Organizational constructs and the structure of space:
A comparative study of office layouts

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Abstract
In this paper, we present a comparative study of five office layouts occupied by three different organizations focusing on the following organizational constructs: "communication", "control", "territoriality", "privacy" and "status". Our aim is to fill in the gaps that exist in the literature regarding the relationships between these organizational constructs and office layouts. For the purpose, we define various generic spatial properties of these constructs, and use these properties as the basis for a "space syntax" analysis of the office layouts. Based on our findings, we present a set of spatial strategies used by these organizations linking the relational spatial descriptors of space syntax to the organizational constructs. Since these strategies have intuitively clear implications on the behaviour and actions of an organization, they may be used as aids to the design and performance assessment of office layouts in general.

Keywords
office layouts, communication, control, territoriality, privacy, status

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1. Introduction

"Organizational constructs" are mechanisms used by an organization to define its characteristics and actions involving, among other things, the physical environment. "Communication", "control", "territoriality", "privacy" and "status" are a few important examples of these constructs. In the literature, researchers frequently use these constructs to describe office settings. They link them to such performance indicators as "satisfaction" and "productivity". Designers and office organizations themselves also use these constructs to justify the design and/or reorganization of office layouts. However, the relationships between office layouts and the organizational constructs are not carefully studied in the literature or in practice. In this paper, we study the patterns of these relationships and suggest ways to describe these patterns using spatial descriptors.

One important reason for a lack of any systematic studies on the effects of office layouts on organizational constructs is the fact that each organization defines and uses its constructs in different ways from the other. For example, in a "design office" communication may be characterized by a continual discussion over the

work in progress; status by a lack of differentiation; control by a relaxed set of behavioural codes; and so on. In contrast, in an "advertising agency" communications may be characterized by an urgency to impress people immediately; status by different roles representing a coalition of widely diverse groups of people; control by a rigorous set of behavioural codes since an internal competition for scarce resources may exist; and so on.

Another important reason for a lack of any systematic studies on the effects of office layouts on organizational constructs is the very complex and multidimensional nature of the constructs themselves. They all engage, to a varying degree, an interrelated set of ideas pertaining to humans. (For definitions of these constructs, see Rashid 2002.)

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Researchers are also to be partly blamed for a lack of any systematic studies on the effects of office layouts on organizational constructs. Generally, they assume that people in an office know what communication, control, territoriality, privacy, or status may mean for the organization. Hence, researchers ask people such questions as "do you have enough privacy in your work area?" or "can you communicate effectively with others?" etc., without giving clear definitions of these constructs. This happens because studies related to job-satisfaction and performance are most often based on research models derived from social and/or environmental psychology. Consequently, variables measured are based on a preconceived notion of importance and relevance.

In addition, researchers provide several models of each construct using different environmental aspects. Each model appears to be valid within its own research context. For example, in some studies proximity between workers is studied to define privacy; in others the number and height of the enclosure; and there are even others where the number of doors is studied to define privacy. As a result, it is almost impossible to use any of the models to develop a comparative framework of analysis for different kinds of office settings.

To make matters worse, researchers do not provide any clear definitions for such useful terms as open-plan and cellular layouts or good and bad layouts. In a similar fashion, they often take complex physical variables out of their contexts without realizing that these variables may lose relevance when taken out of context. Consider the very-often-used physical variable "location". In several studies, the location of a person in an office is related to the status of the person, and it is expected that the people of higher status would occupy "corner" locations in office layouts.

However, simple terms like "corner" may not always capture the complexity of the concept of location, which sometimes defines a position only in relation to the building layout as a whole.

Our guess is that researchers, who study the effects of office settings on organizational constructs, in general do not know how to describe several important spatial properties, particularly the relational ones, of building layouts. As a result, the importance of building layouts in the study of organizational constructs remains unclear in the literature. This is evident in the fact that of all the studies on office settings reported in the "Environment and Behaviour" journal since the early 1970s, only a few provide drawings of the office layouts (e.g., Becker et al., 1983; Ornstein, 1999), and none attempts to characterize the spatial properties of the settings as represented in these layouts to describe organizational constructs.

In sum, there are no good parameters for characterizing office layouts in terms of organizational constructs. Most of the parameters found in the literature are context-dependent, hence cannot be applied to study different kinds of offices. Terms such as "open-plan vs. cellular", "rectilinear vs. free-plan" or "good vs. bad layout" are too imprecise to support either office research about the impact of layout or the effective use of layout to achieve the organization's purposes. For these and other reasons, it has been difficult for an organization to evaluate proposed office layouts and to make trade-off decisions between layouts and other issues involving organizational performance. (See Rashid 2002 for a complete bibliography of office studies)

2. Space syntax and organizational constructs

In this study, we attempt to establish systematic relationships between organizational constructs and office layouts. In this regard, the descriptors of "space syntax" are useful, because they allow us to characterize building layouts in terms of accessibility - both visual and physical - at the local and global levels (for a complete list of references on space syntax, see the Proceedings of the Space Syntax Symposium, 1997, 1999, & 2001). These accessibility patterns are probably among the most fundamental spatial properties of communication, control, territoriality, privacy and status, as we describe below. Location, proximity, openness, enclosure, and other similar spatial properties of these constructs used in several previous studies are in fact functions of accessibility at a very generic level.

"Communication", which refers to information exchange and/or transmission - whether structured or unstructured - may depend on interactions and encounters in a spatial setting. The intensity of communication within an office may increase with an increase in the degree of accessibility both at the local and global level of the

layout. If local accessibility is increased, encounter and interaction potentials at the local level may increase, resulting in an enhanced sense of localized group identity. Conversely, if global accessibility is increased, a larger organizational identity may be engendered as opposed to a group identity. Thus, a prudent balance between local and global accessibility may be required in order to sustain spatial integrity of groups as well as organizational identities.

"Control", which refers to the amount of restrictions imposed on communication and behaviour, may decrease with a decrease in the degree of accessibility in a spatial setting. Put another way, if accessibility is restricted, then the amount of spatially sustained communication may diminish. Likewise, if accessibility between different localized spatial entities is controlled, then territoriality may increase. Conversely, if accessibility between different localized spatial entities is not restricted, then territoriality may diminish.

"Territoriality", which refers to the sense of boundary of an individual or a group in a spatial setting, may diminish with an increase in the degree of accessibility primarily at the local level. That is because if the patterns of accessibility do not generate any locally differentiable spatial entities, it may be difficult to sustain a group identity due to intrusions. However, in such a system an individual may very well find its own territory, which, however, is better defined as privacy than territoriality.

"Privacy", which, among other things, refers to the degree to which an individual is accessible - both physically and visually - in a spatial setting, may diminish with an increase in the degree of access and with a decrease in the degree of control primarily at the local level. That is because if a space is properly shielded from its surrounding and if the access to the space can be sufficiently controlled by the user, it may matter less for privacy whether the space is globally accessible or not. However, for privacy it is better if a space has restricted access both at the local and global levels in order to make sure that a visitor does not find themselves at a place where they are not welcome.

"Status", which refers to one's position in an organization, may be impacted differently as the degree of accessibility to and visibility of one's space changes. For example, in an office setting where frequent interactions between workers and managers are not encouraged, the managers would probably occupy spaces that are physically and/or visually less accessible. Conversely, in a setting where frequent interactions between workers and managers are encouraged, then the purpose of the organization would be better served if the managers occupy accessible spaces. In situations where immediate supervision and control of the sub-ordinates by a

supervisor are a functional requirement, a compromise between status and functional demands may be required. In such situations, the supervisor may need to have better accessibility at the local level, but they may still occupy a space that is globally less accessible when compared to their subordinates.

If the above descriptions of the relationships between accessibility and the organizational constructs are valid and unambiguous, then it is possible to characterize these constructs using various techniques of space syntax, as shown below in our case studies.

3. Case studies

3.1 Methods

In the study, we use five office layouts of three federal organizations of the US Government that represent different organizational types and work situations. Our study data includes drawings of the office layouts, informal interviews with the top- and/or mid-level managers, and some field observations of these organizations.

We use the techniques of the axial map analysis of space syntax to describe the patterns of accessibility of the office layouts. In addition to the integration values, the connectivity values, and the lengths of the axial lines of the axial map of a layout, we also use the following spatial concepts in the study: 1) the shape of the circulation core defined by the most integrated set of axial lines, 2) the concept of spatial hierarchy based on global and local accessibility defined by integration and connectivity values, and 3) the degree of congruence between the geometric order of a layout and the order of its axial structure defined by the correlations of the local and global spatial variables.

We use the data of our interviews and field observations to verify, understand, and explain the findings of the axial map analysis in relation to communication, control, territoriality, privacy and status within the office settings of our organizations.

3.2 Case study 1: An office where people do routine low interaction work

Our first case study is a customer call centre of a federal agency of the US Government. It provides a one-stop service to customers using data and telecommunication systems. The majority of the employees here are customer service representatives (CSRs), who are trained to answer clients telephonically. A CSR processes information at a location where s/he receives it with occasional help from others. There exists a daily even pace of routine work. A CSR working on a computer or a phone may need some degree of privacy in order to perform efficiently. However, some kind of control must also be exercised to ensure that a CSR provides efficient and proper telephone services to their customers.

This organization as a whole has a short order of hierarchy. There are several large, partially independent, permanently defined work groups. Individuals work as parts of a group, but group activities involving all individuals of a group are rare. Communications within and between workgroups are well defined and/or controlled. Collaboration among individuals in various workgroups is not seen as particularly significant for the success of the organization.

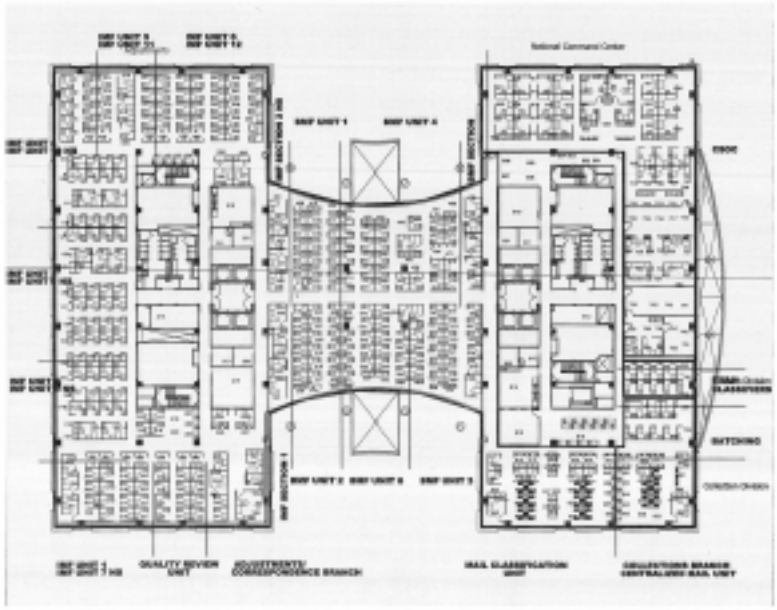

Figure 1: The second floor layout of case study 1 (not to scale).

Figure 2: The sixth floor layout of case study 1 (not to scale).

Here, we study the second and sixth floor layouts of the six-story call centre building (Figures 1 & 2). Our findings from the axial map analysis suggest that the patterns of interrelationship of the axial lines are similar both at the local and global levels of these layouts. In addition, the size of the potential field of movement and interaction, as described by the sum of the lengths of axial lines, is also comparable

in both cases (Table 1). In these layouts, circulation spaces have the highest mean integration value, followed by common spaces, then by customer service representatives, and section managers and supervisors or directors have the least mean integration value depending on the floor level (Tables 2, 3, 4, & 5). In other words, there is a hierarchy based on the degree of accessibility of various functionally distinct spatial categories in these layouts. Public areas are more accessible than private offices, and the offices of low-ranking workers are more accessible than the offices of high-ranking workers.

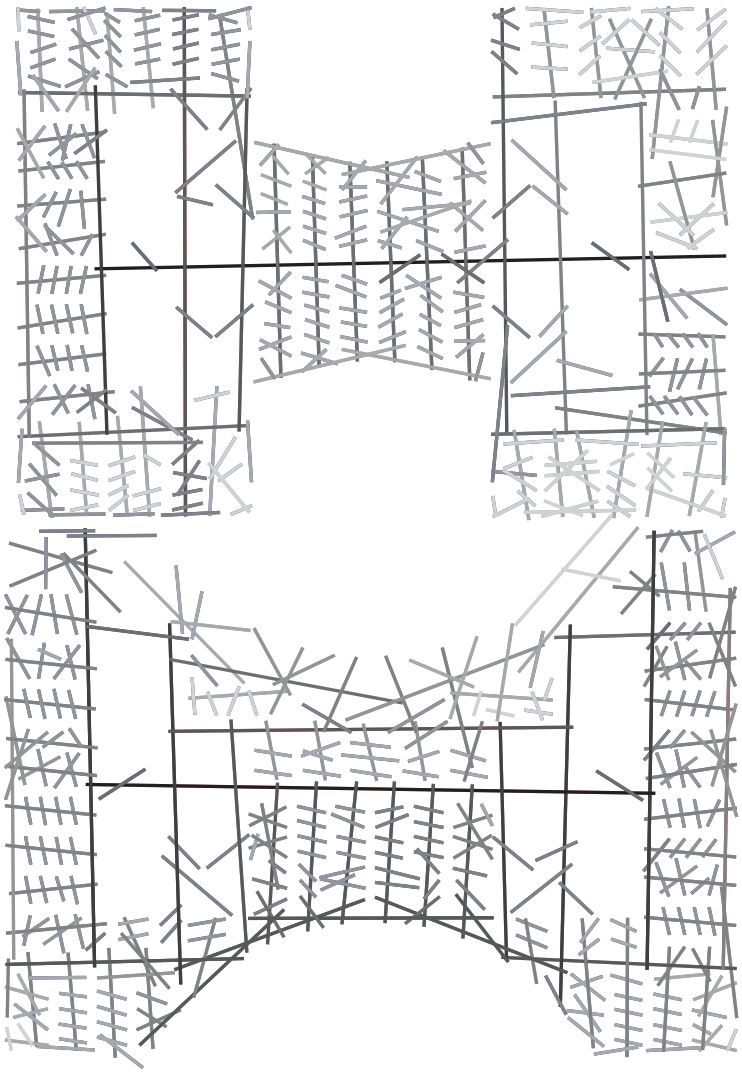

Figure 3: The axial map of the second floor layout of case study 1.

Figure 4: The axial map of the sixth floor layout of case study 1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Case study 1: Layout 2	328	343	1.045	9678	29.50	3.073	1.507	28.217
Case study 1: Layout 6	331	320	0.966	9500	28.70	3.144	1.48	29.691
Case study 2: Old Layout	244	253	1.037	8449	34.62	3.510	1.242	33.395
Case study 2: New Layout	226	106	0.469	7210	31.90	5.245	1.515	68.025
Case study 3	70	81	1.157	4523	64.61	4.864	1.767	55.838

(1)	Total no. of work-spaces	(5)	Length of axial lines per workspace
(2)	Total no. of axial lines	(6)	Mean Connectivity
(3)	No. of ax-ial lines per work-space	(7)	Mean Integration
(4)	Sum of all axial lines	(8)	Mean length of axial lines

Table 1: Summary of the spatial properties of the five layouts of the three case studies

	(1)	(2)	(3)	(4)	(5)
Total number of axial lines	343	35	228	71	13
Mean Integration	1.507	1.373	1.433	1.771	1.759
Mean Connectivity	3.073	2.4	1.763	8.042	1.154
Mean Length	28.217	20.057	16.446	71.593	27.464
Regression	r = 0.594	r = 0.403	r = 0.141	r = 0.715	r = 0.057
(Connectivity vs. Integration)	r^2 = 0.352	r^2 = 0.162	r^2 = 0.02	r^2 = 0.511	r^2 = 0.003
	p <.0001	p = 0.0164	p = 0.0332	p <.0001	p = 0.85
Regression	r = 0.862	r = 0.830	r = 0.763	r = 0.740	r = 0.559
(Connectivity vs. Length)	r^2 = 0.742	r^2 = 0.689	r^2 = 0.583	r^2 = 0.548	r^2 = 0.313
	p <.0001	p <.0001	p <.0001	p <.0001	p = 0.0475
Regression	r = 0.666	r = 0.363	r = 0.143	r = 0.842	r = 0.266
(Integration vs. Length)	r^2 = 0.444	r^2 = 0.132	r^2 = 0.02	r^2 = 0.709	r^2 = 0.071
	p <.0001	p = 0.0319	p = 0.0308	p <.0001	p = 0.38

(1) Whole axial map
(2) Axial lines- Section Managers and Supervisors (SM&S)
(3) Axial lines-Customer Service Repre-sentatives (CSR)
(4) Axial lines-Circulation Spaces (CIR)
(5) Axial lines-Common Facilities (COM)

Table 2: Spatial properties of the second floor layout of case study-1 based on axial map analysis

Mean Integration:	CIR (1.771)	> COM (1.759)	> CSR (1.433)	> SM&S (1.373)	
Mean Connectivity:	CIR (8.042)	> SM&S (2.4)	> CSR (1.763)	> COM (1.154)	
Mean Length:	CIR (71.593)	> COM (27.464)	> SM&S (20.057)	> CSR (16.446)	

Table 3: Rank order of different space categories of the second floor layout of case study-1 based on different spatial properties of the axial map.

	(1)	(2)	(3)	(4)	(5)	(6)
Total number of axial lines	320	13	17	239	67	14
Mean Integration	1.48	1.308	1.44	1.369	1.83	1.683
Mean Connectivity	3.144	2.923	2.647	1.866	7.97	1.857
Mean Length	29.691	39.662	20.938	18.048	71.197	29.807
Regression	r = 0.695	r = 0.608	r = 0.462	r = 0.322	r = 0.601	r = 0.446
(Connectivity vs. Integration)	r^2 = 0.483	r^2 = 0.369	r^2 = 0.213	r^2 = 0.104	r^2 = 0.361	r^2 = 0.199
	p <.0001	p = 0.0275	p = 0.0622	p < .0001	p <.0001	p = 0.1098
Regression	r = 0.854	r = 0.224	r = 0.609	r = 0.685	r = 0.754	r = 0.811
(Connectivity vs. Length)	r^2 = 0.729	r^2 = 0.05	r^2 = 0.371	r^2 = 0.47	r^2 = 0.568	r^2 = 0.658
	p <.0001	p = 0.4626	p = .0095	p <.0001	p <.0001	p = 0.004
Regression	r = 0.685	r = 0.135	r = 0.660	r = 0.124	r = 0.666	r = 0.332
(Integration vs. Length)	r^2 = 0.469	r^2 = 0.018	r^2 = 0.436	r^2 = 0.015	r^2 = 0.444	r^2 = 0.11
	p <.0001	p = .6602	p < 0.0001	p = 0.0553	p <.0001	p = 0.2467

(1) Whole axial map
(2) Axial lines- Directors and CEOs (DIR)
(3) Axial lines- Section Managers and Supervisors (SM&S)
(4) Axial lines-Customer Service Representa-tive (CSR)
(5) Axial lines-Circulation Spaces (CIR)
(6) Axial lines-Common Facilities (COM)

Table 4: Spatial properties of the sixth floor layout of case study-1 based on axial map analysis

Mean Integration:	CIR (1.83)	> COM (1.683)	> SM&S (1.44)	> CSR (1.369)	> DIR (1.308)
Mean Connectivity:	CIR (7.97)	> DIR (2.923)	> SM&S (2.647)	> CSR (1.866)	> COM (1.857)
Mean Length:	CIR (71.197)	> DIR (39.662)	> COM (29.807)	> SM&S (20.938)	> CSR (18.048)

Table 5: Rank order of different space categories of the sixth floor layout of case study-1 based on different spatial properties of the axial map

However, the rank order of space categories based on the mean integration values does not map onto their rank order based on the mean connectivity values, even though there is a good correlation between these two spatial variables in these layouts (Tables 2 & 4). Put simply, the logic of hierarchy and status is able to explain the layouts at the global level, but it fails to do so at the local level. This occurs probably because at the local level control of direct access takes precedence over hierarchy. The fact that the axial lines of sections manager and/or supervisors have a higher mean connectivity value, i.e., a higher degree of control over direct access, than that of CSRs is quite important for this particular organization where the performance and efficiency of CSRs may depend on the degree of supervision and control.

Spatial hierarchy and control are also manifest in the tree-like circulation system of the second and sixth floor layouts represented by the axial maps collared using integration (Figures 3 & 4). In general, the tertiary order circulation spaces connect individual workspaces; the secondary order circulation spaces that span within local areas connect the tertiary spaces; and the primary order circulation spine that cuts across and through the local areas connects the secondary order circulation spaces. A tree-like system, like the one we observe here, splits as it grows. In order to go from one part of this system to the other part, it is necessary to go back to the node where the split occurred and choose a new line of movement. We suspect that such a restricted system of movement may work well in these settings where people do routine low interaction works.

Additionally, within the generalized tree-like structure of the spatial system, the distribution of colour does not follow the geometry of the sixth floor office layout in the way it follows the geometry of the second floor layout. On the sixth floor, some of the peripheral spaces are more integrated to the whole system, thus forming a part of its secondary order circulation system (Figure 4), pointing to the fact that the geometric order of the layout may be different from the order of its relational pattern.

In the greyscale axial map of the sixth floor layout, we observe yet another phenomenon in relation to the area of the directors that is not immediately available from its geometry. Geometrically speaking, these offices are located at the most important place in the layout. However, in the relational pattern of axial lines, the area is very poorly connected to the whole system (Figure 4). The observation suggests the facts that an area located at a geometrically important location in a layout may not always have an easy access and may not always have a central place in the relational pattern.

The low mean connectivity value of common areas suggests that there are not many axial lines directly connected to the axial line of these areas (Tables 2 & 4). This is probably good for this particular organization where common areas are used for routine and/or planned activities. Note, however, that common areas are the places where informal interactions occur, and that the probability of interactions in these areas may increase if several other areas are directly accessible to and from them. If no such provision exists, as we see in these layouts, then a potential source for serendipitous interaction has been eliminated.

Finally, the predictable and routine work pattern of the call centre, which is already evident in the rigid geometric order of its layouts on the second and sixth floor, is further enhanced by good positive correlations between connectivity, integration and the lengths of the axial lines (Tables 2 & 4). These findings would suggest that there are both local and global orders in terms of geometry and space structure of the layouts of the call centre. In another setting, a strong syntactic order may exist without any geometric order. However, such a setting may not serve the purpose of the organization under investigation.

In summary, the space syntax analysis of the second and sixth floor layouts of the call centre shows that, both these layouts meet the functional as well as some of the socio-cultural requirements of the organization. They follow the logic of hierarchy and status at the global level. However, issues related to the control of direct access become more important at the local levels of these layouts. In addition, in both these layouts, the circulation system is used to fulfil the demands of status and control. Consistent with the expectations of the organization, territoriality is emphasized, and interaction and collaboration are de-emphasized in these layouts. Furthermore, the regularity of functional processes of the organization is reflected in the geometric order as well as in the order of axial structure of these layouts. However, no attempt is made here to redefine work processes and culture using the office layouts as a tool. According to our interviews, the managers are happy with the layouts, which, as a part of the quality work environment within the building, have contributed to an increased level of productivity.

3.3 Case study 2: An office where people primarily work in groups

Our second case study is a regional headquarters of a public real estate organization of the US Government. There are several divisions included in the organization. Each of these divisions performs different functions and has several groups working on different projects or tasks. The functional responsibilities of a group are defined by a division. It is possible that groups perform their tasks in different ways. Occasionally, members from several divisions would be brought together to work

on a special project. However, each member of such an action group or a task force would still work as a member of her/his original division, if not as a member of her/his previous group.

Like our previous case study, this organization also has a short order of hierarchy. There are only a few layers or ranks in each division, and each manager has a very wide span of control. Consequently, the power structure of the organization is highly centralized. Communication within and between groups and divisions are not well defined in the organization. Probably, the nature of communications varies with the type of work a group performs. Diversity of functions also precludes any simple generalization about the nature and pace of group work.

The current leadership recognizes that collaboration among individuals and groups is important for the success of the organization. It also acknowledges the facts that a collaborative environment must provide facilities to enhance and encourage formal as well as informal interactions between workers.

Here, we study two different office layouts in the regional headquarters (Figures 5 & 6). One of these layouts, called the "old layout", was occupied by the organization for almost a decade. The other layout, called the "new layout", has been occupied by the organization only recently. The comparison between the old and new layouts should be interesting because the leadership of the organization wants to increase the amount of interaction and collaboration in the office using the office layout as a tool.

Unlike the layouts of the call centre, we find strong dissimilarities in the axial maps of the old and new layouts of the present case study. The dissimilarities prevail both at the local and global levels of the layouts (Table 1). There are also differences in the rank orders of the mean integration values of different categories of spaces of the old and new layouts. In the old layout, directors and/managers are located on more integrated axial lines than their subordinates are (Table 7). In contrast, in the new layout, managers and directors are located on less integrated axial lines than their subordinates are (Table 9).

However, there is no difference in the rank orders of the mean integration and connectivity values of different space categories in either of the layouts (Tables 7 & 9). That is because, unlike the call centre, in our present case study, local control over direct access is not a big issue because an individual does not need to be supervised and their performance has little or no direct correlation to the overall output. As a result, the relationship between status and accessibility is more direct in

these layouts: when a person needs to be accessible, they are accessible at both local and global levels, as in the old layout. Conversely, when a person needs to be less accessible, they are less accessible at both the levels, as in the new layout.

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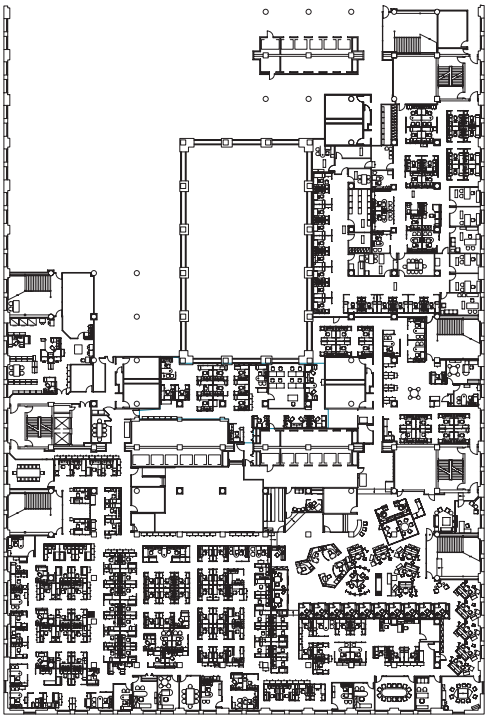


Figure 5: The old layout of case study 2 (not to scale).

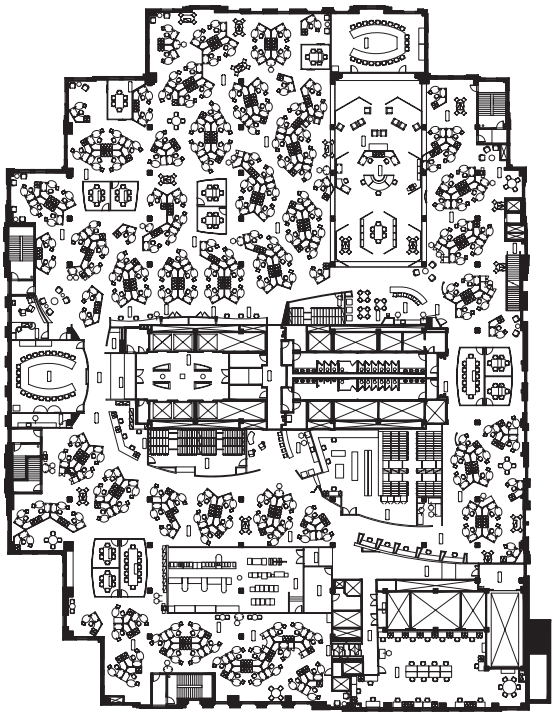


Figure 6: The new layout of case study 2 (not to scale).

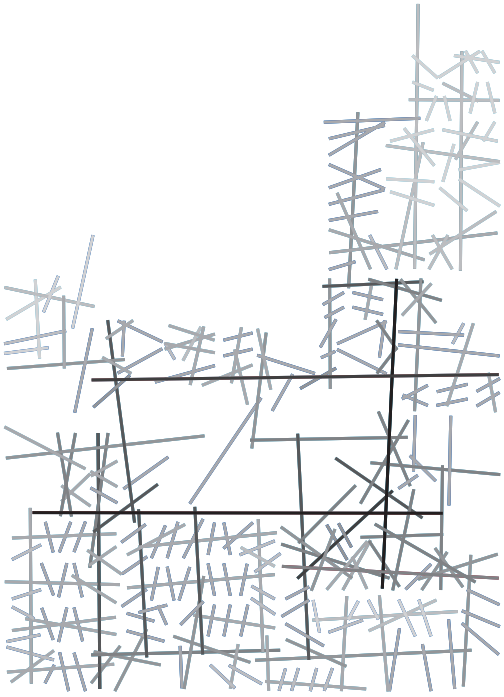


Figure 7: The axial map of the old layout of case study 2.

Figure 8: The axial map of the new layout of case study 2.

	(1)	(2)	(3)	(4)	(5)
Total number of axial lines	253	37	152	52	29
Mean Integration	1.242	1.199	1.189	1.442	1.376
Mean Connectivity	3.510	4.189	2.855	7.885	5.724
Mean Length	33.395	39.504	26.132	71.961	59.673
Regression	r = 0.619	r = 0.603	r = 0.602	r = 0.541	r = 0.601
(Connectivity vs. Integration)	r^2 = 0.383	r^2 = 0.363	r^2 = 0.362	r^2 = 0.293	r^2 = 0.361
	p <.0001	p <.0001	p < .0001	p <.0001	p = 0.006
Regression	r = 0.885	r = 0.946	r = 0.928	r = 0.823	r = 0.863
(Connectivity vs. Length)	r^2 = 0.784	r^2 = 0.896	r^2 = 0.861	r^2 = 0.677	r^2 = 0.745
	p <.0001	p < 0.0001	p <.0001	p <.0001	p < .0001
Regression	r = 0.566	r = 0.544	r = 0.519	r = 0.543	r = 0.587
(Integration vs. Length)	r^2 = 0.321	r^2 = 0.296	r^2 = 0.269	r^2 = 0.294	r^2 = 0.345
	p <.0001	p = 0.0005	p < 0.0001	p <.0001	p = 0.0008

(1) Whole axial map
(2) Axial lines- Directors and/or Managers (D&M)
(3) Axial lines-Workstations (WS)
(4) Axial lines-Circulation Spaces (CIR)
(5) Axial lines-Common Areas (COM)

Table 6: Spatial properties of the old floor layout of case study-2 based on axial map analysis

Mean Integration:	CIR (1.442)	>	COM (1.376)	>	D&M (1.199)	> WS (1.189)
Mean Connectivity:	CIR (7.885)	>	COM (5.724)	>	D&M (4.189)	> WS (2.855)
Mean Length:	CIR (71.961)	>	COM (59.673)	>	D&M (39.504)	> WS (26.132)

Table 7: Rank order of different space categories of the old floor layout of case study-2 based on different spatial properties of the axial map

	(1)	(2)	(3)	(4)	(5)
Total number of axial lines	106	9	80	91	36
Mean Integration	1.515	1.470	1.487	1.550	1.550
Mean Connectivity	5.245	5.111	5.188	5.703	5.589
Mean Length	68.025	67.596	66.876	71.113	69.356
Regression	r = 0.733	r = 0.928	r = 0.688	r = 0.731	r = 0.634
(Connectivity vs. Integration)	r^2 = 0.537	r^2 = 0.862	r^2 = 0.473	r^2 = 0.535	r^2 = 0.403
	p <.0001	p = .0003	p < .0001	p <.0001	p < 0.0001
Regression	r = 0.752	r = 0. 832	r = 0.753	r = 0.765	r = 0.839
(Connectivity vs. Length)	r^2 = 0.566	r^2 = 0.692	r^2 = 0.567	r^2 = 0.585	r^2 = 0.704
	p <.0001	p = 0.0054	p <.0001	p <.0001	p < 0.0001
Regression	r = 0.574	r = 0. 851	r = 0.534	r = 0.623	r = 0.406
(Integration vs. Length)	r^2 = 0.329	r^2 = 0.725	r^2 = 0.285	r^2 = 0.388	r^2 = 0.165
	p <.0001	p = 0.0036	p < 0.0001	p <.0001	p = 0.0140

(1) Whole axial map
(2) Axial lines- Directors and/or Managers (D&M)
(3) Axial lines-Workstations (WS)
(4) Axial lines-Circulation Spaces (CIR)
(5) Axial lines-Common Facilities (COM)

Table 8: Spatial properties of the new floor layout of case study-2 based on axial map analysis

Mean Integration:	CIR, COM (1.550)	>	WS (1.487)	>	D&M (1.470)		
Mean Connectivity:	CIR (5.703)	>	COM (5.589)	>	WS (5.188)	>	D&M (5.111)
Mean Length:	CIR (71.113)	>	COM (69.356)	>	D&M (67.596)	>	WS (66.876)

Table 9: Rank order of different space categories of the new floor layout of case study-2 based on different spatial properties of the axial map

As opposed to the tree-like circulation system observed in the layouts of the call centre, we observe a wheel like circulation core in both the old and new layouts of our present case study (Figures 7 & 8). The similarity between the two layouts however ends here. The axial map of the old layout (Figure 7) is differentiated in the way it was in our previous case study. Except for one or two areas, the spatial hierarchy can be clearly observed in the axial structure of the layout. From the primary

circulation extend out the secondary circulation spaces; from these secondary spaces extend the tertiary circulation spaces; and so on. Distinctly different spatial zones also emerge out of the pattern. In most cases, these emerging spatial zones map onto the divisions and/or group of organization, according to our field observations.

The new layout is very different from the old layout with respect to the configuration of the axial map (Figure 8). The axial lines are much longer and their number much fewer in the new layout. These are achieved by taking away the boundaries and/or enclosures around individual workstations. As a result, these offices have become an integral part of the circulation system or vice versa. Each axial line now runs through several spaces of different types. We can read an axial line as a circulation space, an office space, a common area, or all of these at the same time. Consequently, there is a lack of significant differences between the spatial properties of different spatial categories (Table 9).

Unlike the old layout, there is also a lack of order in the collared axial map of the new layout. The more integrated lines are lumped on one side of the layout. No spatial hierarchy and territory are evident in the collared map. Instead of demarcating territories, the axial lines with high integration values cut across the territories defined by the organization suggesting that movement, encounter, and interaction are given primacy over territoriality in the new layout. This is further supported by the fact that the axial lines of the common spaces and the circulation spaces have the same mean integration value in the new layout. Put another way, these spaces have the same degree of global accessibility and are equally potent for spatially generated encounter and interaction in the new layout. However, at the local level the degree of accessibility of the common spaces is less than that of the circulation spaces as shown by the mean connectivity values, thus giving these common spaces a sense of remoteness at the local level (Table 8).

However, there are strong correlations between integration, connectivity, and the length of the axial lines in both these layouts (Tables 6 & 8) suggesting that the axial structures of the two layouts have both local and global orders. However, the orders in the axial structure exist in the presence of a geometric order in the old layout, and in the absence of a geometric order in the new layout.

In summary, our study shows that the old and new layouts of our second case study are significantly different from one another. In the old layout, according to our analysis, spatial hierarchy meets the need of the organization; the circulation system follows the logic of territoriality; and the geometric order of the layout is shored up by the order of the axial structure of the layout. As a result, as we were told, the old

layout worked very well and users liked it. The fact that the new layout is different from the old layout would suggest that the organization wants to change its work processes and culture using the layout as a tool. Nevertheless, it is only worrying to note that the new lay out is very different from the old layout. Since the new layout has been occupied only recently, we are yet to see if its spatial structure creates difficulties in the way work has been done for a decade in the organization and if this destroys an already existing spatial culture of the organization for the sake of an unknown new one.

3.4 Case study 3: An office designed to unite the parts of an organization

Our third case study is a segment of a regional headquarters of another federal organization of the US Government. This federal organization has three different service organizations. Traditionally, these service organizations have worked independently. Only recently, the parent organization has realized that more collaboration and information exchange at the decision-making levels of these service organizations are needed in order to simplify and improve its business processes.

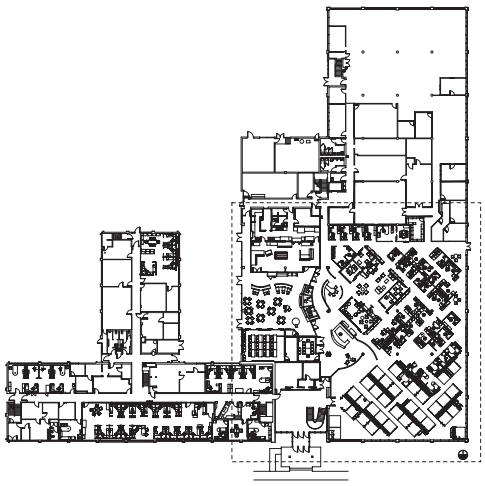
As one of the early steps, the organization has redesigned a part of its office, which we study here, to co-locate only the top-level people - administrators, directors, and project managers - of the three service organizations (Figure 9). The decision was based on an assumption that spatial co-location would force these people to interact with each other more frequently - both formally and informally. As a result, there would be more information exchange between them than was possible before when they occupied spaces at different locations.

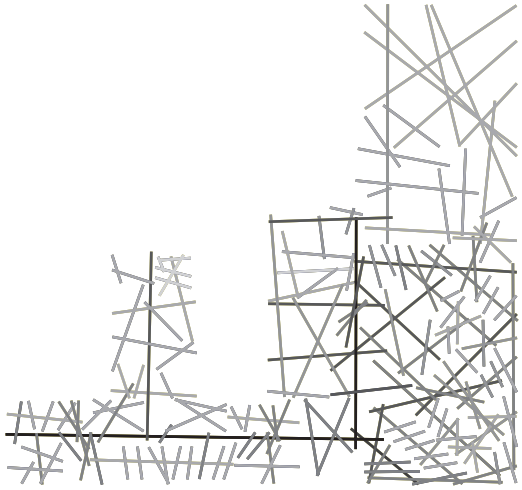
Since the people in the office segment are from three different service organizations, we expect at least three different group territories in the office layout. Given the fact that each individual occupies a very high status in their organization, the membership of any group here may be defined by differences rather than by similarities in their roles and functions. Conflicts and tensions are likely to exist within the environment due to the differences in the value systems of the three organizations. Supervision and control of individuals at this high level of the organization is less important. No restriction is expected on the amount and types of interactions. Rather, interactions are encouraged, as we have already stated.

Figure 10 shows the axial maps, collared using the integration values of the axial lines, of the office segment under study and of the whole floor layout within which the segment is located. According to these collared maps, we see no significant differences in the axial structures of the office segment considered independently

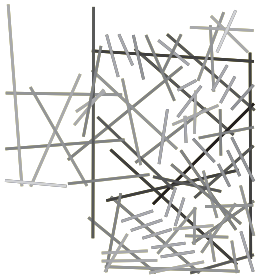
and considered as a part of the larger system. That is because the segment is only loosely connected to the other parts of the layout and is, in itself, quite large when compared to the whole layout.

Figure 9: The first floor layout and the office segment under study, within the dashed line, of case study 3 (not to scale).





(a)



(b)

Figure 10:
a) The axial map of the first floor layout of case study 3
b) The axial map of the office segment under study of case study 3

	(1)	(2)	(3)	(4)
Total number of axial lines	81	55	29	38
Mean Integration	1.767	1.706	2.077	1.832
Mean Connectivity	4.864	3.818	8.069	5.737
Mean Length	55.838	43.114	92.299	69.075
Regression	r = 0.830	r = 0.782	r = 0.796	r = 0.780
(Connectivity vs. Integration)	r^2 = 0.689	r^2 = 0.612	r^2 = 0.634	r^2 = 0.608
	p <0.0001	p <0.0001	p <0.0001	p < 0.0001
Regression	r = 0.769	r = 0.746	r = 0.434	r = 0.637
(Connectivity vs. Length)	r^2 = 0.592	r^2 = 0.556	r^2 = 0.188	r^2 = 0.406
	p <0.0001	p < 0.0001	p = 0.0187	p < 0.0001
Regression	r = 0.657	r = 0.695	r = 0.384	r = 0.510
(Integration vs. Length)	r^2 = 0.432	r^2 = 0.483	r^2 = 0.147	r^2 = 0.260
	p <0.0001	p < 0.0001	p = 0.0399	p = 0.0011

(1) Whole axial map
(2) Axial lines- Directors and/or Managers (D&M)
(3) Axial lines-Circulation Spaces (CIR)
(4) Axial lines-Common Areas (COM)

Table 10: Spatial properties of the partial floor layout of case study-3 based on axial map analysis

Mean Integration:	CIR (2.077)	>	COM (1.832)	>	D&M (1.706)
Mean Connectivity:	CIR (8.069)	>	COM (5.737)	>	D&M (3.818)
Mean Length:	CIR (92.299)	>	COM (69.075)	>	D&M (43.114)

Table 11: Rank order of different space categories of the partial floor layout of case study-3 based on different spatial properties of the axial map

The circulation system of the office layout is like a net defined by a set of very highly integrated lines; there is no periphery-periphery dichotomy in the axial map; nor is there any distinct spatial hierarchy defined by the integration values of the lines. Every office space in it is located on lines no more than one-step-away from some very integrated lines. This office layout, which accommodates three different groups of people from three different service organizations, does not represent, at least in its axial structure, any group territories. Rather, the layout has the most egalitarian axial structure of the ones we have studied so far, which is a very true representation of the aspiration of the parent organization that wants "to make one large organization out of three different service organizations."

The layout may provide a better field of potential interactions than the other layouts, since its axial structure has the highest mean integration value of all the layouts studied so far (Table 1). However, the interaction potential of the layout may partly be diminished by the facts that the length of axial line per workspace and the numbers of axial line per workspace are very high in this layout ensuring some privacy and flexibility within the layout.

Even though the layout of this segment of office as a whole shows some degree of tension between autonomy and interaction, the placement of common spaces suggests that issues related to interaction and collaboration between workers have been considered carefully in the layout. There are several well-defined areas for formal and informal interactions within the layout. All these common spaces are located on very integrated axial lines. Interestingly, of all the functions, the informal meeting areas have been given the most important places both in the axial and geometric structures of the layout.

Like most of the other layouts studied here, different types of spaces are distributed in the layout of this office segment according to their accessibility requirements both at the local and global levels (Table 11). In addition, we find strong correlations between integration, connectivity, and the length of the axial lines (Table 10) suggesting that the axial structure of the office segment may have intelligible local and global orders.

In summary, our study of the layout of this office segment shows why and how the layout may weaken the idea of territoriality and may help to foster an environment of interaction. In the process, we suspect that the layout would undermine status and would compromise privacy of some very important people in the organization. We did not observe any notable spatial manoeuvre to mitigate these problems. However, other ways to mitigate these problems may still exist, which we do not study here.

4. Summary of the study and concluding remarks

Our study reveals the following key differences and similarities of the five office layouts of the three federal organizations (Table 12):

1) The shape of the circulation core is different in these layouts: Some follow the logic of territory, while others do not.

2) In some layouts, the underlying spatial structure has a strengthening effect, while in others it has a weakening effect on territoriality.

3) Spatial hierarchy based on accessibility reflects functionally distinct spatial categories in all these layouts except one. In general, public areas are more accessible than private offices, and the offices of low-ranking workers are more accessible than the offices of high-ranking officers.

4) The structure of space and the location of common spaces within it vary in these layouts depending on the importance given to interaction and collaboration in these organizations.

5) Global accessibility and direct access interact differently in these layouts depending on the demands of local control and supervision.

6) The relationship between the underlying spatial order and the geometric order of the layout is different in these layouts, which affects organizational constructs in several ways.

	(1)	(2)	(3)	(4)	(5)
Case study 1: Layout 2	Tree-like	Strengthened by axial structure	Reflects functionally distinct spatial categories	Do not map onto each other	Co-exist
Case study 1: Layout 6	Tree-like	Strengthened by axial structure	Reflects functionally distinct spatial categories	Do not map onto each other	Partly co-exist
Case study 2: Old Layout	Wheel-like	Strengthened by axial structure	Reflects functionally distinct spatial categories	Map onto each other	Partly co-exist
Case study 2: New Layout	Wheel-like	Not related to axial structure	Partly reflects functionally distinct spatial categories	Partly map onto each other	Order in axial structure exists w/o geometric order
Case study 3	Net-like	Weakened by axial structure	Reflects functionally distinct spatial categories	Map onto each other	Partly co-exist

(1) Shape of the circulation core
(2) Group territoriality
(3) Spatial hierarchy based on accessibility
(4) Rank orders of local & global accessibility of space categories
(5) Orders in geometry and axial structure

Table 12: Summary of the findings

Our study also reveals that these observed differences and similarities of the layouts are in part a result of some basic spatial strategies, such as the ones described below, knowingly or unknowingly used by the people who conceived these layouts:

1) The number of axial lines per workspace is fewer in the organizations that encourage interaction than it is in the organizations that do not encourage interaction. That is because for a given number of workspaces in a layout, the lower the number of axial lines the higher the potential for interaction. Put simply, for a given number of workspaces, the number of interactions is likely to be higher if offices are put along a single corridor instead of two or more corridors.

2) The length of axial line per workspace is shorter in the organizations that encourage interaction than it is in the organizations that do not encourage interaction. That is because the length of line is related to travel distance. The lesser the length of axial lines per workspace the lesser the travel distance and the higher the potential for interaction. Put another way, a person may choose to talk to their neighbour rather than to go across the building to talk to another person on the same matter.

3) The interconnectedness of the axial structure is higher in the organizations that encourage interaction than it is in the organizations that do not encourage interaction. That is because the degree of interconnectedness of a spatial structure relates to choices of movement and opportunities for interaction.

4) A strongly defined group territory within the organizations we study usually has a highly interconnected local axial structure that is cut across by fewer axial lines in order to provide a sense of local coherence. In addition, the local structure of the territory also has minimal connections with the global structure.

5) The higher the privacy requirements of a space in these organizations the lower the integration and connectivity values of the axial line on which the space is located and the fewer the number of axial lines cutting across the space. That is because an axial line with low connectivity and integration is locally and globally less accessible, and the amount of movement across a space may depend on the number of axial lines cutting across the space.

6) To discourage frequent interactions between workers and managers, in some organizations managers occupy spaces on segregated axial lines because these spaces are less accessible. Conversely, to encourage frequent interactions between workers and managers, in others managers occupy spaces on integrated axial lines because these spaces are more accessible.

To conclude, the spatial strategies that we observe in our case studies are important because they relate the abstract structure and processes of an organization to the generic laws of spatial depth and accessibility using a set of constructs that are very useful in the everyday life of an organization. We can use them to describe and compare the organizational constructs of widely different office layouts. We can also use them to explain and understand the performance of a layout in terms of these constructs. Additionally, we can use these strategies to lay out an office if the nature of the organizational constructs is known. A reasonable question, however, is the extent to which these organizational constructs are more a function of psychological and volitional aspects of an organization than of a perfect application of some spatial strategies such as the ones observed in our case studies. In our ongoing research on offices, we hope to look at the complex relationships of space and human behaviour and expectations in relation to these organizational constructs in an attempt to resolve this and other similar questions.

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