Engineering Management
Field Project

Developing Standard Logic for a Detailed Engineering Project Schedule in the Process Industry

By

Kara A. Miller-Karns

Spring Semester, 2009

An EMGT Field Project report submitted to the Engineering Management Program
and the Faculty of the Graduate School of The University of Kansas
in partial fulfillment of the requirements for the degree of
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Executive Summary

A good schedule is critical to the successful execution of any project. This is especially true in the process industry, where construction schedule overruns can be costly to the client due to lost production capability. Developing a standard schedule to be used as template on detail engineering projects, not only increases the quality of the project schedules, but provides a standardized method of executing projects, which allows means to measure and track performance to improve efficiency on projects.

The process of developing a project schedule can be broken down into two steps; project planning and project scheduling. The focus of this report is on the project planning phase of schedule development. The results from an Interactive Project Planning Meeting (IPPM) for a standard detailed engineering project in the process industry will be used to develop scheduling logic for use in developing detail engineering project schedules. However, because the IPPM does not clearly distinguish relationships between tasks, precedence diagrams will be used to outline these relationships, while the IPPM results will be used to fill in activity durations and lag times. Once the scheduling logic is developed, it will be input into a scheduling software program, so that it may be used as a template for preparing new detail engineering project schedules. In addition, recommendations will be made on the formats required for standard report templates for the various stakeholders of a project.

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List of Abbreviations and Nomenclature

ADM – Arrow Diagramming Method

CSA – Civil Structural Architectural

DCS – Distributive Controls System

DDP – Dimensional Data for Piping

FF – Finish to Finish Activity Logic Relationship

FS – Finish to Start Activity Logic Relationship

FAT – Factory Acceptance Test

GAs – General Arrangement Drawings

HMI – Human Machine Interface

IFB – Issue for Bid

IFC – Issue for Construction

IFD – Issue for Design

IPPM – Interactive Project Planning Meeting

ISOs – Isometric Drawings

P&IDs – Piping and Instrumentation Diagrams

PDM – Precedence Diagramming Method

PFDs – Process Flow Diagrams

RIE – Remote Instrument Enclosure

SIS – Safety Instrumented System

SF – Start to Finish Activity Logic Relationship

SS – Start to Start Activity Logic Relationship

Spec - Specification

Chapter 1 – Introduction

Developing a schedule is an important element to the successful execution of any project. This is especially true in the process industry, where engineering design and construction projects are complex, often executed in congested process areas, and over a relatively short time frame during a process unit downtime. Construction schedule overruns can be very costly to the client due to lost production capability. In addition, schedule overruns increases the risk of a safety incident occurring, due carelessness on the part of workers in their haste to finish the project.

One way to prevent construction schedule overruns is to execute detail engineering design as efficiently as possible in order to maximize the amount of time available in the project schedule for construction. To be able to accomplish this, engineering companies must have a standard approach to executing detail design.

Developing a schedule requires the following steps(Cori, 1985, 79):

1. Defining the project objectives
2. Breaking down the work to be accomplished
3. Sequencing the project activities
4. Estimating activity durations and costs
5. Reconciling the project schedule with project time constraints
6. Reconciling the project schedule with project resource constraints

7. Reviewing the schedule

Steps 1 and 2 can be defined as the project planning, while steps 3-7 can be defined as the project scheduling.

A common tool used for project planning is an Interactive Project Planning Meeting (IPPM). The IPPM utilizes the full wall scheduling technique in which defined project tasks and milestones are mapped out on a scheduling wall and coordinated between disciplines to meet the project objectives. The advantage to this method is the interaction between disciplines. It allows for obstacles to be identified early, and enables project team consensus on plan of execution of the project. However, a drawback to this method is that neither the relationships between tasks, nor the critical path of the project are clearly shown (Cori, 1985, 79).

In addition, for the tool to be effective, the scheduler must have an intimate understanding of how projects are executed, which usually comes through several years of experience.

While every project varies in scope and complexity, in general, the same tasks are performed from project to project. Because of this, an IPPM can be conducted for a standard sized project which can then be used as a basis for a standard schedule. Once a standard schedule is developed, it can easily be modified as necessary from project to project to fulfill individual requirements.

However, developing a schedule is not enough to ensure successful execution of a project. The schedule must also be communicated effectively among the project team, project management, and the client. A trap that many schedulers fall into, and as a result lose credibility, is making the schedule report too complex (Rastelli, 1993, 13). The level of detail in a schedule must be appropriate to the role of the person viewing it.

The primary focus of this report is on the project planning phase of schedule development. The results from an IPPM for a standard detailed engineering project in the process industry will be used to develop scheduling logic for use in developing detail engineering project schedules. In addition, recommendations will be made on the formats required for standard report templates for the various stakeholders of a project.

Chapter 2 – Literature Review

In this section, the fundamentals of planning and scheduling are reviewed. Topics include the difference between planning and scheduling, the characteristics of schedules, and the types of formats used for communicating schedules. In addition, a method of developing standard schedules is outlined.

Fundamentals of Planning and Scheduling

The article "Fundamentals of Master Scheduling for the Project Manager " provides a guide for a project manager to use to prepare a project schedule. The guide breaks schedule development into the following steps (Cori, 1985, 79):

1. Defining the project objectives
2. Breaking down the work to be accomplished
3. Sequencing the project activities
4. Estimating activity durations and costs
5. Reconciling the project schedule with project time constraints
6. Reconciling the project schedule with project resource constraints
7. Reviewing the schedule

In the article "Project Management: Scheduling Tools & Techniques," a similar list is provided, but further breaks down the steps into specific project planning and scheduling activities.

Project planning and scheduling are actually two separate activities. Project planning can be defined as the setting of goals and objectives to be attained (Kibler, 1985,10) or identifying and developing a list of the activities required to execute a scope of work (Rastelli, 1993, 13). Scheduling can be defined as the mechanics of planning generally determined through the use of analytical techniques (Kibler, 1985,10), or determining the timing and sequence with which the plan is executed (Rastelli, 1993, 13). While there is some debate between authors to where the sequencing step falls, in the seven step process described above, steps 1 and 2 are generally considered to be part of project planning, while steps 3 through 7 are generally considered to be part of project scheduling.

Both planning and scheduling can be divided into four subgroups: Engineering, Procurement, Construction, and Project (Kibler, 1985, 10). The engineering subgroup concentrates on planning and scheduling of all the discipline engineering tasks in order to streamline the process. The procurement subgroup assists in organizing the purchasing of materials and equipment as required by the engineering process. The construction subgroup is concerned with developing efficiency in the construction process by coordinating the information received by engineering and procurement. The project subgroup assembles the engineering, procurement, and construction information into report progress relative to the combined project.

Planning

As mentioned above, project planning is the process of defining project objectives and determining the activities or tasks required to meet those objectives. As part of this process, these activities should be assigned a unique identifying code, and should also be organized such that they are able to be grouped according to related activities This organization of activities is often called a work breakdown structure (AACE RP No. 23R-02, 2009, 2).

As the size and complexity of the project increases, the work breakdown structure expands, and the number of activities increases. However, the fundamentals of planning and scheduling remain the same (Rastelli, 1993, 14).

Scheduling

Once the work breakdown structure has been defined, the relationships between activities, called scheduling or activity logic, can be determined. These relationships determine the order, or sequence, in which activities are executed to meet the project objectives.

The Association of the Advancement of Cost Engineering International (AACE) provides a guideline for developing activity logic for use in sequencing activities in the “Recommended Practice No. 24R-03, Developing Activity Logic.” AACE defines the four logic relationships used in sequencing activities. These relationships are Finish-to-Start (FS), Finish-to-Finish (FF), Start-to-Start (SS), and Start-to-Finish (SF). The most common of the four relationships is the Finish-to-Start, which simply means that one activity must finish before a second activity can start. The Finish-to-Finish relationship is defined by two activities finishing at the same time, where the Start-to-Start relationship is defined by two activities starting at the same time. The last relationship, Start-to-Finish, is defined by an activity that must start before a second activity can finish. Additionally, these relationships can be modified by introducing a lag time (AACE RP No. 24R-03, 2009, 2).

Once the scheduling logic is determined, the time and resource parameters are applied. This begins by first adding durations to each activity, and calculating the total time. Activity durations should then be adjusted according to the project time constraints, and the resources available to execute the work.

Characteristics of Schedules

A schedule is a graphic illustration that optimizes the sequencing of tasks and available resources toward the project objective. (Aptman, 1986, 32) The following characteristics are essential for an effective schedule (Cori, 1985, 79):

- Understandable by those who must use it
- Sufficiently detailed to provide a basis for measurement and control of project progress
- Capable of highlighting critical tasks
- Flexible, easily modified and updated
- Based upon reliable time estimates

- Conform to available resources; and
- Compatible with plans for other projects that share these same resources

In addition to these characteristics, the effectiveness of a schedule is dependent upon the communication between the scheduler and the project team members. Good communication is required to ensure that all activities are identified as the scope of work is refined, and that any changes that occur throughout the course of the project are reflected in the schedule. The key component to help facilitate communication with team members is a schedule that is easy for non-schedulers to understand. (Rastelli, 1993, 13)

Planning Techniques and Schedule Formats

Several tools and techniques can be used for planning and scheduling. The most common are

- Milestone chart
- Gantt chart
- Full Wall Schedule
- Network Diagrams

Each of these tools have advantages and disadvantages, depending on the complexity of the project.

Milestone Chart

The milestone chart is simplest form of schedule and best applied to small projects being executed by only a few people, since it does not define the relationships between activities. This form can also be used to summarize complex schedules involving several tasks. Advantages of the milestone chart include the ease and minimal cost of preparation. The disadvantage is that, by only showing completion dates of activities, it could result in uncertainty of activity start dates and the relationships between tasks (Cori, 1985, 82). The milestone schedule can be used to depict engineering, procurement, construction, and start-up activities, including significant project events such as contract awards and equipment deliveries, in a logical format (Kibler, 1985, 11).

Gantt Chart

The Gantt chart, also called a bar chart, is the most widely used scheduling technique. It is a depiction of the relative sequencing of activities to each other in a clear form (Aptman, 1986, 33). It also overcomes some of the shortfalls of a milestone chart in that overlapping activities are more easily shown. While a Gantt chart , like a milestone chart, does not show relationships between activities, it has the advantage of being easier to understand than a network diagram. (Cori, 1985, 82). Because a Gantt chart is typically easy to read, it is an effective tool for communication (Aptman, 1986, 33). Furthermore, precedence networks are often translated into Gantt charts to use for estimating resources and budgeting (Cori, 1985, 82). A project summary schedule is typically shown as a Gantt chart and is a summary of the level of detail found in the project's working schedule, which is typically shown as a network diagram. Translating a network diagram into a Gantt chart is useful in displaying the project critical path in sufficient detail to accurately define how work-around plans may be developed (Kibler, 1985, 11).

Full Wall Schedule

The development of a full wall schedule is a planning and scheduling technique in which vertical and horizontal lines are drawn on a large wall. The spaces between the vertical lines represent a set time interval, and the horizontal lines separate the members of the project team. The defined project tasks and milestones are then mapped out in the spaces and coordinated between each team member to meet the project objectives. Advantages to this method include the interaction between disciplines, which allows for obstacles to be identified early and resolved. Full wall scheduling also enables project team consensus on plan of execution of the project. Disadvantages include the significant time commitment and difficulty in coordinating a common time for team members to conduct the session. In addition, though they must be known to complete the schedule, the relationships between tasks are not clearly shown. Therefore, when changes occur during the project, the project manager must rely on his or her memory to reconstruct the information (Cori, 1985, 82).

Network Diagrams

Network diagrams, or sometimes called precedence networks, are graphical models that portray the sequential relationships between key events in a project and show the plan of action. Network diagrams identify the critical path, the longest sequence of connected activities through the network, of a project which serves as a basis for planning and controlling a project. Furthermore, the AACE recommends using a the full wall schedule as a basis for the network diagram (AACE RP No. 24R-03, 2009, 2).

The following questions should be asked in evaluating the use of the network diagram on a project:

- Are activities well defined?
- Can activities be started, stopped, and conducted separately within a given sequence?
- Do activities interrelate with other activities?
- Are activities ordered in that they must follow each other in a given sequence?
- Does an activity, once started, continue without interruption until completed?

If the answer to these questions is yes, then the use of network diagrams may be appropriate (Cori, 1985, 82).

Advantages to using network diagrams include the ability to show relationships between activities and the ability to distinguish between those activities which are critical to the successful execution of a project and those which are less critical. Disadvantages include the relative difficulty of communication and reporting of the schedule to those who are unfamiliar with the tool. In addition, due to the complexity of the relationships, a significant time commitment and computer software are required to develop the schedule and track progress.

There are two basic methods of developing network diagrams used to logically represent activities: arrow diagramming and precedence diagramming. The Arrow diagramming method (ADM), also known as activity-on-an-arrow diagramming, illustrates an identifiable start and finish of each network activity. Arrows are used to represent work activities, while nodes, usually depicted as a squares or circles, represent events that define the start or finish of activities (Kibler, 1985, 12). The ADM method is pictorially accurate but more cumbersome in the analytical techniques required to obtain program output. Predecessors and successors to project activities are portrayed, but the true logic relationship is difficult to display accurately. Arrow diagrams are effective tools for planning complex projects, however, they are often difficult to analyze and are not typically a good tool for communication (Aptman, 1986, 34). Additionally, only the Finish-to-Start logic relationship can be applied (AACE RP No. 24R-03, 2009, 3).

Precedence diagramming method (PDM), also known as activity-on-a-node diagramming, indicates the predecessor and successor relationships, but does not generally display activities in time scale (Kibler, 1985, 12). Each preceding activities, or predecessor, controls the start or finish of succeeding activities, or successors. In addition, all four activity logic relationships can be used (AACE RP No. 24R-03, 2009, 2). The PDM is easily identifiable, logically organized, and represents the true scope of work (Kibler, 1985, 12). Precedence networks are favored among construction managers. Rather than depicting activities as an instantaneous achievement, precedence networks depict activities as work packages (Aptman,1986, 35)

Developing Standard Schedules

In “Development of a Knowledge-Based Schedule Planning System”, Yunus, Babcock, and Benjamin outline a method to develop a schedule planning system for construction projects. The method starts with modeling the system, then prototyping, or building, the system. The modeling stage is broken down into two steps; identifying the work breakdown structure and developing precedence relationships. (Yunus, Babcock, and Benjamin, 1990, 41). The modeling stage, therefore, is process of project planning and scheduling as described above. The prototyping phase, however, involves inputting the logic developed in the modeling phase into database driven software. The result of inputting the logic is the creation of a schedule planning system that can be used as a basis for many projects.

Chapter 3 – Procedure and Methodology

Developing standard scheduling logic for use in preparing detail engineering project schedules has many advantages. While it is useful to conduct an IPPM at the onset of a project to plan the work, the resulting wall schedules are often difficult to translate into scheduling logic from scratch unless the scheduler has an intimate understanding of how projects are executed. Unfortunately, this usually requires a many years of experience. Not only does standardizing the logic allow the scheduler to start with a template, and modify the logic as needed depending on the requirements of the individual project, but it also makes up for the lack of experience of young schedulers. In addition, it allows for better efficiency and increased quality of the project schedules.

However, it is not enough to only develop a standard scheduling logic for use by the project schedulers. The resulting schedule must also be communicated effectively among the project team, project management, and the client. To facilitate communication, standard schedule reporting templates should be developed as well.

<u>Developing Standard Scheduling Logic</u>

To develop a standard scheduling logic, the method outlined by Yunus, Babcock, and Benjamin for developing a schedule planning system for construction projects will be implemented. This method starts with modeling the system, followed by prototyping.

Modeling

The modeling stage is broken down into two steps, identifying the work breakdown structure and developing precedence relationships. This is consistent with Steps 1 through 4 of the seven step process for schedule development in “Fundamentals of Master Scheduling for the Project Manager” (Cori, 1985,79)

Step 1: Defining the project objectives

Before developing a schedule the project objectives for a standard detailed engineering project in the process industry must be defined. These objectives should include the scope of work, the time frame in which the work is to be completed, any major milestones outside the scope of work that must be met, such as permitting requirements, and a general idea of the resources desired to complete the project.

Step 2: Breaking down the work to be accomplished

Once the scope of work has been determined, a list of activities should be developed to complete the scope of work. Most projects in the process industry involve the installation of equipment, piping, instruments, electrical and control systems, and foundations. The type and quantity of these items, however, vary from project to project. For the purposes of building standard scheduling logic, though, engineering activities to install these items must be identified. These activities should be grouped according to engineering discipline, and given a unique identifying code.

Step 3: Sequencing the project activities

Once activities have been identified, they should be sequenced according to the order of execution. The simplest method of sequencing activities is developing a precedence diagram for each discipline using the four logic relationships. In addition to showing the relationships between tasks within each discipline, the precedence diagrams should show relationships with the activities in other disciplines, including procurement and construction if applicable.

Step 4: Estimating activity durations and costs

After completing the precedence diagrams for each discipline, activities should be assigned durations in order to meet the overall project schedule. The duration of an activity will determine the resources required to complete it, which then determines its cost. However, since the main objective of this report is to develop standard scheduling logic, resource allocation and cost determination will not be performed.

Prototyping

Once the standard scheduling logic has been developed, the next step is prototyping. This simply means inputting the logic developed in the modeling stage into a scheduling software package and reviewing for accuracy. For the standard schedule to be effective, the scheduler must have an understanding of how to use the program effectively as well as an understanding of how projects are executed. The precedence diagrams enable the scheduler to understand the latter. Once the scheduling logic has been programmed, it should be reviewed by the appropriate stakeholders for accuracy and applicability. After the reviews and any necessary revisions have been completed, the logic is then available to use as a template at the onset of detail design projects.

Determining Standard Report Formats

A schedule can be communicated in several forms. Whatever, the form, however, it must have the appropriate amount of detail required by the user. Once the standard formats have been identified, standard templates for reporting schedules can be developed.

Chapter 4 – Results

The results from the development of standard scheduling logic are discussed below. First the project objectives were defined, followed by outlining the work breakdown or activities for each discipline. Once this was completed, the activity logic and durations were established, and then input into a scheduling software program. Finally, the formats for the different schedule reporting requirements were determined.

Project Objectives

The objectives for a standard detailed engineering project in the process industry are to complete the following engineering activities:

- Process engineering
- Mechanical Engineering
- Instrument and Controls Engineering
- Piping Engineering and Design
- Civil / Structural / Architectural (CSA) Engineering
- Electrical Engineering

In addition to engineering activities, some procurement and construction activities occur during the detail engineering phase. However, these activities will be tracked in separate schedules.

While there is no standard duration to a project, for the purpose of developing standard scheduling logic, it will be assumed that these engineering activities will be completed over the course of a fifteen month period of time. Additionally, it will be assumed that no major milestones external to the project will be required.

Work Breakdown

To complete detailed engineering for a standard project in the process industry, many activities must be accomplished by each discipline. A complete list of these activities can be found in the Appendix A. The roles and the responsibilities of each discipline are described below.

Process

The process engineer is responsible for the overall design and function of the process, and provides the data that serves as a basis for sizing equipment, piping, instruments, and electrical equipment. Some detail process engineering activities may actually occur in front end engineering. However, since these activities are critical to all other disciplines' detail design activities, they are listed in the detailed engineering schedule as "confirming" activities. Furthermore, another company may complete the front end engineering, and these activities would be confirmed again at the beginning of detailed engineering.

Mechanical

The mechanical engineer is responsible for the design and specification of process equipment, and ensures that the equipment purchased conforms to the design. Included in the equipment design and specification, the mechanical engineer determines the metallurgy, paint codes, insulation, and fire proofing requirements for equipment.

Instrument & Controls

The instrument and controls engineer is responsible for specifying, purchasing, and programming all instruments and controls systems required to properly operate the process. In addition, the instrument and controls engineer ensures that the instruments and controls systems purchase conform to the design.

Piping

The piping discipline consists of piping design and piping engineering activities. The piping engineer is responsible for the overall design of the piping system, including piping specifications and stress analysis, while the piping designer determines the layout of equipment and pipe to minimize the amount of piping, while maintaining proper spacing requirements for access and maintenance. For some projects, a portion of the piping engineering and design is done in an offshore engineering firm. For the purposes of developing standard schedule logic, it will be assumed that the offshore engineering firm will be used, and the both piping engineers and designers will have review activities.

Civil / Structural / Architectural

The civil / structural / architectural (CSA) engineer is responsible for the design of all sitework, foundations, structural steel, and buildings required to build, support, and/or house the equipment and instruments. Depending on the subsurface soil conditions of the project site, two different types of foundation systems may be required. The standard activities include both types of foundations for each piece of equipment or steel structure.

Electrical

The electrical engineer is responsible for the design and specification of the wiring and electrical systems required to power equipments and instruments, The electrical engineer also ensures that all electrical systems purchase conforms to specifications.

Activity Sequencing and Duration Estimating

To help sequence the detailed engineering activities, an IPPM was conducted for a standard project. However, when reviewing the wall schedule resulting from the IPPM, many engineering activities critical to the success of a project were not shown. In addition, while the durations of the tasks were clearly denoted, it was difficult to determine the relationships between activities across disciplines. Therefore precedence diagrams were developed for each discipline. While procurement and construction activities are tracked in separate schedules, the relationships between these and some engineering activities were shown. The completed precedence diagrams were reviewed by the department managers for accuracy.

The precedence diagrams can be found in Appendix B. However, the general relationships between disciplines are outlined below.

Process

The process engineer provides the data to size equipment, piping, and instruments. Equipment and instrument data is provided primarily in the form of process datasheets. In addition, equipment and instrument summaries can be found on the equipment and instrument lists, respectively, or on the Piping and Instrumentation Diagrams (P&IDs). The process engineer is also involved in the vendor document reviews of equipment and instrumentation.

The P&IDs are the primary form of communication of the scope of work between the process engineer and the piping discipline. The P&IDs show the specifications, sizes, insulation and tracing requirements, and routings of pipe, as well as any valves, instruments, strainers, or other piping components in the line. In addition to the P&IDs, the line list is a shared document between the process engineer and piping engineer. The process engineer provides a summary of each line, while the piping engineer determines the test pressures, stress requirements, and other design information required per design codes.

The sequence diagram for the process discipline can be found in Figure 1 in Appendix B of this report.

Mechanical

The mechanical engineer mainly interfaces with the process, piping, CSA, and procurement disciplines, and to a lesser extent, instrument and controls, and electrical disciplines as well. The general relationship between the mechanical and process disciplines are described above. Both the instrument and controls engineer and the electrical engineer provide information that effects the design of equipment packages. Examples of instrument and controls information are level instrument details and machine monitoring systems. An examples of electrical information is motor design information. The main form of communication between these disciplines are through the equipment list and vendor document reviews.

The sequence diagram for the mechanical discipline can be found in Figure 2 in Appendix B of this report.

Instrument and Controls

The instrument and controls engineer interfaces with the process, piping, mechanical, and electrical disciplines. The general relationship between process and mechanical disciplines are described above. The instrument and controls engineer provides instrument details to the piping designer necessary for installation of instruments in the piping. This is completed though the Dimensional Data for Piping (DDP) module, which is a software program that interfaces with the pipe model and allows the instrument and controls engineer to input the certified dimensions of each instrument into the model. The instrument and controls engineer also provides the IO List information to the electrical engineer, which necessary to complete the circuit schedule. In addition, the instrument and controls engineer must provide instrumentation wiring information to be captured in the cable tray design.

The sequence diagram for the instrument and controls discipline can be found in Figure 3 in Appendix B of this report.

Piping

The piping discipline interfaces with all other disciplines. Relationships between the process, mechanical, and instrumentation and controls disciplines have been described above. The piping discipline also provides the piping loads and other information to the CSA engineer for the design of the main pipe racks and miscellaneous pipe supports. In addition, the piping discipline and civil engineer work closely in the design of underground pipe.

The sequence diagram for the piping discipline can be found in Figure 4 in Appendix B of this report.

Civil / Structural / Architectural

The CSA engineer mainly interfaces with the mechanical, piping, and electrical disciplines, though some interaction with process. The relationships between the mechanical, piping, and process disciplines have been discussed above, and the relationship between the CSA and electrical engineer is described below. The sequence diagram for the CSA discipline can be found in Figure 5 in Appendix B of this report.

Electrical

The electrical engineer relies on information from the process, mechanical, instrumentation and controls disciplines as described above. In addition, the electrical engineer relies on information from the CSA engineer regarding locations of underground duct banks, and provides electrical equipment and cable tray information to the CSA engineer for incorporation into the foundation design.

The sequence diagram for the Electrical discipline can be found in Figure 6 in Appendix B of this report.

Programming Scheduling Logic

A common scheduling program used in the process industry is Primavera, and is a complex, but valuable tool for schedulers. Using the work break down structure, the activities were inputted according to discipline. As the activities were entered, the activity codes were automatically assigned according to a each discipline's format, but were changed if required to match grouping or sequencing. Once the activities were entered, durations to activities were applied to each activity using the results from the IPPM. Then, using the precedence diagrams, the predecessors and successors were assigned, and any lag times required applied. The resulting schedule for a standard detail engineering project was reviewed by the department managers for accuracy and validity.

Recommendations for Standard Report Formats

The different users of the project schedule are listed below.

- Project Manager
- Lead Discipline Engineers
- Client Management
- Corporate Management

A project manager, as he or she is involved in the day to day execution of the project, requires a high level of detail. Thus, a precedence network schedule showing the critical path should be used. However, a discipline lead engineer may not be concerned with how other disciplines are executing their work, but would like to what resources are required to complete his or her discipline's activities. In this case, a Gantt chart should be used. In the same regard, a corporate manager or a client may want to know the overall schedule of the project, but not the day to day details, in which case a project summary schedule or milestone schedule should be used.

Chapter 5 – Suggestions for Additional Work

The focus of this report has been on developing standard scheduling logic, which is important for preparing detail engineering project schedules. Not only does it improve the quality of the schedules, but it can provide the means to increase the efficiency with the execution of projects. However, a schedule must also be understandable by those who use it. For this reason, standard templates for reporting detail engineering project schedules are just as valuable as the standard scheduling logic. Recommendations were made on the types of schedules that should be used for the various stakeholders of a project. Areas for future work include developing these reports.

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Appendix A – Work Breakdown

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Appendix B – Precedence Diagrams

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Appendix C – Interactive Project Planning Meeting Results

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