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Sedentary and Fleeting Activities and Their Spatial Correlates in Offices

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Abstract

In this study of the relationships between knowledge worker activities and office design, two sets of activities - generically termed as fleeting and sedentary activities - are considered. Fleeting activities include walking (or movement), face-to-face interactions, and visible copresence (i.e., the number of people seen from a space or position). Sedentary activities include meeting, working on computer, talking on telephone, talking, writing, reading, paper handling, and pausing.

We observe these activities in a moderately large landscaped office using two different methods. One is the Time Utilization Survey (TUS) method where the field observer observes both sedentary and fleeting activities from a set of points on a predefined route. The other is the "space syntax" method where the observer observes fleeting activities as she walks along an observation route.

We investigate if the sedentary activities in well-defined spaces would have the same spatial predictors as the fleeting activities in ill-defined spaces. For this, we use two sets of spatial descriptors: One set includes integration and connectivity of spaces in a layout computed using the axial map analysis techniques of "space syntax". The other set includes degree and closeness of individual workspaces in the network of visibility computed using the network analysis techniques. Our study shows that the fleeting activities are better predicted by integration and connectivity, while the sedentary activities are better predicted by degree and closeness. This finding is important for it suggests that we may need different spatial strategies to influence fleeting and sedentary activities in offices.

Keywords: Sedentary Behavior, Fleeting Behavior, Spatial Predictors, Time Utilization Survey (TUS), Space Syntax

Research Setting: Workplace/Office

Introduction

Knowledge workers are a predominant workforce in our workplaces. For knowledge workers to thrive, organizations must support their workstyle - how they work and the kind of work they do. A proper understanding of knowledge workers' work style may help us to design better workplaces promoting their control over the work environment. When a workplace meets the specific needs of knowledge workers and help them to take control of their own environment, knowledge sharing, teamwork, creativity and innovation improve.

In order to understand knowledge workers' work style, we observe their activities in a moderately large office of a federal organization. Our observation includes two kinds of activities: sedentary activities in well-defined spaces (e.g., individual workspaces) and fleeting activities in ill-defined and fluidly occupied spaces (e.g., circulation spaces). In the sedentary activities, we include meeting, working on computer, talking on telephone, talking, writing, reading, paper handling, and pausing. In the fleeting activities, we include movement (or walking), face-to-face interactions, and visible copresence (i.e., the number of people seen from a space or position).

We use the behavioral observation techniques of TUS (Time Utilization Survey) and space syntax. TUS, a tool developed by DEGW, provides a very robust picture of space-utilization and activity patterns across distinct organizational subpopulations using a systematic, computer-aided process. However, TUS is not particularly effective at documenting relatively fleeting behaviors.

In contrast, the observational techniques of space syntax are effective in examining activities that may or may not be explicitly tied to work tasks and in covering ill-defined and fluidly occupied spaces. In addition, space syntax also includes a set of computerized techniques allowing systematic links to be established between observed behaviors and different spatial attributes. Space syntax techniques achieve these advantages, however, through a relatively narrowed focus on space and behavior.

Taken together, these two methods produce rich and robust data that covers explicit work activities as well as secondary activities indirectly tied to work activities. In addition, these methods also produce data covering all types of utilized space, from well-defined spaces (e.g., private offices) to spaces in between (e.g., circulation). As a result, the behavioral data collected using the two methods may help us better understand the work styles of knowledge workers and the spatial correlates of these workstyles. We seek to understand these associations, because we want to use space to support knowledge workers' work style.

Methods

Overview

Our study was conducted at the new landscaped office of a federal organization. The office is located in the downtown of a major metropolitan area. Our study included the office area shown within the dashed line (**Figure 1**). We performed the space syntax and visual network analyses of the layout, and observed behaviors using the space syntax and Time Utilization Survey (TUS) methods. These layout analyses and observation techniques are described below.

Layout Analysis

Space syntax

Space syntax techniques provide rigorous descriptions of building layouts (for details of the theories and techniques, see Hillier & Hanson, 1984; Hillier, 1996). For our purpose, we represent the layout as a set of the minimum number of longest sight lines needed to cover every space and to complete every circulation ring of the layout following the space syntax conventions

(**Figure 2**). In the space syntax literature, each of these sight lines is known as an axial line, and the complete set of lines covering a layout as an axial map. An axial map provides a rigorous way to describe how we see and move in a layout based on the assumptions that in space individuals prefer to move along a straight-line as represented by an axial line unless there is a reason not to do so; and that the way individuals move in space is very often defined by the number of choices available from their lines of movement.

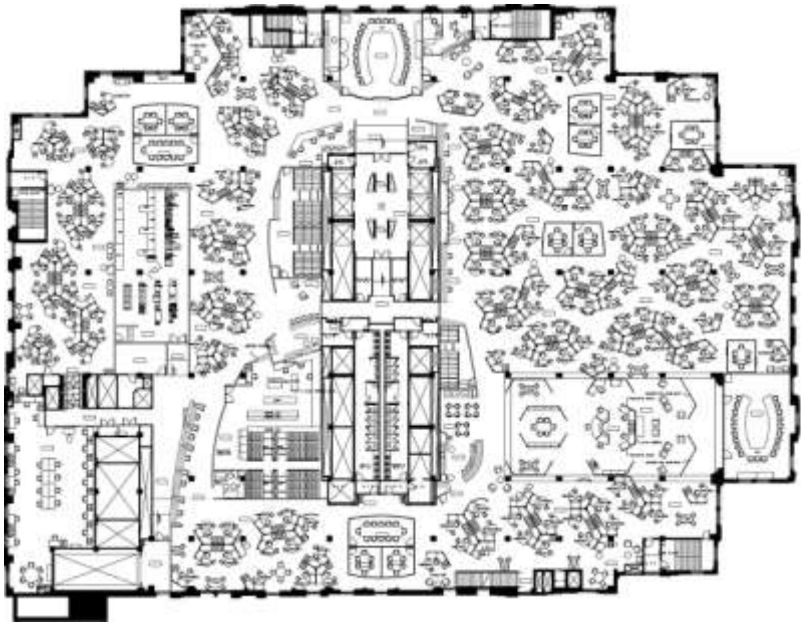

Figure 1: The plan of the landscaped office.

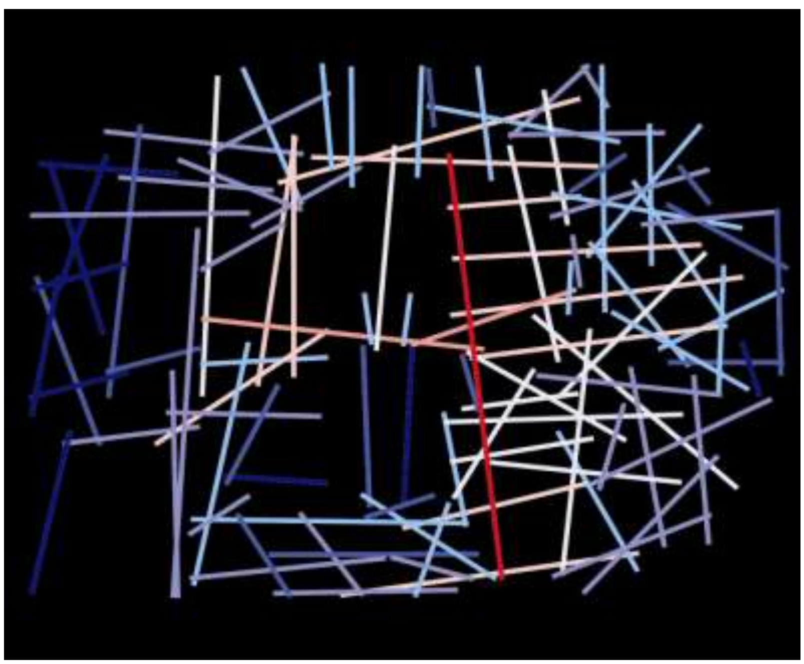

Figure 2: The axial map of the landscaped office colored using integration. The lines with high integration are shown in red, and the lines with low integration are shown in blue.

The “Spatialist” computer program, developed at Georgia Tech, was used to assess the relational pattern of the axial lines in an axial map (Peponis et al. 1998, 1998a, 1997). We use two important descriptors of interconnectedness of the axial structure, connectivity and integration, in our present study. Connectivity of an axial line is the number of axial lines directly connected to the line. Connectivity, a local property of an axial line, is interesting because it describes the degree of choices present on the line: Higher connectivity means more choices of movement from the line. Integration, on the other hand, is a global property describing the connectedness of an axial line to all other axial lines of an axial map: Higher integration of an axial line means higher degree of accessibility from all other spaces. The length of axial lines, representing the reach of the visual field of a space, is also used in the study to describe the degree of visibility available from the space.

Visibility network

In order to find out how an individual workspace is connected to all other workspaces in the network of visibility, we develop a square array or matrix where the rows and columns of the array include all individual workspaces of the network and the cells of the array describe the relationships of visibility between all pairs of workspaces using ones and zeros. If two individuals are visible to each other, then each of the two cells describing their relationships get ones; and if two individuals are not visible to each other, then their corresponding cells get zeros. In order to find out who are visible to whom, we draw the 360° visual field from the workstation of each individual. Anyone inside the visual field of an individual would then be visible to the individual. **Figure 3** describes the general outcome of the process.

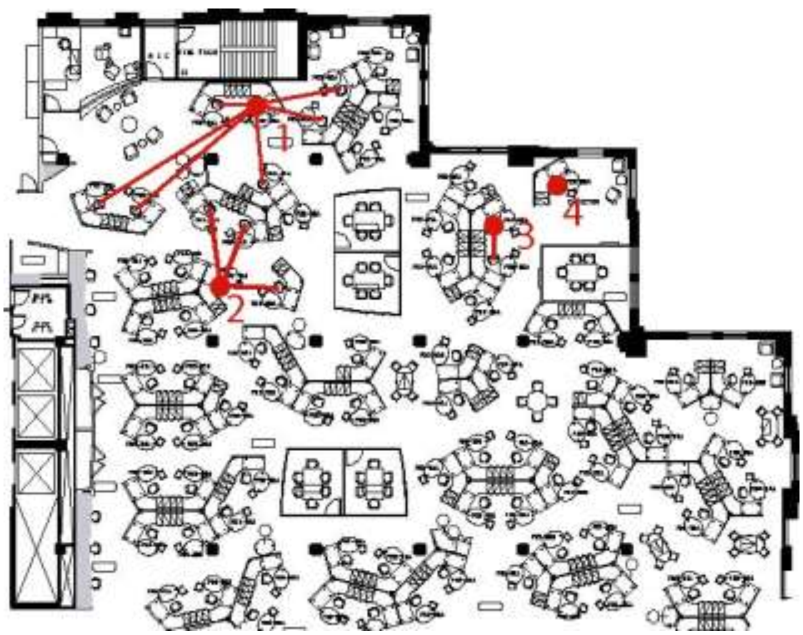

Figure 3: The number of workspaces seen from four different workspaces: Workspace-1 sees six workspaces; workspace-2 sees three workspaces; workspace-3 sees one; and workspace-4 sees none.

Representing the visibility network data in a matrix format easily allows us to apply the network analysis software to summarize and find various patterns in the network. For this study, we use Ucinet for Windows (2002) to calculate two network values: degree and closeness. The degree of an individual workspace is the number of other individual workspaces visible from the workspace. It is thus a measure of how exposed a workspace is to other workspaces around it: Higher degree means more immediate exposure of an individual workspace to other workspaces. Degree may positively affect face-to-face interaction in a setting. In contrast, it may also be a source of stress. A person visible by more people may feel a lack of privacy, may be forced to stay longer in her workstation, may be forced to work more, or may simply pretend to work more under constant surveillance.

Closeness of a workspace describes how close the workspace is to all other workspaces in the visibility network. It is computed based on the shortest distance (i.e., minimum number of intervening persons) between any two individual workspaces in the visibility network. It is a descriptor of how visible a workspace is in the whole visibility network: Higher closeness means more exposure to all workspaces in a setting. In this sense, the effects of closeness may be similar, but more intense, to those of degree.

Behavior Observation

Space syntax observation technique

The space syntax observation technique uses the linear segments of an observation route as units of observation. The field observer observes behaviors along each observation segment as she walks at a regular pace (**Figure 4**). This linear technique of observation, being continuous in space and time, has been very effective in examining fleeting behaviors that may or may not be explicitly tied to work tasks in ill-defined and fluidly occupied spaces (such as corridors, lobbies, and lounges). In addition, this technique has allowed us to link systematically observed spatial behaviors to various attributes of the axial lines of the axial map of a layout.

In our study we limit ourselves to three fleeting spatial behaviors, which are movement, interaction and copresence. *Movement* was defined as the number of moving people, *face-to-face interaction* as the number of people seen engaged in face-to-face interaction and *visible copresence* as the number of visible people, active and/or inactive, along a segment of the route. For recording purposes, we use an up-to-date floor layout with the route drawn on it. The space syntax analysis of the layout is performed before selecting a route. Based on the analysis, integrated as well as segregated spaces of different types are included in the route. In total, about thirty rounds of observation are made along the route.

TUS Observation Technique

In contrast to the space syntax observation technique, the Time Utilization Survey (TUS), a tool developed by DEGW Consulting, is a point-based observation technique where the field observer walks along a route to observe behaviors only at a predefined set of points (known as “route stops”) (**Figure 5**). By providing temporally and spatially discrete description of behaviors, the point-based technique gives the observer a greater flexibility in sampling. The types of behaviors and the number and types of spaces one can observe in a point-based technique are limited only by the purpose and resources available for a project. For convenience and economy, we use about 210 route stops in our study. The observer use a hand-held computer telling her where and what she should be observing.

For our study, we use four categories of route stops: workspaces, ancillary spaces of a department, support spaces shared by all departments, and paths or circulation spaces, and observe some twelve types of activities and/or non activities: empty, temporarily unoccupied, meeting, working on computer, talking on telephone, talking, writing, reading, paper handling, pausing, and activity data not obtainable. For each route stop in a circulation space, we also record both static (standing, and standing and talking, etc.) and moving (walking, and walking and talking, etc.) activities.

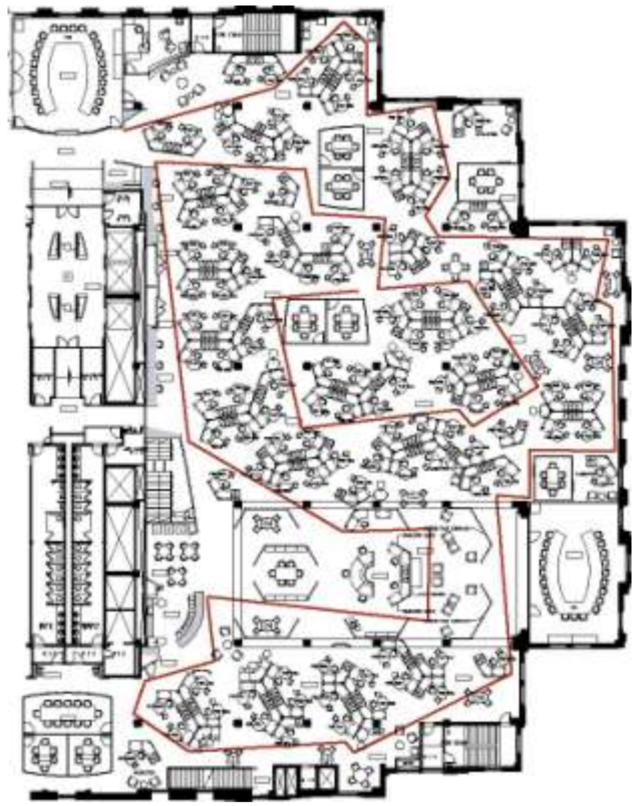

Figure 4: The observation route used for the space syntax method.

Figure 5: The observation route used for the TUS method.

Results

Characterizing the work environment

According to our analysis of the observational data, people are very active as well as interactive in the setting. The correlation between the total number of observed people and the total number of active people, and between the total number of observed people and the total number of interacting people are very strong (r = 0.98, p = 0.00; r = 0.72, p = 0.00; respectively). The correlation between the total number of interacting people and the number of people meeting but not walking is also very strong (r = 0.95, p = 0.00), suggesting that most observed interactions are static and somewhat formal in nature (**Table 1**).

In addition, when working alone individuals are likely to use computers most (r = 0.89; p = 0.00). When alone, they are also likely to talk, telephone, write, read, and handles papers, but not as much as they would use computers (r = 0.39; p = 0.00; r = 0.56; p = 0.00; r = 0.5; p = 0.00; r = 0.59; p = 0.00; and r = 0.32; p = 0.00; respectively).

With another person, individuals generally do meeting, talking, or telephoning (r = 0.38; p = 0.00; r = 0.48; p = 0.00; r = 0.15; p = 0.00) but do not do computing, writing, reading, or paper handling (as there are no significant correlations between the number of interacting people and these activities). In a group of three or more, people generally do meetings, and generally do not do any other activity (**Table 2**). The trend regarding group behaviors does not change for different categories of spaces.

	total observed people	total people meeting but not walking
total interacting people	0.72(0.00)	0.95 (0.00)
total active people	0.98(0.00)	

Table 1: Correlations among people performing different generic functions (for all route stops, N = 227)

	meeting	talking	telephone	computing	writing	reading	paper handling
1 person	-.18(0.01)	.39(0.00)	.56(0.00)	.89(0.00)	.50(0.00)	.59(0.00)	.32(0.00)
2 people	.38(0.00)	.48(0.00)	.15(0.02)	ns	ns	ns	ns
3 people	.59(0.00)	ns	ns	-.14(0.04)	ns	ns	ns
4 people	.70(0.00)	ns	ns	-.16(0.02)	ns	ns	ns
5 people	.49(0.00)	ns	ns	ns	ns	ns	ns

Table 2: Correlations between activities and group size (for all route stops, N = 227)

Spatial correlates of fleeting and sedentary activities

Accessibility of a layout as described by space syntax and visual connectedness of the visibility network of workspaces affect movement in space, but in different ways. All kinds of movement (or walking) tend to decrease in more visually well-connected locations. In contrast, they tend to increase in more axially connected or accessible spaces. The latter trend is stronger when movement is recorded along the path segments by a moving observer (integration: r = 0.57, p = 0.001; connectivity: r = 0.68; p = 0.00) (**Table 3**).

However, accessibility described by space syntax does not affect whether a space is temporarily occupied or not, but visual connectedness of the visibility network does. The chance that a space may remain temporarily unoccupied during a workday decreases as visual closeness or centrality of the space increases. This is evident in the fact that the number of times a space is temporarily unoccupied decreases for more visually central locations (closeness: r = - 0.21, p = 0.02) (**Table**

4). This suggests that an individual at a more a visually central location is likely to remain at her desk longer.

Again, interconnectedness or accessibility of a space within a layout calculated from the axial map does not affect interactions in a space, but visual closeness calculated from the visibility network does. Our analysis shows that the total number of people interacting decreases at more visually central locations. In addition, the number of interactions involving two people also decreases at visually central locations. This trend becomes stronger in some interaction types when we consider interactions in the workspaces only (**Table 5**).

For observations recorded using the space syntax method, the trend however is reversed. We observe that both total number of interacting people and the number of interactions involving two people decreases in spaces with higher integration and connectivity. For these spaces, we find no correlations between interaction and degree or between interaction and closeness (**Table 5**).

Additionally, interconnectedness of a space within a layout calculated from the axial map does not affect the type of activity in a space, but visual closeness calculated from the visibility network does. All kinds of sedentary work increase in more visually central locations (**Table 6**). We observe no change in the trend in different kinds of workspaces.

	Movement (with no activity) at route stops	Movement (with talking) at route stops	Total movement at route stops	Movement recorded on path segments while walking (N=32)
For all route stops (N = 227)				
Integration	0.15(0.02)	0.17(0.01)	0.17(0.01)	
Connectivity	0.19(0.00)	0.18(0.01)	0.20(0.00)	
Degree	-0.31(0.00)	-0.23(0.00)	-0.32(0.00)	
Closeness	-0.39(0.00)	-0.29(0.00)	-0.39(0.00)	
For route stops on paths only (N = 51)				
Integration	0.25(0.07)	0.28(0.05)	0.29(0.04)	0.57(0.00)
Connectivity	0.25(0.07)	0.24(0.08)	0.28(0.04)	0.68(0.00)
Degree	ns	ns	ns	
Closeness	ns	ns	ns	

Table 3: Correlations between spatial variables and movements observed at route stops and path segments

	Number of temporarily unoccupied assigned work spaces
Integration	ns
Connectivity	ns
Degree	ns
Closeness	-.21(.02)

Table 4: Correlations between the number of temporarily occupied assigned workspaces and spatial variables (for all workspaces, N = 119)

	Total interacting people	Number of 2-people interactions
For all spaces (N = 227)		
Integration	ns	ns
Connectivity	ns	ns
Degree	-0.18 (0.01)	-0.21 (0.00)
Closeness	-0.19 (0.00)	-0.22 (0.00)
For workspaces only (N = 119)		
Integration	ns	ns
Connectivity	ns	ns
Degree	-0.2(.03)	-0.19(.04)
Closeness	-0.33(.00)	-0.39(.00)
For route stops on paths only (N = 51)		
Integration	-0.3(.03)	-0.29(.04)
Connectivity	-0.3(.03)	-0.25(.07)
Degree	ns	ns
Closeness	ns	ns

Table 5: Correlations between the number of people interacting and spatial variables

	telephoning	computing	writing	reading	paper handling
Integration	ns	ns	ns	ns	ns
Connectivity	ns	ns	ns	ns	ns
Degree	0.16(0.02)	0.17(0.01)	0.15(0.03)	ns	0.21(0.00)
Closeness	0.24(0.00)	0.34(0.00)	0.22(0.00)	0.22(0.00)	0.27(0.00)

Table 6: Correlations between sedentary work and spatial variables (for all route stops, N = 227)

Summary and Discussion

In sum, the findings of our study were as follows:

• Most observed interactions were static and somewhat formal in nature.

• People performed different activities individually and in groups.

• Integration and connectivity showed good positive correlations with movement. In contrast, degree and closeness of a space in the visual network showed negative correlations with movement.

• Whether a space remained occupied or not during the workdays was affected by degree and closeness, but not by integration and connectivity of the space.

• Interaction in a space was affected by degree and closeness, but not by integration and connectivity of the space.

• All kinds of sedentary work increased in spaces with high degree and closeness, but integration and connectivity of a space had no effects on sedentary work in the space.

The study was interesting for it used two different observation techniques in order to capture as many activities in as many spaces as possible within the office. As result, we got a very robust description of both sedentary and fleeting activities in the office. The data allowed us to study the association of these activities with each other, and to find out the spatial correlates of these activities.

For the study, we used two sets of spatial descriptors, and our findings regarding spatial correlates of activities were interesting from both design and theoretical standpoints. From design standpoint, the findings suggested that different activities were associated with different attributes of design: Sedentary activities were associated more with the properties of visibility network of individual workspaces, and fleeting activities were associated more with the properties of the axial maps (i.e., the network of sightlines).

These findings make perfect sense from a theoretical standpoint. The axial map analysis is based on the assumption that our movement in space may depend on visual and physical accessibility and, as a by-product of their effects on movement, these spatial attributes may also affect face-to-face interaction and visible copresence. In contrast, the visibility network analysis assumes that how we see others from our workspaces may have effects on how we act in these spaces because of mutual surveillance. It is then only natural that we should find better correlations between fleeting behaviors and the descriptors of axial maps, and between sedentary behaviors and the descriptors of visibility networks. However, it is difficult to generalize our findings, because our observations using both the TUS and space syntax techniques were completed at one landscaped office only. It may be useful to see if space would have similar associations with knowledge workers' behaviors in other more visually restricted and geometrically regular office settings.

Authors' Note

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