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EECS 372
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Workplace Layouts and Collaborations

Overview

In an office environment, collaborations between employees are incredibly valuable. They provide a chance for people with different ideas and strengths to get together and pool their abilities to create something that any single employee could not have done alone. Therefore, a natural question that arises is: How can these collaborative interactions be maximized?

In Jason Owen-Smith's paper, "A Tale of Two Buildings: Socio-Spacial Significance in Innovation," Owen-Smith found that "the extent to which scientists share overlapping space significantly increases both the formation of new collaborations and their success in securing external funding." This model and paper attempt to further explore this idea in an agent-based setting.

The model is created in NetLogo version 5.0.4, with analysis done in BehaviorSpace. The model provides a visual interface of an office layout and its employees, and attempts to model daily random interactions of these employees driven by the layout of the workplace. It attempts to analyze how these layouts impact interactions by varying factors within the layouts and answer the question: "How does the physical layout of a workplace affect employee collaborations?"

In analyzing the affect of physical space distribution on collaborations, insight can be gained on how to best structure office spaces to maximize employee teamwork. Although this model explores layout effects on collaboration without taking into account other potential factors such as employee comfort or aesthetics, the results are still valuable as a component of office layouts that should be taken into account.

Furthermore, an agent-based approach to the analysis of the effect of physical space on teamwork can potentially shed insight onto the problem in ways that a traditional observational study cannot. In an agent-based approach, there is no confinement to office spaces that exist currently: any number of layout attributes can be tested that may in other circumstances be hard to come by due to their infrequency or non-existence. Also, an agent-based approach allows for accelerated observance of patterns that could take years to manifest in a real-life setting, in a way that gives a very visual overview of the patterns. It is far easier to test quantitative measures when every employee is following a fixed set of rules that can be analyzed and recorded.

Implementation

In this model, the main agents are the employees. They are situated in an office environment, which is visible on the display as the background. Office space and traversable areas are black or gray, and walls (which employees cannot pass through) are yellow. There are three potential "destinations," or places where employees need to travel throughout the day – a bathroom, a drinking fountain or water cooler, and a cafeteria or food court. The bathroom is represented by the green patch in the display,

the drinking fountain by the blue, and the cafeteria by the red. The employees themselves are represented by people-shaped turtles. Employees are colored blue if they are currently not engaged in a research project and colored red if they are.

Every employee has a countdown as to when they need to head to different destinations within the office, and once a countdown for one of the destinations hits zero, the employee walks the shortest path that does not pass through any walls to his destination. Along the way, if he passes by another employee there is a certain probability that the two people will interact. This probability of interaction can be controlled by a slider, labeled “interact-probability,” on the model interface.

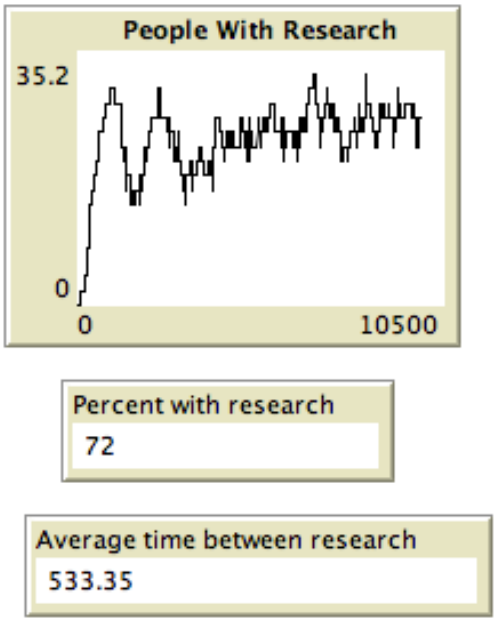
The interactions between employees are kept as simple as possible in order to focus on the layouts as opposed to the interactions themselves. Given that two employees interact, if both of them are currently looking for a research project, they partner up for a set amount of time to work on the project. While two employees are engaged in a project together, they have a link between them in order to visually demonstrate their connection throughout the duration of their collaboration. Furthermore, they go about their activities and walks to different places in the office as usual, but they do not look for more research. That is, an interaction with a person already engaged in research will not result in any partnering.

There are a number of pre-made layouts that can be called up by clicking the named buttons. These layouts reflect common workplace arrangements in many modern offices, and are there to provide a visual representation of how employee walks and random interactions can occur. There are also buttons for a very simple square-

cubicle layouts with certain aspects varied, which are the layouts that have been used for analysis of the model. Furthermore, in order for a user to explore specific physical arrangements he or she is curious about, this model includes the option to draw your own layout and place employees within in, and then run the model to examine the behavior within that layout compared to other common layouts.

The interface also contains a couple tools to help gauge the effect of layouts on interactions in a quantitative way. There is a plot of the number of people who are engaged in a research project at any given time as well as a monitor that keeps track of the percentage of people who have a research projects. There is also a monitor labeled "Average Time Between Research" which keeps track of the average number of ticks that the average person has to wait before he finds another research project (Figure 1).

Figure 1



Many of the decisions in the implementation and design of the model and the agent rules reflect a desire to keep the model simple, understandable, and easily visualizable, as the visual component is one of the main advantages of an agent-based approach to a problem. There are many factors that go into how a collaboration between two employees is formed, but in this model the assumption is that random interactions lead to fraternizations that then lead to teamwork. As a result, in order to keep the focus on the layout attributes, the interactions themselves were kept as simple as possible by having them determined by a probabilistic measure rather than trying to take into account all of the nuances and decisions that go into a formation of a partnership.

Similarly, in a true research setting, people often work on more than one project at a time, and implementing that sort of a change in the model would be a valuable extension. However, the binary of having versus not having a research project was used to keep the model very visual (with the changes in research status simply reflected by an obvious change in color).

Analysis

The analysis that was done on this model takes into account a couple of potential layout attributes and varies those to examine how they affect collaborations. However, there are many more layout characteristics that could be examined in many different ways, and this model was made to specifically encourage further exploration of these

other attributes that are not explored in this paper. The ability to easily create custom layouts facilitates this further examination.

Analysis was done on a very simple layout in which the number of employees, location of employees, and size of the entire office space was held constant. Two different attributes of the layout were varied: the location of walls that impede and direct movement, and the locations of the three communal areas relative to one another.

In terms of locations of the walls, tests were run on three different variations:

1) Individual cubicles with hallways surrounding each (Figure 2).
2) Individual cubicles with more limited hallways (Figure 3).
3) No walls at all (Figure 4).

In terms of the relative location of the communal areas, similarly, three different arrangements were tested:

1) A centralized area containing all three (Figure 5).
2) The three areas spaced out along the same hallway (Figure 6).
3) The three areas spaces out along the entire workplace (Figure 7).

Figure 2

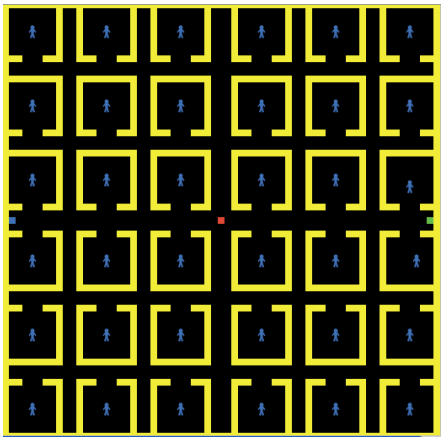


Figure 3

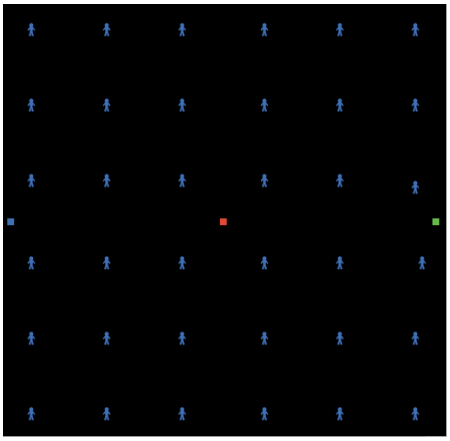


Figure 4

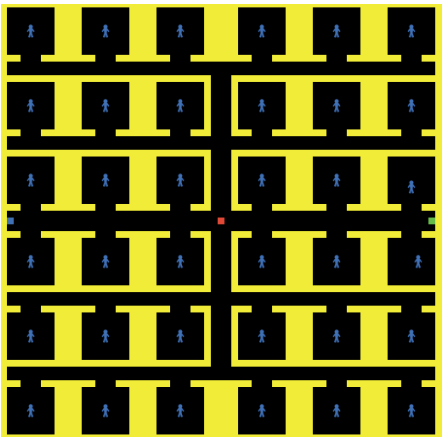


Figure 5

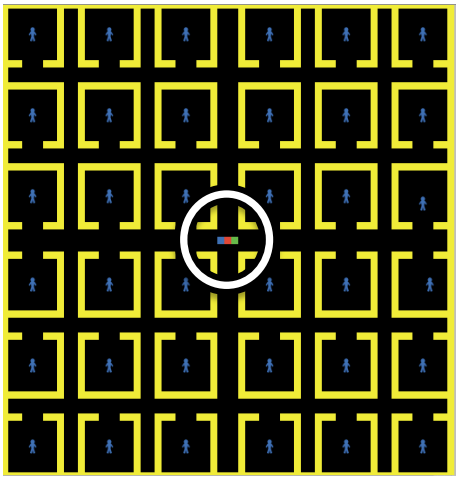


Figure 6

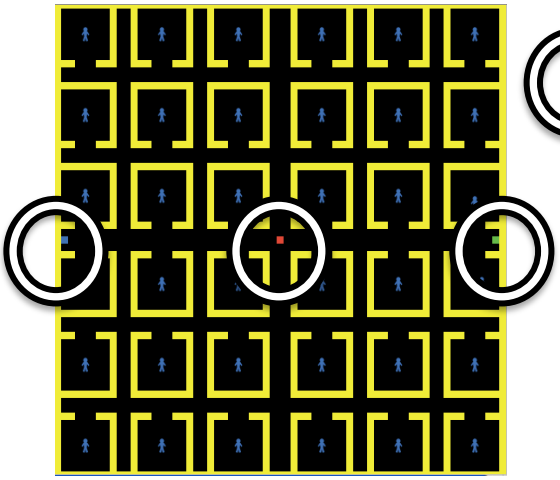
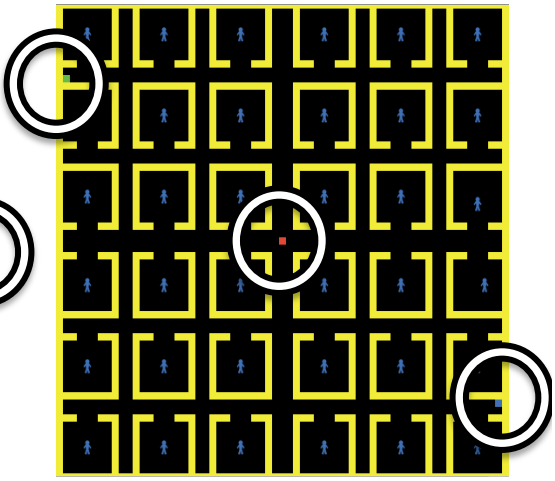


Figure 7



All possible permutations of these sets of three arrangements were tested in order to determine what combinations of attributes lead to the most efficient collaboration. The measures that were calculated for each test were: average percentage of employees engaged in a project at a given time, and average amount of

time that an employee is without a research project. Ideally, a layout that promotes teamwork and collaboration would maximize the first of these measures and minimize the second.

The tests themselves were run in BehaviorSpace, with each layout being tested 20 times and the average of the measures mentioned above recorded. The tests were run with the interact-probability slider at 50%. Each of the 20 trials per layout was performed by allowing the model to run for 10,000 ticks (providing sufficient time for the simulation to reach its equilibrium) at which time the values for the two measures were recorded. The 20 values were then averaged to get a single descriptor per layout for each of the two tested measures.

Results

The results show a very evident trend of how layouts affect collaborations. In general, the layouts with no walls promoted random interactions better than those with restricted hallways, which performed better than those with simple cubicles with surrounding hallways. Similarly, the locations of communal spaces affected the rate of interactions. The more clustered the areas were, longer the time employees went without research and the lower the percent with research were. Figures 8 and 9 below demonstrate these results.

Figure 8

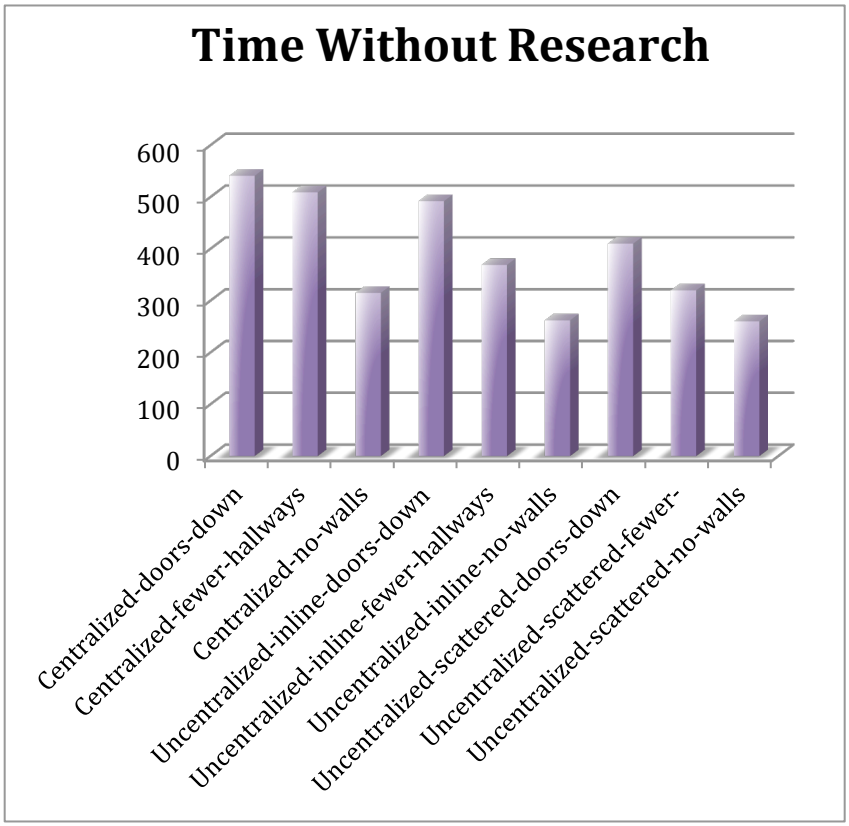
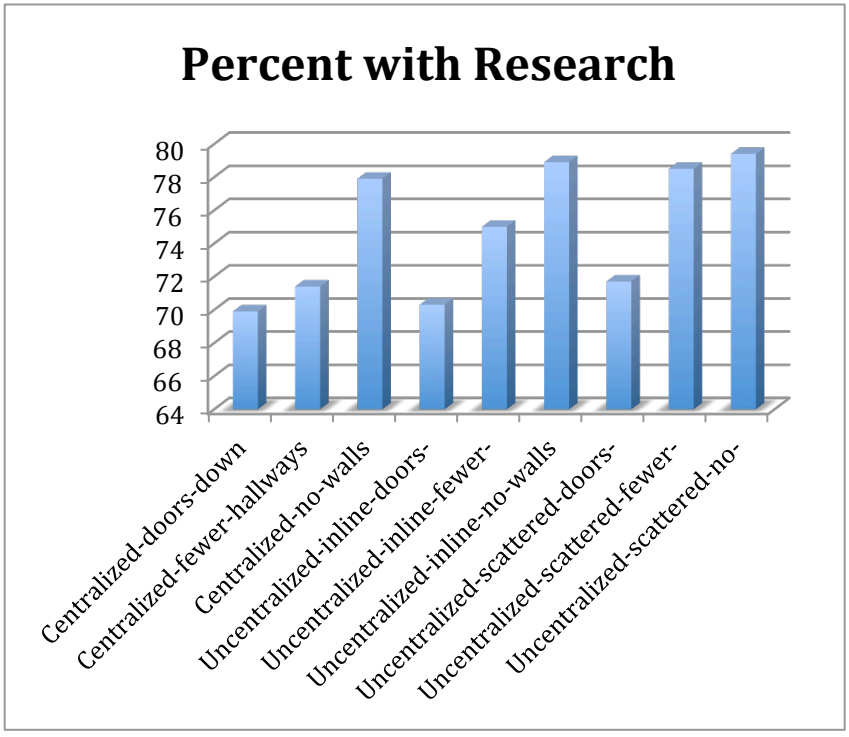


Figure 9



The layout with the optimum measures of the nine that were tested is the one that contained no walls and had the communal areas scattered throughout the workplace. A possible reason for these results is that when there are no walls separating employees from one another, by the rules of the model two employees can interact even when one of them is sitting in his office, whereas in the other two layouts that contain cubicles surrounded by walls, no person can enter another employee's cubicle on the way to a communal area, and as a result all interactions occur when employees are on their way to a destination.

Since people tend to value privacy while working, the no-wall approach to a layout may not be the most feasible one, but as the graphs show, the layout in which the hallways are restricted and the communal areas are scattered comes very close to the performance of the similar layout with no walls at all.

However, a scattered, spread out arrangement of communal spaces is decidedly superior to any of its counterparts when it comes to promotion of collaboration. In all of the arrangements of walls and hallways, the layouts that scattered the communal areas across the layout as opposed to in a centralized area led to more interactions and teamwork. Furthermore, not only were the quantitative measures superior, in observing the model running it becomes obvious that scattered destinations lead to more diverse partnerships, since if all of the areas are in the center of the layout, the employees on one side of the office have no incentive to travel to the opposite side of the office.

Conclusion

This agent-based model examining how layouts affect workplace collaborations confirmed that certain layout attributes lead to increased chances of employee partnering due to random interactions. Specifically, the scattered placement of communal areas such as bathrooms, drinking fountains, and cafeterias results in a greater incidence of collaborations than a centralized area of these office destinations. Furthermore, a layout with no walls whatsoever in which employees can move around freely also leads to increased collaborations, but barring complete freedom of movement, restricting the hallways through which employees can travel results in more random interactions, leading to more collaborations.

These findings strongly suggest that the physical arrangement of space has a significant impact on office teamwork; both in how pathways and walking areas are formulated as well as how communal areas are interspersed throughout the workplace.

References

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