



Activity-based flexible office: exploring the fit between physical environment qualities and user needs impacting satisfaction, communication, collaboration, and productivity

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Abstract

Purpose:

Corporations balancing real estate holding (CRE) costs with recruitment-retention increasingly employ Activity-Based Flexible Offices (AFO) to right-size environments for a mobile workforce. In this layout, workers have the option to select between a mix of unassigned workstations and alternative work settings (AWS) that support autonomy and mobility. The open layout encourages visibility and access to colleagues to enhance communication and collaboration. Nevertheless, studies into the effects of AFO environment attribute effects on worker needs and work outcome are sparse. Therefore, this study focused on understanding how environmental features and psychological or job needs impact observed and perceived satisfaction, communication, collaboration, and perceived productivity.

Method:

Data were collected in a case organization piloting an AFO before implementation across their CRE portfolio. A mixed methods approach was employed, including systematic observations, space syntax, and surveys collecting information on observed and perceived satisfaction, communication, collaboration, and productivity.

Findings:

Collaboration instances were higher in AWS's, especially more visible and accessible open areas, supporting higher impromptu interactions and enhanced perceptions of productivity of team members and cross-team members. Privacy requirements linked to a greater demand for

enclosed AWS's. Team communication satisfaction depended on how easily teams were located. Almost half of the user teams clustered within workstation zones corresponding to territoriality needs. Job autonomy satisfaction depended on the availability of preferred workstation or AWS, enabling private, uninterrupted work that enhanced perceived productivity.

Conclusion:

The case study findings indicated a correlation between the AFO environment and worker needs impacting workplace satisfaction, communication, collaboration, and perceived productivity.

Originality:

The findings from this case study indicated that a fit between the AFO environment and needs impacted workplace satisfaction, communication, collaboration, and perceived productivity.

Introduction

Research into the impact of the design and configuration of workplace environments on employee productivity, satisfaction, and organization profitability has been well established (De Been and Beijer, 2014, Rolfö et al., 2018, Babapour et al., 2018, Wohlers et al., 2017). Enhancing satisfaction with physical work environments is crucial for organizations, as it has been directly linked to job satisfaction and other outcomes such as productivity, stress, or retention (Hoendervanger et al., 2018, De Been and Beijer, 2014, Rolfö et al., 2018, Vischer, 2007). Personal and job associated needs may impact satisfaction with work environments (Wohlers et al., 2017, Wolfeld, 2010, Jahncke and Halin, 2012). Corresponding to these findings

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3 scholars have developed the Person- Environment Fit (PEF) theory which discusses that
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5 dissatisfaction may result from inappropriate adjustment between psychological needs and
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7 physical environment attributes (Kristof-Brown et al., 2005).
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10 Organizations are interested in exploring alignment of their corporate real estate (CRE)
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12 portfolio with employee activities and well-being (Alker et al., 2014, Appel-Meulenbroek et al.,
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14 2015, Brunia et al., 2016). Novel workstyles, new generations, technology, and transforming
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16 lifestyles-have increased the demand for exploring the positive and negative outcomes of new
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18 office layouts and the extent they fit psychological and organizational needs (Brunia et al., 2016,
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20 Cai and Khan, 2010). As a result, architects and interior designers strive to create dynamic and
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22 responsive work environments that correspond to user needs.
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26 Shared office spaces and hot-desking are not new concepts, however technological
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28 advances since hot-desking’s inception in the 1990’s have radically changed the need for desk-
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30 based work or even office-based work. As workers embrace a work-life integration ethos of
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32 “work anytime, anywhere”, organizations are seeing real estate space utilization rates averaging
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34 between 60%-70% (JLL, 2019). In response, organizations are innovating ways to reduce square
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36 footage per worker while providing relevant and adaptable workplaces for individual focused
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38 work and team collaboration. The Activity-Based Flexible Office (AFO) is a newly transpired
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40 office environment trend for efficiency and flexibility where employees decide where, when, and
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42 how to perform the work (Appel-Meulenbroek et al., 2011). It has been linked to reduced
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44 overhead costs, enhanced workplace satisfaction and productivity, and increased networking
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46 opportunities (Gorgievski et al., 2010, Appel-Meulenbroek et al., 2011, De Been and Beijer,
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48 2014, Babapour et al., 2018, Candido et al., 2018, Hoendervanger et al., 2018).
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3 In response to underutilized space across an organization's CRE footprint, the foundation
4 of AFOs is based upon right-sizing the workplace with the freedom to select from a variety of
5 work spaces based on user needs (Gorgievski et al., 2010). This concept is translated into
6 transparent spaces including unassigned workstations in open areas and different non-assigned
7 open and enclosed alternative work settings (AWS) for all employees (Appel-Meulenbroek et al.,
8 2011, Montanari et al., 2017, Hoendervanger et al., 2018, Wohlers et al., 2017). The limited
9 amount of empirical research on AFO's to date has been overall positive.

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11 Satisfactory operational outcomes for organizations depend on effective communication
12 and collaboration patterns of employees that facilitate productivity and knowledge transmission
13 (Alker et al., 2014, Brunia et al., 2016, Markhede, 2010). Therefore, workplace designers strive
14 to create spaces that enhance the chances of impromptu face-to-face communication.
15 Understanding how AFOs promote employee satisfaction, communication, collaboration, and
16 productivity is crucial for optimum task accomplishments and potential questions raised by the
17 development of this new type of workplace (Wohlers and Hertel, 2017, Rolfö et al., 2018, De
18 Been and Beijer, 2014, Babapour et al., 2018).

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20 The popularity of knowledge work in current organizations introduces a challenge for
21 office environments that simultaneously support psychological and job needs to ensure desired
22 work outcomes. The theoretical framework for this study was based on combining existing AFO
23 office models suggested by Hoendervanger et al. (2018) (an integrated approach to providing a
24 mix of spaces related to a needs-supply fit for workers), and Wohlers et al. (2017). We
25 hypothesize that AFO spatial features (flexibility, workstation characteristics, visibility, and
26 accessibility) as well as satisfaction with environmental fit for psychological and job needs
27 relevant in the context of AFO environments (privacy, territoriality, autonomy, mobility,

concentration) impacts work outcomes in AFO environments (satisfaction, communication, collaboration, and productivity) (Figure 1). The following paragraphs will expand on these spatial features, psychological and job needs, and desired work outcomes.

1) Spatial features: AFO work environments are flexible spaces with unassigned workstations and a combination of open and enclosed areas that are expected to enhance visibility and accessibility, face-to-face interaction, access, likelihood of encounters, and frequency of communication (Peponis et al., 2007, Appel-Meulenbroek et al., 2015, Hoendervanger et al., 2018, Wohlers and Hertel, 2017, Rashid et al., 2006).

2) Psychological and job needs: Privacy is defined as a psychological need for workers to seclude from social interaction or distraction accordance (De Been and Beijer, 2014, Appel-Meulenbroek et al., 2014). Concentration is also critical for task accomplishment, especially when employees need to focus on complex work (Hoendervanger et al., 2018). Although AFOs contain enclosed AWS to mitigate the negative impact of lack of privacy and noise, the majority of AFO settings are open and transparent. This condition has been linked to reduced privacy, concentration, and satisfaction (Wohlers and Hertel, 2017, Danielsson and Bodin, 2009, Hoendervanger et al., 2018).

Territoriality is described as the behavioral representation of feelings of ownership towards social or physical objects (Brown, 2009). Personalization and establishing physical and social boundaries in offices enable expressions of territoriality (Brown, 2009, Appel-Meulenbroek et al., 2014, De Been and Beijer, 2014). Studies suggest that the flexible and unassigned nature of AFO spaces may impose adverse work conditions by not supporting territoriality and opportunities to maintain strong team communication and interaction (Ekstrand and Karsten Hansen, 2016, Rolfö et al., 2018, Wolfeld, 2010, Danielsson and Bodin, 2009,

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3 Hoendervanger et al., 2018). Thus, we hypothesize that users' need for privacy and territoriality
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5 are negatively impacted in AFO settings.
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8 Autonomy refers to employees' level of control of time and place to accomplish job tasks
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10 (Demerouti et al., 2014, Van der Voordt et al., 2012). Literature suggests a positive relationship
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12 between a higher psychological need for autonomy and flexibility of working in different
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14 locations (Van Yperen et al., 2014, van Koetsveld and Kamperman, 2011). Unassigned
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16 workstations and alternative work settings (AWS) in AFOs are expected to enhance flexibility
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18 and choice of spatial options corresponding to the need for personal and job autonomy (Appel-
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20 Meulenbroek et al., 2011, Wohlers et al., 2017).
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24 Mobility in the work environment is one of the central concepts of AFOs supporting the
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26 need for users to move around and use activity settings of choice (van Koetsveld and
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28 Kamperman, 2011). Therefore, AFO will be a good fit for an employee with job tasks entailing
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30 frequent movements between settings (Hoendervanger et al., 2018).
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33 3) Work outcomes: The diversity of work setting choices, high visibility, and unassigned
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35 workspaces in AFOs are expected to support job needs that require unplanned social interaction
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37 and intra-team communication, which are positively linked to worker satisfaction with an AFO
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39 environment (van Koetsveld and Kamperman, 2011, Wohlers et al., 2017, Hoendervanger et al.,
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41 2018). In contrast, AFO environments may not be a good fit for workers demanding routine,
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43 concentrated work, or frequent contact with teams. Therefore, we hypothesize that satisfaction
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45 with the workplace, communication, collaboration, and perceived productivity are influenced by
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47 workers psychological and job needs that are affected by spatial features.
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52 Despite the increasing implementation of AFOs, there are limited empirical studies that
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54 evaluate the effectiveness of AFO environments related to worker needs. This research attempts
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to determine whether the environmental features of an AFO is supportive of the suggested personal and job requirements and its impact on satisfaction, communication, collaboration, and perceived productivity.

Methods

Setting

This explorative case study was performed at a large technology company, headquartered in North Carolina, USA that planned on making a significant “cultural shift” from a traditional workplace setting to an AFO setting. Cultural shifts are recognized as a challenging leadership task as they aim for altering goals, roles, processes, ethics, communications, and attitudes within organizations. As with many established organizations, the case study company’s current traditional workplace setting was based on a typically hierarchical arrangement with all employees in assigned spaces: senior management in private enclosed offices, general staff in cubicles, and managers in slightly larger cubicles. Employee career expectations included entitlement to larger cubicles and enclosed offices as they were promoted through the organization. Occupancy data collected by the organization over two years indicated a consistent 60% utilization rate of their office space, reinforcing the need to implement a new real estate portfolio asset management strategy. As part of this strategic decision process, the planned cultural shift to an AFO setting would eliminate all assigned offices and cubicle workstations at a ratio of 1 desk:1 employee in favor of unassigned seating at a ratio of 1desk:1.6 employees with activity-based workspaces. In addition to more efficiently utilize real estate by transitioning to an AFO setting, the company aimed at creating a more aesthetic workplace, incorporating their new branding colors and graphics to create an environment that fostered collaboration, mobility, and interaction.

Before implementing an AFO setting throughout the company's entire real estate footprint, a partial floor in one of the organization's buildings was renovated to represent a modern atmosphere that incorporated AFO principals, giving 115 employees from four departments diverse and flexible spaces for collaboration and concentration. The pilot participants provided feedback on the impact of the design and configuration of the AFO setting. The organization planned to use the input to modify the AFO standards used in the pilot to maximize the effectiveness of their AFO setting in the portfolio-wide rollout. The AFO setting in this study provided a 39% reduction in real estate per employee, from 123 sf/person in the traditional setting to 75 sf/person in the AFO setting.

The pilot AFO design included the introduction of the organization's eight new branding colors and environmental graphics program refreshing a primarily grey, white, red, and black scheme. Most of the space was carpeted, with resilient flooring in open alternative workspaces, and a polished concrete circulation path through the area. Ceilings were lay-in acoustical tile. Most enclosed spaces used modular walls with writeable surfaces, integrated monitors, and one full glass wall at the entrance side of each room. Repeaters were added to increase the range of the somewhat spotty existing WIFI system.

The 8,345-sf floor plan was organized into open workstation areas and a variety of AWS (See Figure 2). These spaces include: (a) *workstations*: seventy workstations in 4-10 station clusters in the open-plan areas. A height-adjustable-desk, ergonomic seating, and either one or two monitors in each workstation; (b) *small enclosed rooms*: six phone /focus rooms of approx. 80 sf each furnished in a variety of soft seating for 2-3 people. Monitors were not included in the phone/focus rooms; (c) *team rooms*: six enclosed team rooms at approx. 120 -100 sf furnished with typical conference room tables and chairs and a monitor; (d) *small open area*: one small

open phone room of approx. 80 sf furnished with soft seating for 2-3 people; (e) *large open areas*: five large open furnished areas of approx. 280 sf that included a variety of soft seating, small four-person meeting table configurations with monitors, and four duck-out areas with casual seating; and (f) *lockers*: assigned lockers for all of the 115 participants.

Data Collection

The organization engaged in a test-pilot of the proposed AFO design guidelines before rolling out the change company-wide. Goals for the test pilot included verification of the desk to employee ratio, the number of enclosed and open activity-based workspaces, the types of furnishings used, improved employee collaboration, and workplace satisfaction. A mixed method approach was employed that integrated ethnographic methodologies (surveys and observations) and space syntax for triangulation. Ethical approval was granted before data collection. Each method is described in additional detail below.

Spatial analysis

Space syntax theory is a framework that recognizes connections between spatial layout and user behavior (Peponis et al., 2007, Rashid et al., 2006, Haq and Luo, 2012). In space syntax, the layout is recognized as a set of connected spaces with measurable visibility and accessibility values (Haq and Luo, 2012, Turner, 2004, Behbahani et al., 2017). Visibility is measured through connectivity values, defined as the number of immediate neighbors that are linked to a corresponding space or vertex (Behbahani et al., 2017, Turner, 2004). Accessibility is measured through *Step-depth* values, described as the average number of edge turns that one needs to travel from the current location to visit other locations in the layout (Turner, 2004). *Mean depth* is calculated by allocating a step-depth value to each space in relation to how many spaces it is away from the original space that is inversely related to visibility values (Turner, 2004).

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3 The more segregated spaces have higher mean depth (MD), and conversely, more
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5 accessible spaces gave lower MD values (a negative relationship between a variable and MD is
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7 indicative of the variable's positive relationship with spatial accessibility). This study employed
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9 Depthmap, an open-source and multi-platform spatial analysis software, to perform space syntax
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11 analysis. The software creates different maps of different spatial relationships based on lines,
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13 nodes, and connections (accessibility, visibility, etc.) and performs graph analysis of the resulting
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15 network. Since space syntax can be modeled before construction, it is recognized as an effective
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17 and cost-saving tool for evaluating desired spatial properties, such as visibility or accessibility,
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19 before detailed design or construction occur. (Haq and Luo, 2012, Rashid et al., 2006, Rashid et
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21 al., 2009)
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25 26 **Behavior mapping**

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28 Observation data were collected using DOTT[®], a web-based interface that allows for a
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30 customized coding system. Pilot participants wore color-coded and numbered badges,
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32 corresponding to their department and role (staff, manager, director, admin, etc.). The observer
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34 systematically walked around a predefined observation route and documented users, posture,
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36 interactions, departments, and the number of people in rooms. The workplace usage was
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38 documented in the morning, noon, and afternoon each day, for five days during a typical working
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40 week. In total, 1681 events were collected (Figure 3).
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45 **Surveys**

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47 Qualitative methods were employed to identify significant issues and subjects for the
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49 client. Employees and a steering committee participated in focus groups as representatives of the
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51 AFO users and leadership. After documenting and reviewing the comments, we compiled a list
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53 of elements and potential questions aligned with the research objective and AFO workspace
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attributes. Framework questions were mainly derived from literature and previously developed instruments (Appel-Meulenbroek et al., 2014, Rolfö et al., 2018, Mishra et al., 2012, Hoendervanger et al., 2018, Brown, 2009).

The post-occupancy survey consisted of questions regarding spatial features (flexibility, visibility, accessibility, workstation characteristics), psychological and job needs (privacy, territoriality, autonomy, mobility, concentration), and outcomes (satisfaction, communication, collaboration, perceived productivity). Responses were given on a five-point scale ranging from 1 (very dissatisfied) to 5 (very satisfied), 1 (never) to 5 (all the time), or 1 (strongly disagree) to 5 (strongly agree). Examples of survey questions and theme classifications are presented in Table 1.

Content validity of the instrument was subjectively evaluated by researchers, management team, and literature reviews (Rubio et al., 2003). Further, the pilot survey was launched to quality experts and practitioners to verify its content (Rubio et al., 2003). After conducting pilot tests and removing or editing ambiguous questions, participants were tested on two occasions, a week apart, until satisfactory levels of reliability was attained ($r=.72$, $p < 0.05$).

Descriptions about the research purpose and a survey link were emailed to the 115 AFO pilot participants. Survey participation was voluntary and data confidentiality was ensured to participants in the invitation. The researchers were not granted approvals for gathering ethnicity, gender, and age information. The principal component extraction method was employed to verify if factors based on the data correspond to conceptual framework factors. The analysis derived factors based on high loading values in the rotated component matrix. In total, 82 employees participated from Department 1 ($n = 29$, 39.2%), Department 2 ($n = 14$, 18.9%), Department 3 ($n = 26$, 35.1%), and Department 4 ($n = 5$, 6.8%).

Open-ended responses

Open-ended responses were collected through the survey link to further explore perceptions of communication, collaboration, privacy, territoriality, job satisfaction, and performance.

Analysis

Descriptive, correlation and linear regression (for survey responses), and binary regression (for observational data) were performed in SPSS version 18. To evaluate team clustering (neighborhoods), unassigned workstation areas were divided into three main zones. The boundary was defined by team rooms between Zone A and B, and the 90-degree angle within the pilot area footprint orientation in zone C (Figure 4). To account for departmental mixing, for each user sitting next to a person from another department in unassigned workstations a value of one was assigned, and others were documented as zero. The open-ended responses were reviewed and clustered into themes to grasp underlying reasons for the survey ratings.

Results

Satisfaction

Survey findings

Descriptive results indicated a high satisfaction score for the workplace environment ($M = 3.61$, $N = 82$). Most users indicated that they were satisfied or highly satisfied with their workplace (70.7%, $n = 48$). Only a few questionnaire respondents reported being unsatisfied or very unsatisfied with the environment (18.3%, $n = 15$). Perceptions of workplace support for concentrated work at workstations ($\beta = .73$, $p < 0.001$), use of large enclosed spaces ($\beta = .28$, $p = 0.005$), and availability of preferred workspaces ($\beta = .30$, $p = 0.015$) were significant predictors

for workplace satisfaction. This model explained 63% of variance in workplace satisfaction, $F(3, 69) = 42.34, p < .001$. One-way ANOVA analysis indicated that departmental differences were not a significant factor for work environment satisfaction or frequency of impromptu interactions at workstations.

Descriptive analysis explored employee mobility workstyles as a characteristic of job demands. We found that 47.6% ($n = 39$) of workers use a single work setting but often use other locations (travelers); 22% ($n = 18$) perform activities at a single work setting and rarely use other locations (dwellers); 15.9% ($n = 13$) perform some activities at a single work but often use other locations (explorer); and 14.6% ($n = 12$) use multiple work settings and rarely base at a single location (nomads). Results showed that the difference between mobility workstyles and workplace satisfaction was insignificant, $F(3, 78) = .896, p > .05$.

Open-ended results

Table 2 provides examples of responses and themes associated with workplace satisfaction. Opportunities for meeting new people, desk adjustability, and impromptu social interaction were positive qualities for some users. However, some users complained about how the ambient noise was distracting and resulted in a high demand for enclosed rooms. AFO layout functioned poorly for team identification and territoriality for users demanding higher intra-team communication.

Communication and Collaboration

Observational findings

Face-to-face communication mainly happened along pathways and workstations, versus AWS ($n = 59, 37\%$, $n = 57, 35\%$, $n = 45, 28\%$, respectively). Table 3 compares documented face-to-face interactions in AWS, reflecting that most interaction happened in large open seating

areas. This was because documenting face-to-face communication in enclosed AWS was not achievable for the observer. To overcome this observational shortcoming, we documented the number of users in closed rooms as an indication of collaborative behavior. Findings showed that most collaborative work (with groups of two or more) happened in AWS, especially in team and large open areas (64%, $n = 136$, $N = 380$), versus workstations ($n = 136$, 36%) (see Table 3).

Correlation analyses were performed between spatial properties retrieved from space syntax and observed interaction instances. Findings yielded that interaction between two people in AWS was significantly correlated to spatial connectivity ($r = .23$, $p < .001$), visual mean depth ($r = -.20$, $p < .001$), seated connectivity ($r = .175$, $p < .001$), and seated mean depth ($r = -.144$, $p = .003$). This means that interaction between two people in AWS mainly happened in highly accessible and visible areas. Instances of more than two people interacting happened mainly in higher accessible areas ($r = -.123$, $p = .012$). As explained before, the negative coefficient describes a negative association between interaction and mean depth values and thus a positive association between accessibility and interaction.

Table 4 compares the number of user counts in each workstation zone (illustrated in Figure 5). Further, regression analysis indicated that departmental mixing in workstation zones happened in areas with higher accessibility and less seated visibility, (OR = .016, 95% CI [.003, .077], OR = .997, 95% CI [.996, .998], $R^2 = .18$). Additionally, being in Department 3 corresponded to 49% decrease in departmental mixing, 95% CI [.36, .72].

Survey findings

Logistic regression with Forward Stepwise method was conducted to understand significant predictors of face-to-face interaction. The results indicated that a 1-point increase in workstation and laptop use corresponds to 55% and 65% decrease in the odds of interaction

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(95% CI [.27 to .76], $p = .003$; 95% CI [.18 to .69], $p = .003$, respectively). Standing in workstations was significantly correlated with interaction instances ($r = .296$, $p = .001$). Within the AFO, a 1-unit increase in standing behavior instances increased the odds of interaction by 2.03 times (95% CI [1.13, 3.64], $p = .017$).

The regression analysis from survey findings indicated that 57% of variance for the perception of satisfactory communication was predicted by satisfaction with finding individuals at workstations ($\beta = .40$, $p < 0.001$), amenities and quality of workstation ($\beta = .32$, $p = .002$), and support for collaborative work ($\beta = .25$, $p = .10$), $F(3, 63) = 30.62$, $p < 0.001$. Paired sample T-Test indicated a significant difference between perception of communication with teammates ($M = 3.28$, $SD = 1.07$), versus other teams ($M = 3.57$, $SD = 1.08$), $t(3.31)$, $p = 0.001$).

Open-ended results

Table 5 provides examples of open-ended responses and themes as related to team collaboration and communication. Respondents described their satisfaction with flexible work area options. However, some users reflected that they felt “less connected” with their team members. They perceived the difficulty of finding team members reduced team interaction. As a result, some habitually nested in the same workstation so they could be in proximity of team members. For example, one worker stated, “my manager and majority of my team sit in the same spots since we get in early.” This nesting situation was irritating for some other coworkers.

Some workers suggested the need for more structure and identifiable landmarks that defined team neighborhood spaces. Corroborating with observational results, users from Department 3 reported that they always sat at the same workstations. Qualitative results provided in-depth insights on workstyle differences related to informal social interaction and collaborative work. For instance, some users enjoyed how the AFO supported meeting different people and

encouraged collaborative work; and some complained that spontaneous social interaction impeded perceived productivity and concentration.

Perceived Productivity

Survey findings

The average score for perceived productivity was 3.01 ($n = 76$, $SD = .89$). Almost half of the employees reported that they agree or strongly agree that their workplace enables them to work productively (48%, $n = 36$). However, almost a quarter of users strongly disagreed or disagreed about the workplace supporting perceived productivity (26.7%, $n = 20$). Perception of productivity was impacted by different work styles. The analysis yielded that support for concentrated and uninterrupted work at workstations ($\beta = .47$, $p < .001$), support for private discussions in workplace ($\beta = .19$, $p = .017$), availability of small enclosed rooms ($\beta = .17$, $p = .005$), satisfaction with amenities and qualities of workstations ($\beta = .25$, $p = .003$), and frequency of using workstations of choice ($\beta = .145$, $p = .028$) explained 80% of variance in the workplace support for perceived productivity, $F(5, 61) = 52.87$, $p < .001$.

Use of enclosed rooms was impacted by the need for privacy and reduced informal social interaction. The survey analysis indicated that 28% of variability in the use of large, closed spaces was significantly predicted by satisfaction with workplace support for private conversations ($\beta = .44$, $p < .001$) and higher frequency of informal interactions at workstations ($\beta = .34$, $p = .002$), $F(2, 64) = 13.47$, $p < .001$. Respondents expressed the need for more team rooms for enhanced concentration. For instance, a user mentioned, “we need more private collaboration/meeting spaces for more than two-three people.”

The result showed that 9% of variability in the use of small enclosed rooms (phone and focus rooms) and 16% of variance in the use of open meeting areas were significantly predicted

by the frequency of interacting around workstations ($\beta = .25, p = .035, \beta = .23, p = .04$, respectively) and demanding available alternative activity spaces ($\beta = .24, p = .049, \beta = .36, p = .002$, respectively), $F(2, 64) = 4.25, p = 0.18, F(2, 64) = 7.17, p = .002$, respectively.

Open ended results

Table 6 provides examples of statements and emerging themes in response to factors impacting perceptions of productivity. Respondents considered loud conversations and passersby as sources of ambient noise which reduced perceived productivity at workstations. This resulted in high demand for enclosed AWS as a means of supporting privacy and concentration. However, the number of enclosed rooms were inadequate for this matter and finding rooms was considered “time-consuming” and “frustrating.” Reflecting on the need for cultural shifts, users mentioned that nesting behaviors were one of the reasons for room unavailability. As a result, people utilized break areas or open AWS for phone conversations, which was uncomfortable when discussing confidential information and amplified ambient noise around workstations.

Some users emphasized that AFO may fit the needs for Millennial age groups and highly collaborative work but lacks adequate features for supporting concentrated and intra-team communication. They described how locating team members was a challenge impacting perceived productivity and suggested the implication of team neighborhoods. Workstation setup was considered tedious and hindered perceived productivity. Some indicated that implementing partitions between desks may enhance visual and sound privacy. One common theme impacting perceived productivity was technology issues, such as lack of adequate dual monitors or unsatisfactory WIFI connectivity in meeting rooms.

Discussion

Satisfaction

The results demonstrate the importance of workplace layout that supports different task requirements, such as spaces for concentration, collaboration, or team communication (Wohlers et al., 2017, Appel-Meulenbroek et al., 2011). In line with prior literature, the flexibility of AFO spatial settings, specifically a combination of enclosed and open areas that enhance autonomy, enhanced user satisfaction (Candido et al., 2018).

Support for internal mobility was not a significant predictor for workplace satisfaction which is in contrast with previous studies (Hoendervanger et al., 2018, Babapour et al., 2018). Nevertheless, qualitative findings provided in-depth insight into user mobility workstyles. Almost half of the participants indicated that they mainly used a single work setting combined with alternative work areas, supporting previous studies (Montanari et al., 2017). However, almost a quarter of users with routine workstyles reported the need for working at a single work area and rarely other alternative spaces, as noted in prior studies (Wohlers et al., 2017, Rolfö et al., 2018). These users were the most vocal regarding a perceived lack of support for territoriality and intra-team communication (Rolfö et al., 2018, Hoendervanger et al., 2018).

Satisfaction with impromptu and spontaneous interactions around workstations differed based on job needs. Consistent with prior studies (Babapour et al., 2018, Hoendervanger et al., 2018), unscheduled meetings and interruptions connected to job matters had a positive impact on employee performance as it improved collaboration. In contrary, some users found that unplanned face-to-face communication in workstations was considered a source of work interruption that reduced perceived productivity (Babapour et al., 2018, Hoendervanger et al., 2018). These users perceived a higher demand for enclosed AWS for private discussions.

However, the unavailability of rooms due to nesting behaviors reduced perceptions of a satisfactory fit for autonomy, concentration, and privacy.

Communication and Collaboration

Physical proximity and visibility of the floorplan established co-awareness, between team and non-team members, and facilitated information sharing and social interaction that has been found in prior literature (Cai and Khan, 2010, Peponis et al., 2007, Markhede, 2010, Hoendervanger et al., 2018). Our findings indicate that higher visibility and accessibility enhanced face-to-face interactions and fostered knowledge exchanges with non-team members, as supported by prior studies (Rashid et al., 2006, Rashid et al., 2009, Hoendervanger et al., 2018).

Consistent with prior studies (Montanari et al., 2017, Markhede, 2010), face-to-face interactions mainly happened at workstations and circulation paths. However, this behavior was not impacted by spatial attributes, which means that people were interacting in workstations based on necessity not the degree of visibility or accessibility of colleagues. This contrasts with Markhede (2010) findings indicating face-to-face interactions were 50% more likely to happen in higher visible workstations in an open plan office with assigned workstations for diverse departments. This difference may be described as preferences for visibility and intra-team interactions when departments have assigned workstations. Whereas in AFOs there are more chances of departmental mixing, and therefore users avoid sitting in higher visible workstations to prevent distractions and impromptu interactions.

Similar to prior studies (Hoendervanger et al., 2018), workers in jobs that required less mobility and social interaction were relatively less satisfied with the AFO workplace as it did not offer adequate spatial options for concentrated work around workstations.

Satisfaction with inter and intra-team communication depended on work styles and how easily team members were found at workstations (Haynes et al., 2017, Wohlers et al., 2017). In fact, the lack of territoriality was one of the AFO challenges, positively impacting feelings of dissatisfaction, frustration, and inefficiencies that had been noted in prior studies (Ekstrand and Karsten Hansen, 2016, Wolfeld, 2010, Rolfö et al., 2018, Cai and Khan, 2010, Hoendervanger et al., 2018).

Contrary to Wohlers et al. (2017) assumption, satisfaction with intra-team communication was higher than inter-team communication. This may be due to almost half of each department forming clusters in workstation zones, especially in more visible areas, to enhance collaboration and ease of contact (Babapour et al., 2018, Rolfö et al., 2018, Rashid et al., 2006, Peponis et al., 2007, Ekstrand and Karsten Hansen, 2016, Markhede, 2010, Cai and Khan, 2010). Further, standing in workstations also happened in areas with higher levels of visual surveillance and visibility, which promoted interactions among colleagues.

Visible and accessible AWS were a good fit for workers requiring a high level of autonomy and privacy far away from workstations (Jahncke and Halin, 2012, Hoendervanger et al., 2018). Opportunities for inter-team communications were amplified in workstations located in more accessible and less visible areas as these areas supported the need for privacy and concentration, as suggested by prior studies (Markhede, 2010, Wohlers et al., 2017, Appel-Meulenbroek et al., 2015, Haynes et al., 2017).

Perceived Productivity

The findings reported that almost half of the respondents perceived to be productive in the workplace. Work roles and needs impacted the requirement for disruption-free environments for deep thinking and longer periods of concentration, as noted in previous studies (Haynes et al.,

2017, Babapour et al., 2018, Rolfö et al., 2018, Jahncke et al., 2013, Wohlers et al., 2017, Hoendervanger et al., 2018). Amplified interactions and knowledge sharing in the open workplace environment increased perceived productivity for some workers. However, this condition adversely impacted perceived productivity for some other employees by decreasing privacy and increasing noise or distractions for others. (Alker et al., 2014, Rolfö et al., 2018, Haynes et al., 2017, Babapour et al., 2018, Vischer, 2007, Jahncke and Halin, 2012, Hoendervanger et al., 2018). Thus, workers described the need for using small enclosed rooms to focus, reduce distraction from colleagues at workstations, and avoid noise from conversations.

Nevertheless, an inadequate number of enclosed rooms lead to discrepancies between user needs for autonomy, resulting in a reduced perception of productivity (Vischer, 2007, Wohlers and Hertel, 2017, Candido et al., 2018). In addition to spatial features, qualities of the workstation, such as the height of partitions, ease of setup, availability of appropriate equipment and supplies, and reliable Wi-Fi impacted perceptions of productivity, as noted in previous studies (Babapour et al., 2018, Rolfö et al., 2018, Wohlers and Hertel, 2017). Similar to previous literature (Rolfö et al., 2018), users suggested the use of additional partitions at the sides of workstations to separate workstations and eliminate noise, and enhance visual privacy.

Design Implications

Several implications for AFO design emerged from this study related to the framework categories to address how spatial features can support personal and job needs for optimizing work outcomes.

Psychological and Job Needs

Privacy

Providing a higher percentage of single-occupant enclosed private spaces would minimize nesting in larger enclosed spaces. Study participants requiring enclosed spaces for concentrated work reported a lack of readily accessible small enclosed rooms, partly due to other participants nesting in them to perform individual focused work. The smallest enclosed rooms in the study were sized for 2 to 3 people. Providing single-occupant enclosed spaces would increase the number of appropriate spaces for concentrated individual work and allow more efficient use of multi-person enclosed spaces for group interactions. Further, the AFO needs effective leadership related to etiquette and speech policy implementation for enhanced use and satisfaction.

Territoriality

Establish neighborhoods to support intra-team communication and collaboration. Within the study, departmental teams self-organized into neighborhoods by nesting within unassigned workstation areas. Rather than discouraging or ignoring this practice, defining neighborhoods for teams requiring high intra-team communication would support team collaboration and ease of locating team members. Creating neighborhoods designated as quiet zones through physical separation and quiet speech and etiquette policies would support worker needs for concentrated work at workstations. Quiet zone neighborhoods could also offset the need for a higher number of enclosed single-person rooms, addressing worker satisfaction and perceived productivity related to noise and distractions in a cost-effective manner. Decorative cut-felt panels provide some visual separation between the workstations and main circulation path. Delineation between circulation paths and immediately adjacent open work areas using color or textural changes in

carpeting would also provide appropriate visual wayfinding cues while minimizing sound distractions from foot traffic.

Autonomy

Interactions in AFO unassigned workstations are not dependent on visibility and accessibility. Study participants chose less visible/accessible workstations to facilitate focused work and interacted in workstations out of necessity. However, standing at a workstation increased the likelihood of interactions. Modulating the visibility and accessibility of workstation clusters/neighborhoods and using height adjustable desks can provide additional choices in an AFO to accommodate workstyles.

The open nature and workspace choices in the AFO setting encourage collaborative interaction, inter-departmental mixing, and support individual work styles. Study participants felt the AFO setting provided opportunities for meeting new people within their organization and impromptu social interaction, which increased their workplace satisfaction. Conversely, many participants found the ambient noise in the AFO setting distracting. More private spaces enclosed with sound absorbing materials and strategically located throughout the AFO could assist with sound control while maintaining the visual connectivity that correlated to interpersonal interactions within this study.

Mobility

Workers with jobs requiring high levels of social interaction and a variety of AWSs were relatively more satisfied with the AFO environment. However, to fit the needs of employees with a more sedentary workstyle, we suggest allocating shared workstations areas that require less setup time.

Concentration

Provide better control of ambient noise and visual distractions to support concentrated work at workstations. Controlling ambient noise within open work plans is an industry-wide challenge. This study attempted to control noise distraction through strategically placed enclosed spaces; breaking the large open floor plan into zones of 20 workstations; and using finish materials such as carpeted workstation zones, acoustical ceiling tiles, and ceiling hung decorative cut-felt panels between workstations and the main circulation path. However, the polished concrete flooring in the main circulation path connecting workstation zones resulted in complaints regarding continuously loud foot traffic.

Study findings reported a significant correlation between standing while working and increased interactions at workstations. Standing typically occurred in areas of higher visual surveillance and visibility, making it easier for participants to locate and interact with team members as well as increasing interactions between non-team members. This has implications for increased cross-team collaborations. However, users need to be provided with options to adjust partitions or workstations when their work requires higher concentration. Participants expressed the need for visual separation between adjacent workstations to enhance concentration and perceived productivity at workstations. Acoustical panels attached to the sides of adjustable height work surfaces would increase visual separation and provide some additional sound control.

Conclusion

This case study adds to the growing knowledge base by identifying the effects of AFO physical features on communication, collaboration, satisfaction, and perceived productivity outcomes that differ based on job and psychological needs. Workplace satisfaction was predicted

by AFO support of concentrated work, availability of large enclosed team rooms, and availability of workspaces of choice. For workers with higher mobility and autonomy, openness, transparency, and informal interaction opportunities were satisfactory. The unassigned workstation arrangements facilitated inter-communication and departmental mixing. However, almost half of users naturally clustered in the proximity of team members within workstation zones. This behavior corresponded to user job needs for territoriality to promote higher intra-team communication, proximity, and visibility. Job autonomy was impacted by the availability of enclosed team rooms and workstations to focus on complex tasks and discuss confidential matters. For some users, the number of enclosed AWS were inadequate and reduced perceptions of productivity and satisfaction.

Most collaborative work happened in AWS, especially in more visible and accessible locations. Satisfaction with communication was impacted when the AFO environment was a good fit for workers' needs for territoriality, autonomy, and collaborative work. Job demands impacted the perception of productivity. Some workers perceived impromptu social interaction around workstation as enjoyable and enhancing collaboration and perceived productivity. However, for some workers having AWS that support private discussions and concentrated work reduced distractions and amplified perceived productivity. In conclusion, the findings illustrate the significance of evaluating employee workstyle needs before creating AFO environments to satisfy the PEF theory.

Involving employees in the design and planning phases, as well as implementing quiet speech and etiquette policies in work environments are suggestions to enhance employee adaptation and acceptance of unassigned workstations/AFO's. The results of this study are based on a single case study. Therefore, findings should be used with caution. Further research into

correlation among different AFO layouts and demographics, employee needs, actual productivity measures, and satisfaction is necessary. Future research is recommended to document inter-team and intra-team communication during observations to understand the relationship between knowledge exchange, informal social interaction, visibility, and accessibility that would possibly affect collaboration and trust development. Users reported technology issues to be a critical factor in achieving tasks which impacted user satisfaction and communication. Future studies are needed to shed further light on how technology integration in AFO layouts or work systems function as moderators on satisfaction, productivity, or collaboration.

Additionally, future studies are recommended to employ behavioral shadowing or tracking strategies to capture the flexibility of AFO spaces in relation to job tasks. This data will document variation in duration and frequency of use for enclosed rooms, open areas, or workstations based on job demands. This insight can contribute information in deciding the number of rooms related to job tasks in future design recommendations. Comparative studies investigating employee working conditions, behaviors, interactions, and perceptions before and after transitioning to an AFO can provide important insight into the mechanism and effects of AFO environments.

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Activity-Based Flexible Office: Fit between Physical Environment and User Needs

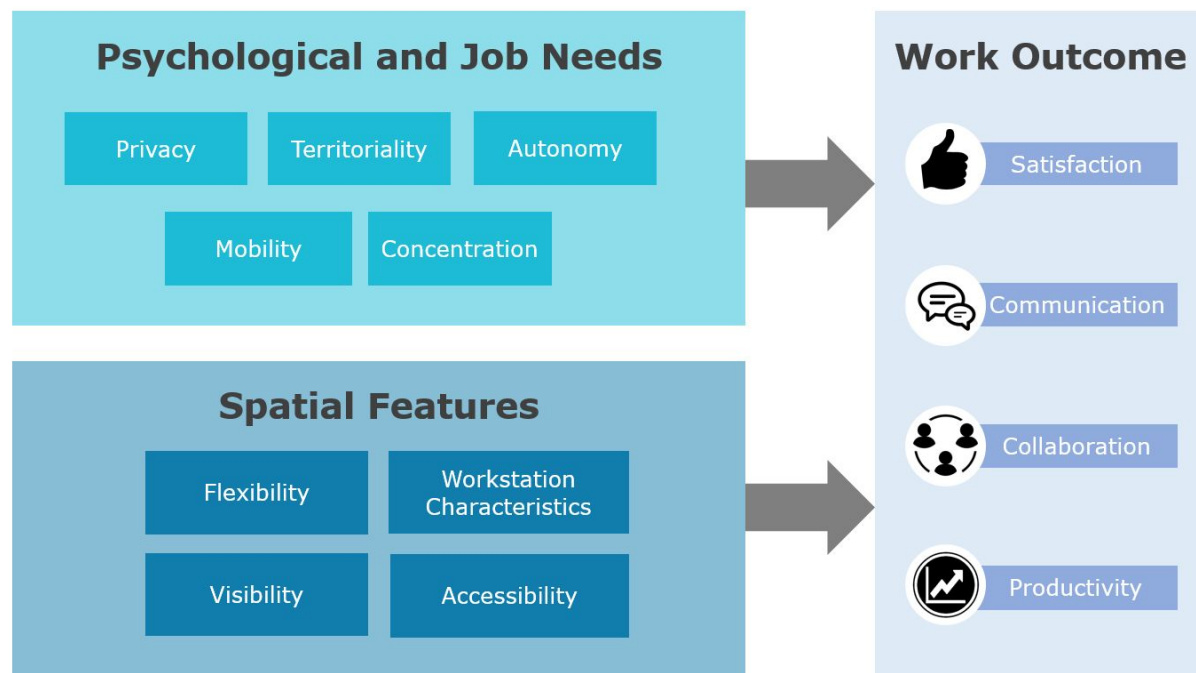


Figure 1. Research framework.

Activity-Based Flexible Office: Fit between Physical Environment and User Needs



Figure 2. Workstations and alternative work area setups in the renovated floor plan.

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

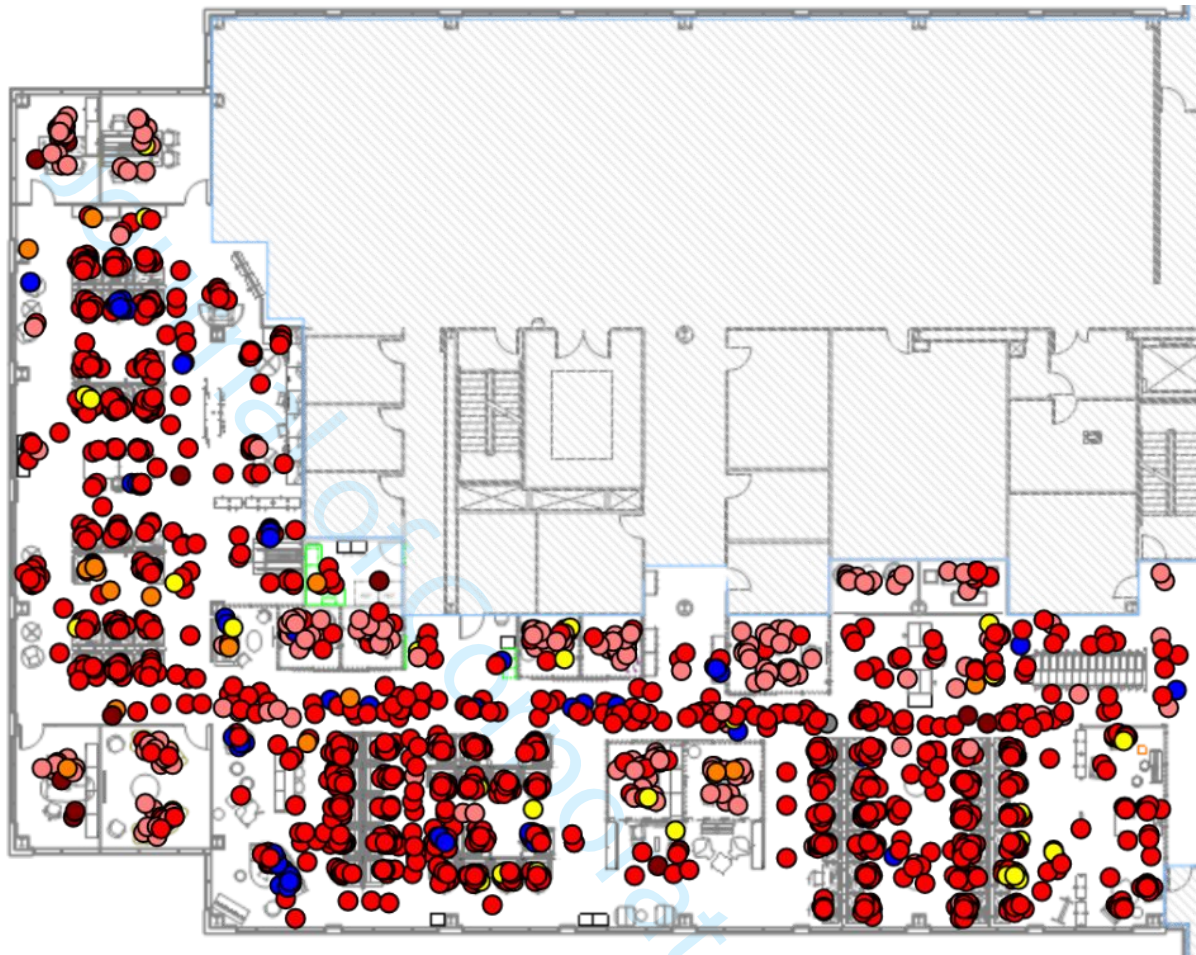


Figure 3. *Observed users of the AFO environment.*

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

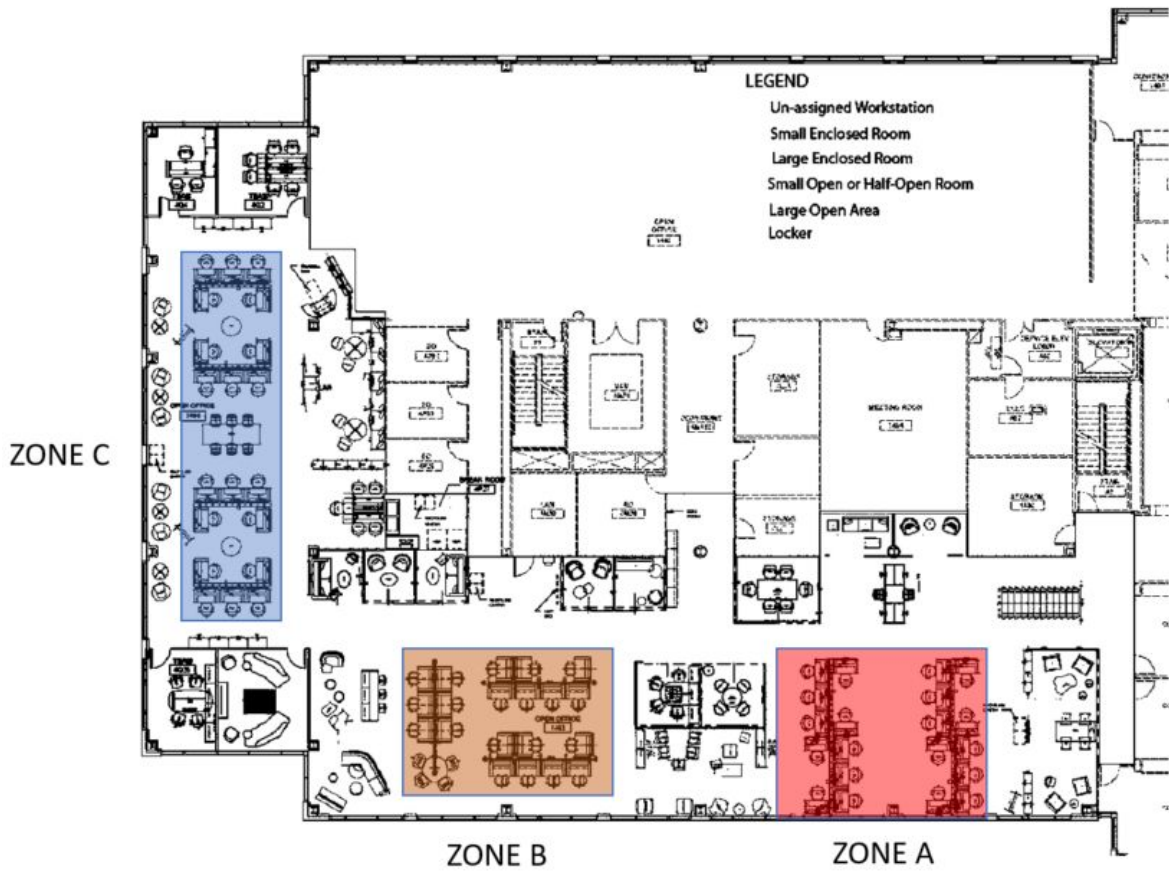


Figure 4. Workstation zones in the AFO layout.

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

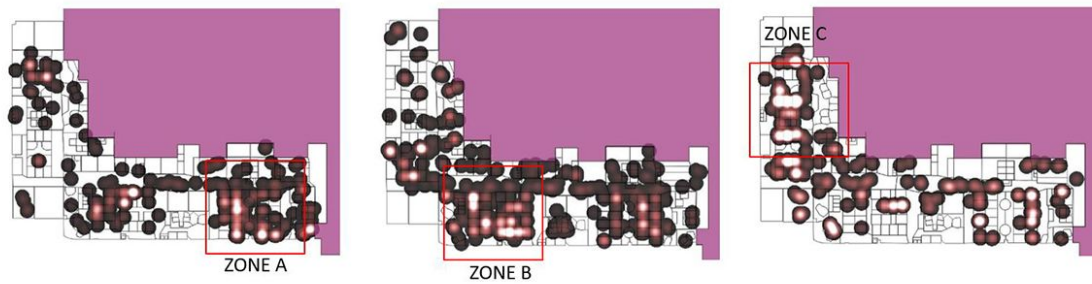


Figure 5. *Visual comparison of user occupancy in unassigned workstation zones indicates departmental clustering (from left to right: department 1 in zone A, department 3 in zone B, and department 2 in zone C).*

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

Table 1. Example of survey questions and classifications

Parameter	Question
Use of AWS	<i>How frequently within the last five workdays have you used...</i> phone rooms focus rooms team rooms
Workstation Attributes	<i>How satisfied are you with...</i> sit/stand desk(s) comfort? cleanliness in workstations? overhead lighting
Privacy	<i>How satisfied are you with your workplace support of...</i> telephone conversations Private discussions
Territoriality	<i>How satisfied are you with ability to find...</i> work-mates/teammates? other teams? your immediate supervisor?
Autonomy	<i>How satisfied are you with your workplace support of...</i> using a workstation of your preference Availability of workspaces (other than a workstation/s)?
Mobility	<i>Select the definition that describes your mobility workstyle more appropriately: I perform most of my activities</i> at a single work setting and rarely use other locations within the office. at a single work setting but often use other locations within the office. at a single work setting but often use other locations within the office. in multiple work settings and rarely base myself at a single location within the office.
Concentration	<i>How satisfied are you with...</i> ability to concentrate in workstations? distractions from unwanted sounds in workstations? visual distractions in workstations?
Satisfaction	<i>How satisfied are you with...</i> a workstation/s? your work environment?
Communication	<i>How satisfied are you with...</i> communication with your teams? communication with other teams? communication with your immediate supervisor?
Collaboration	<i>How satisfied are you with...</i> collaborating on focused work? collaborating on creative work?
Productivity	<i>How satisfied are you with your workplace support of...</i> individual focused work, desk based? individual focused work, away from desk? productive work?

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

Table 2. Examples of open-ended responses and themes on workplace satisfaction.

Acoustics	I cannot concentrate because of the noise and people coming up to me to chat when previously they would not stop by as much.
Concentration	It is harder to focus in this space
Desk Availability	many times, a workstation is not available when I need it.
Workstation characteristics	My primary complaint is with the small size of the workstation; I like the Adjustable desks
Room availability	Need more private collaboration/meeting spaces for more than two-three people
Workstation technology	Provide more double monitors available; I do wish each workstation was supplied with a power cord.
Assigned workstation	Having to find a workspace versus having an assigned space is very unsatisfactory.
Territoriality	I feel less connected to my team
Culture	The only issues I have seen are visitors not observing some of the quiet space, as they are awaiting their meetings in the conference rooms outside of our space.
Social interaction	Have met more people
Autonomy	I enjoy the flexibility to sit anywhere

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

Table 3. Observed communication and collaboration in AWS and workstations.

		Team	Small Open Areas	Large Open Areas	Small Enclosed Rooms	Workstations
Communication	<i>n</i>	9	5	28	3	57
	%	8.82	4.90	27.45	2.94	55.89
Individual Work	<i>n</i>	64	8	43	53	867
	%	6.18	0.77	4.15	5.12	83.77
Collaborative Work	<i>n</i>	86	4	103	51	136
	%	22.63	1.05	27.11	13.42	35.79

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

Table 4. Observed distribution of departments within workstation zones.

		Zone A	Zone B	Zone C
Department 1	<i>n</i>	121.00	70.00	38.00
	% within Zone	46.36	23.89	15.97
Department 2	<i>n</i>	43.00	23.00	139.00
	% within Zone	16.48	7.85	58.40
Department 3	<i>n</i>	97.00	200.00	61.00
	% within Zone	37.16	68.26	25.63
Within Zone	<i>N</i>	261.00	293.00	238.00
	% within Zone	100.00	100.00	100.00

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

Table 5. Examples of open-ended responses and themes on workplace communication and collaboration.

Finding people	There needs to be an easier system to finding people other than walking around the entire space looking for someone.
Neighborhood	We had been told that there would be identifiable neighborhoods and that has not happened. It would be easier to say I am in such and such neighborhood.
Legibility?	describing where you are in the physical space is tough.
Productivity	In some ways, more productive than before (collaboration with others).
Intra -team communication	This has been a challenge and looking for direction on how to not lose the connection with one's team in this new environment.
Inter-team communication	I'm not necessarily unsatisfied with lack of interactions with other teams, it just doesn't happen.; It's nice to be close to people sometimes and see different people.
Distraction	These areas are not conducive to collaborative work with colleagues in person or on the phone because it is disruptive to others in the surrounding areas.
Social Interaction	I don't mind being able to be interrupted by co-workers, in fact I think this is very good for collaboration.
Number of AWS	I love the additional conference rooms because I lead so many meetings and the environment does encourage collaboration with other team members.
Job Needs	This space focuses on collaboration, which is great, but most of my work is individual.

Activity-Based Flexible Office: Fit between Physical Environment and User Needs

Table 6. Examples of open-ended responses and themes on workplace productivity.

Theme	Example
Technology issues	Cell phone service also is bad, rooms have not cell or WIFI signals which make it difficult for taking calls. It needs to be fixed, we are losing productivity because of this issue;
Privacy; Communication	Finding room for conversations is time consuming and frustrating.
Finding team members	Face to Face conversations are worse because you can't find anybody.
Concentrated work	Having some flexibility to work from home a couple days a week would huge for my productivity. There are often too many distractions in the office to allow for focused thought.
Work Style Needs	For those of us who aren't in the ""Millennial"" age group, it seems like these spaces are designed to discourage work from getting done.; Different types of work have different optimal work environments. This environment seems best suited for highly collaborative work and social non-work
Workstation Characteristics	the time it takes to get setup at a workstation in the morning is extremely time consuming