smutný's behalf after he was imprisoned for running an illegal computer repair business, takes part in the masked ball festivities of anti-SOFSEM 1980 in Bílý Kříž, a resort in the Beskydy mountains between the Czech and Slovak republics.

Figure 19: Petr Hájek, computer scientist and logician who co-authored a series of articles on machine intelligence with Ivan M. Havel published in *Mikrobáze* in 1988, lectures here at SOFSEM 1982 in Bílý Kříž.

Figure 20: Jiří Hořejš (right; Štefanová on left), at SOFSEM 1982 in Bílý Kříž. The co-founder of SOFSEM along with Gruska, he was a principal figure in the establishment of computer science in Czechoslovakia. The founder of the Institute for Computer Science at Masaryk University in Brno, Hořejš in 1988 co-authored (with Franěk) a series of articles analyzing science fiction in *Mikrobáze*.

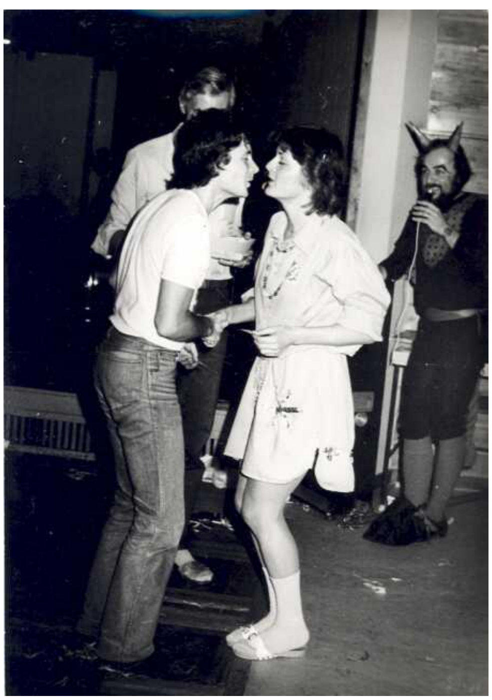

Figure 21: A young Miroslav Bartošek leans in toward his colleague Koňuchová during the Advent season Mikuláš dance at SOFSEM 1985 at the Hotel Magura in Ždiar, Slovakia; Bartošek sits with the steering committee (back row, left) in 1989.

Figure 22: Jiří Franěk (seated, center) at the festivities of SOFSEM 1989, which took place at the Hotel Magura resort in Slovakia in late November, in the midst of the Velvet Revolution. A year earlier, Franěk had collaborated with Hořejš to write a series of critical articles in *Mikrobáze* on science fiction and the political subtext of computing in Czechoslovakia.

Appendix E: Graphs, Maps and Tables

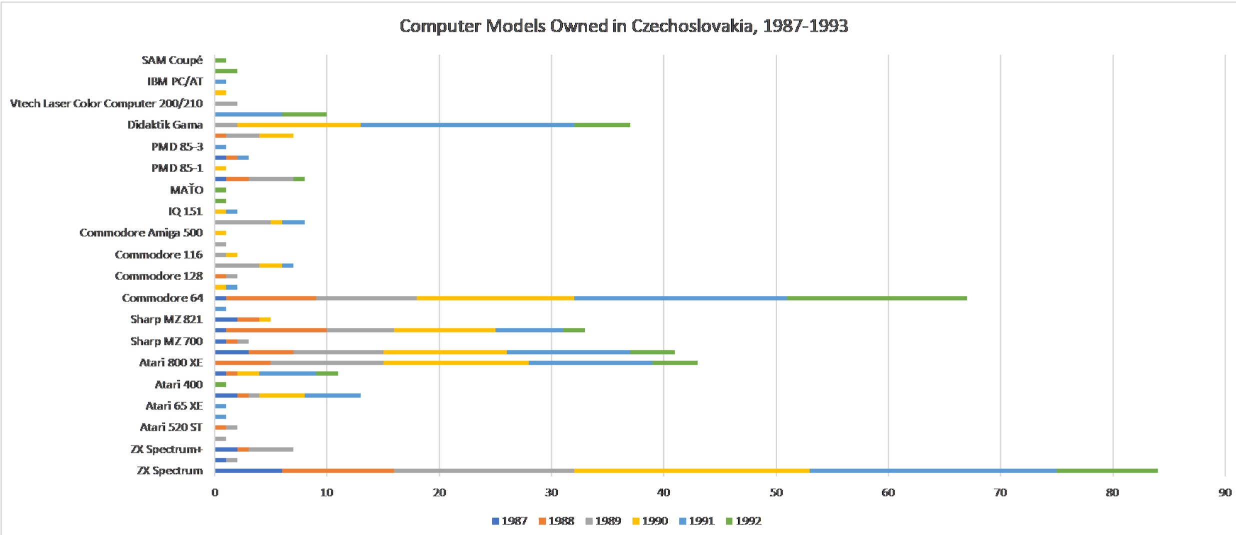

Figure 23: Survey data from six years of classified ads placed in *ABC Mladých Techníků a Přírodovědců* indicates that the most popular home computers in Czechoslovakia were the ZX Spectrum, Commodore 64, Atari 800, Sharp MZ 800 and the Slovak-manufactured Didaktik Gama. However, a variety of more esoteric models co-existed such as the Amstrad CPC 464.

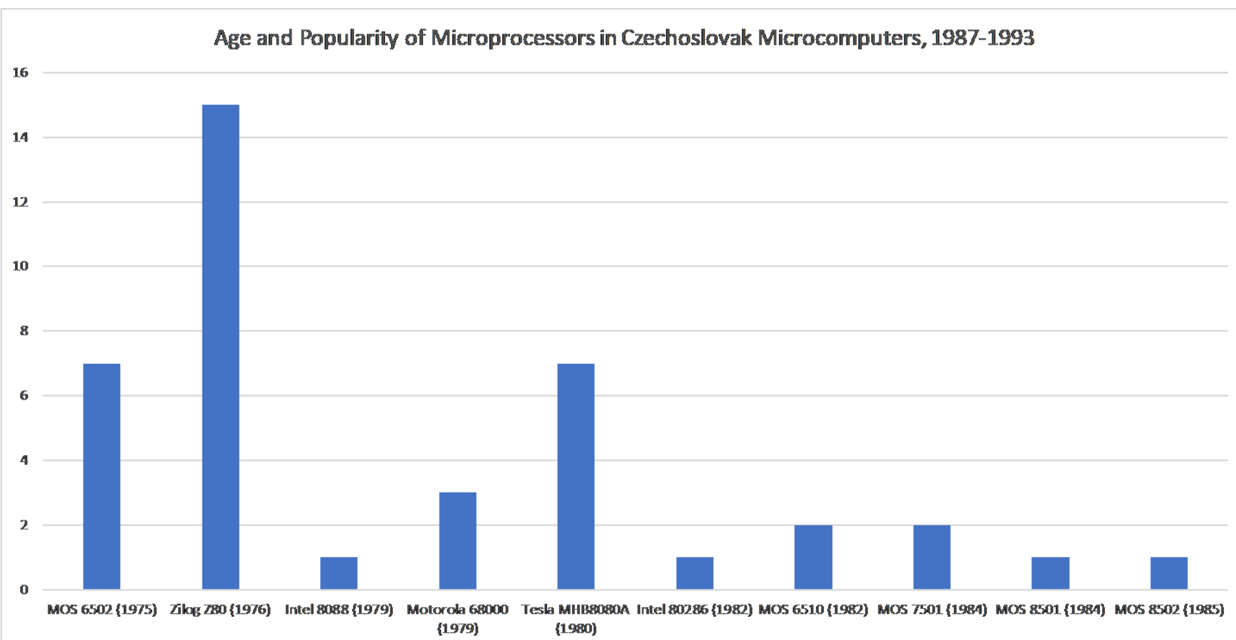

Figure 24: The majority of machines produced in Czechoslovakia, such as the PMD 85, were powered by Tesla's reverse-engineered MHB8080A clone of Intel's 8080 microprocessor; the popularity of Zilog's Z80 CPU is almost entirely due to its presence in the ubiquitous, inexpensive Sinclair ZX Spectrum and its successful Slovak clone, the Didaktik Gama. Although these 8-bit machines powered by 1970s' CPUs had

mostly been replaced in wealthier Western countries by the mid-to-late 1980s, they remained a popular substitute for more expensive home computers in Czech households through the 1990s. Source: Survey data from six years of classified ads placed in *ABC Mladých Techníků a Přírodovědců*.

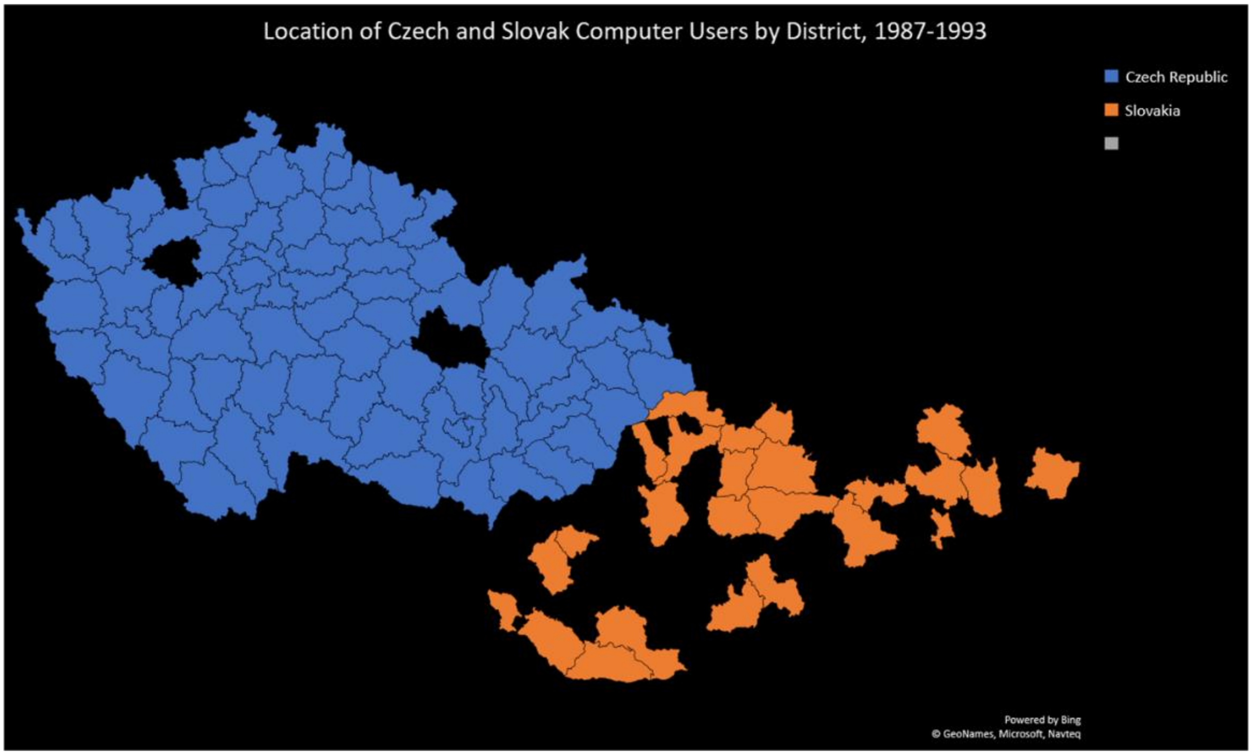

Figure 25: While personal computer ownership was most concentrated in cities, as the next two maps demonstrate, what the map of PC ownership by *okres* (or district, the rough equivalent of a county) shows is how dispersed computer ownership had become by 1993 when the Czech and Slovak republics separated. Visible too is that despite hosting a number of major computer production facilities in Žilina, Piešťany, Bratislava and Banská Bystrica, a relatively poorer Slovakia suffered from computer maldistribution more than its wealthier Western neighbor. Source: Survey data from six years of classified ads placed in *ABC Mladých Techníků a Přírodovědců*.

Figure 26: A user-generated map of PCs in the Czech lands, 1987-1993. Each marker indicates an individual owner. Urban clusters of home computers are where we expect to see them, such as in Prague, Brno and Ostrava. However, ownership in Ostrava is disproportionately high compared to Brno (a larger city), likely due to its proximity to the Polish border and a more open market. Computer ownership in rural or poorer regions, such as northern Bohemia, is abnormally high.

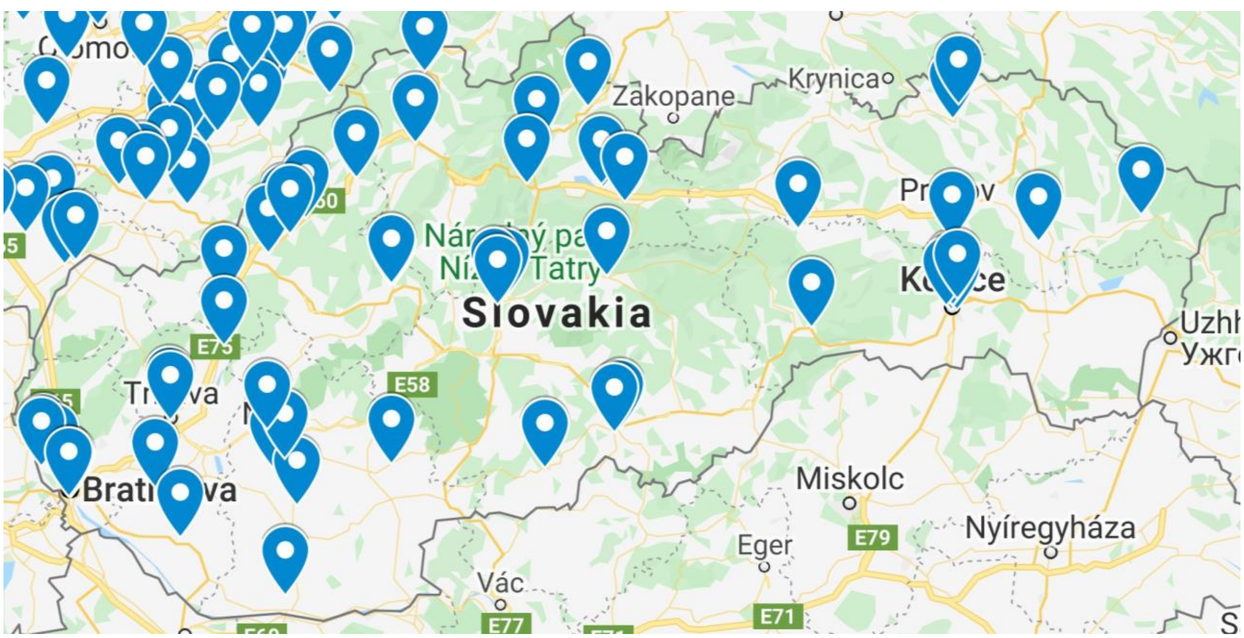

Figure 27: In Slovakia, despite being home to most of the federal state's microcomputer production capacity, PC ownership is surprisingly thin on the ground. Distribution of PCs much more closely tracks the

population distribution overall than in the Czech lands, with clusters of ownership in the major urban areas of Bratislava, Košice, Trnava and Banská Bystrica (also home to a ZÁVT factory). The computers produced in Slovakia from 1987-1993, such as the Didaktik Gama, the PMD 85 series and the Maťo, seem to have flowed out of the republic into Czech hands.

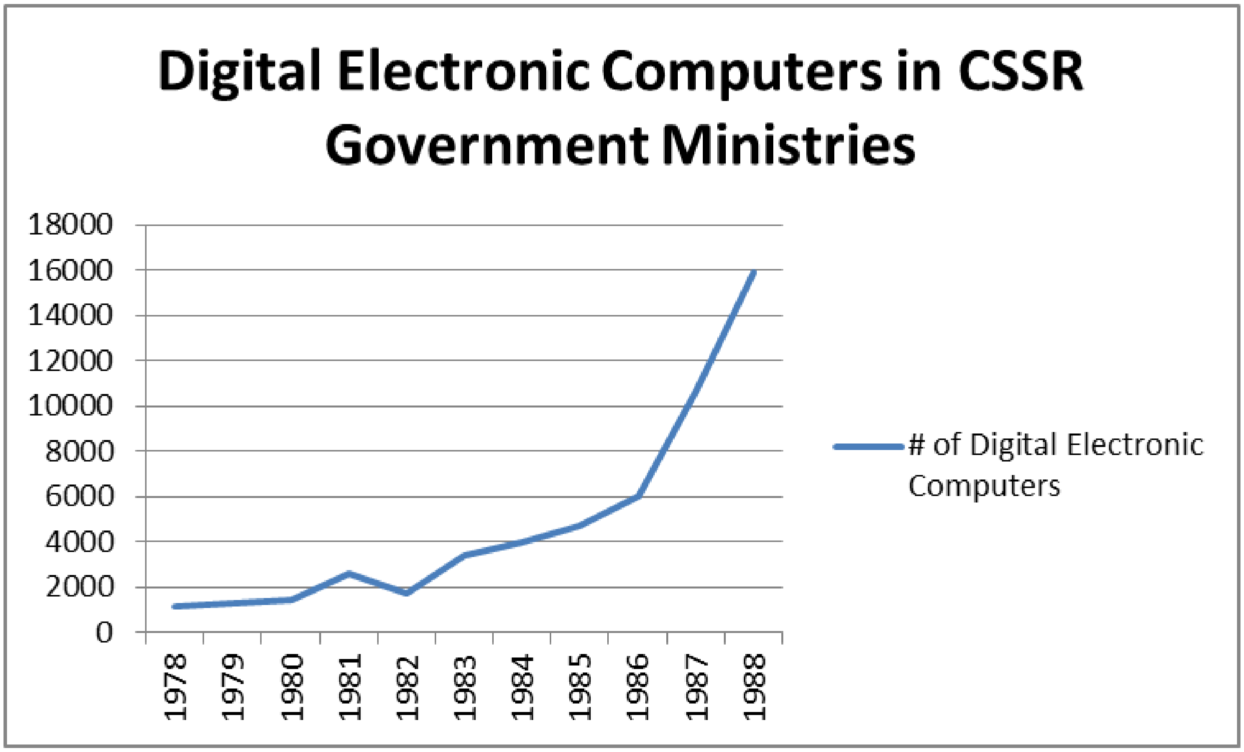

Figure 28: During the microelectronics crisis of the 1980s, and particularly from the mid-1980s onward, Czechoslovak government ministries began rapidly to acquire digital electronic computers from every available source. This contributed to the shortages, bottlenecks and maldistribution of the crisis by placing difficult-to-meet demands on both the country's hard currency reserves (for imports) and the market for home users (as government demand soaked up almost all domestic production capacity). Source: Statistical Yearbooks, Czech Statistical Office, 1979-1988.

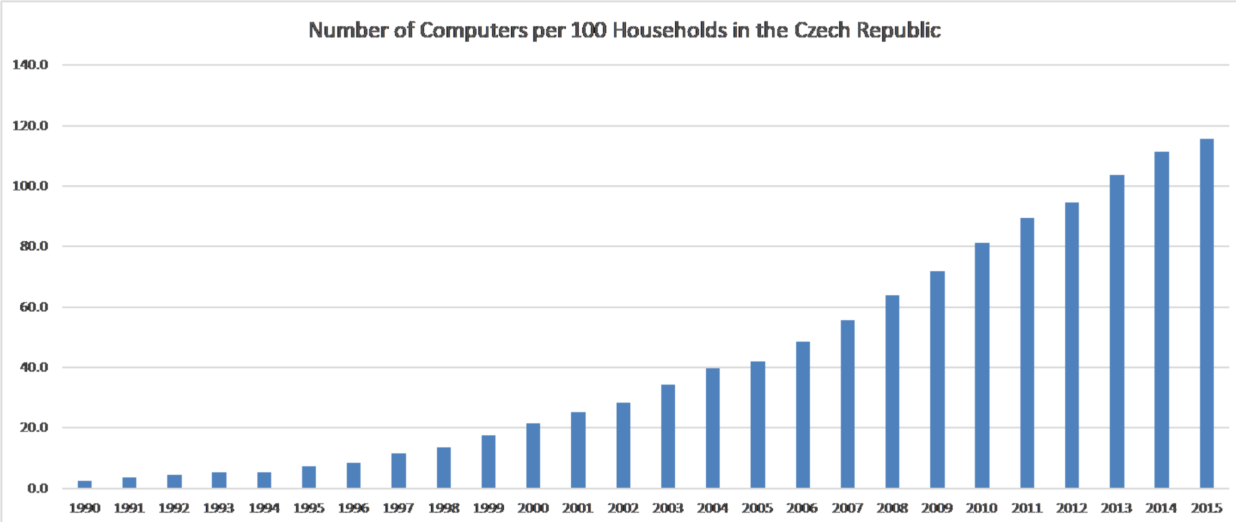

Figure 29: According to the OECD's household survey data, Czech acquisition of home computers followed a steep curve through the first two post-communist decades of the 1990s and 2000s. By 2007, the average number of computers per 100 households in the Czech Republic had reached rough parity (57) with the United States. Due to economic restructuring and relative poverty during the 1990s, older and inexpensive 8-bit home computers such as the Atari 800, Didaktik Gama and ZX Spectrum served school children and families instead of unaffordable imports.

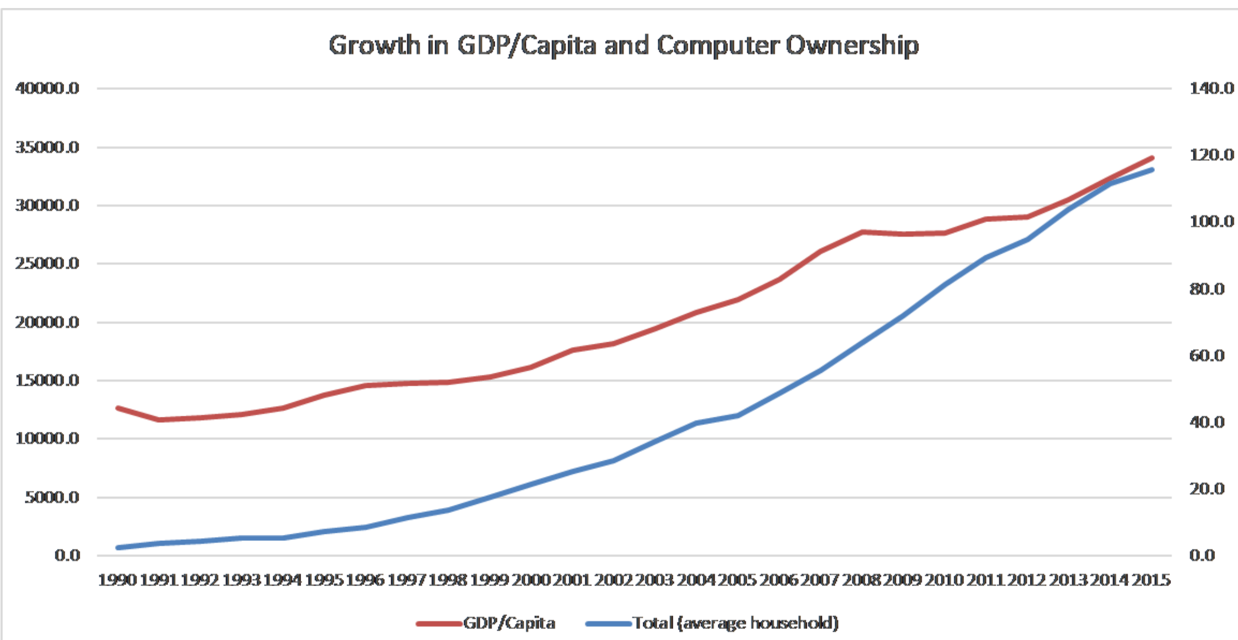

Figure 30: Growth in PC ownership from 1990 did not exactly track with growth in GDP per capita, however, according to OECD household survey data. The acquisition curve for PCs in Czech households rose markedly faster than GDP as a whole, reflecting the computer's status as a *preferential good* that many children clamored for and which adults felt it necessary to spend extra to acquire for educational, entertainment or business purposes.

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