Proposed Design Solutions for the Science and Engineering Complex (SEC) Atrium at Tufts University: Optimized Seating and Utility for the Efficiency and Functionality of Observed Applications

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ME-140 Inventive Design

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Mini Design Challenge #1

28 September 2023

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I. Problem Definition

As an engineering graduate student currently attending Tufts University, I re-design the atrium of the Science and Engineering Complex (SEC) to optimize utility for its most frequent application of independent student work/study, while still serving as a transient site for a meeting place for collaboration with other students/staff, a casual eatery, and a site for occasionally hosting small University events.

II. Stakeholder Identification

Students. I have observed Tufts students as the most frequent users of this space. Applications include studying/doing schoolwork on their laptops/devices, collaborating and meeting with other students/professors/faculty/etc., casual dining, and infrequently, some attend the events hosted here. The significance of this space varies amongst different students: for some, it is a daily/weekly spot to study, eat, charge devices, or work on group projects for extended periods of time. On the other end of the spectrum, some students pass through the space on the way to class without actively thinking about its usage.

The SEC lobby embodies Tufts physically as one of the school's many spaces: it may be a technical resource for somewhere ambient to study, a waiting area between classes, or a spot for meeting other students. The space also embodies Tufts in a metaphorical sense: the visual, aesthetic, and/or other abstract properties influence students' impressions of the school's reputation, and as a result may even affect their academic performance and overall lasting perception of the school even after graduating. Reflecting the STEM educational space: the space is designated, and appropriately seen by many students as part of the Science and Engineering Department, therefore is somewhere where one would expect to see mostly engineering students.

As a student myself and the designer of this project, I use the space as a student would above. I have observed the physical space much more in depth than probably the average user due to the detailing for this re-design.

Professors and Tufts Faculty. This group uses this space for brief meetings with students, for staff events, and may pass through from time to time, as some of their classes and their offices are in the SEC. From my observations, this group of stakeholders use the atrium to sit and chat with students or other staff/faculty. Some may just pass through when going to their classes, labs, and/or offices. Events exclusively for staff/faculty are sometimes hosted here. I have observed professors doing work on their devices here, but it is much rarer when compared to the application by students.

Tufts Administration. This group dictated the budget for the newer part of the SEC. They commissioned the architectural firm, Payette, to design the space. The administration oversees managing the buildings, which includes budgeting, renovations, installations, etc., therefore any changes made to the space would be imperative to seek their approval for budgeting and implementation. This includes the director of strategic capital programs, who ensured that the original SEC construction was "on schedule and aiming to cause as little disruption as possible" (Howard, 2015).

Original Design Firm, Payette. In 2017, the architectural firm, Payette, finished its commission to join the older historical buildings via the new SEC renovation. They describe it as a "Heart, Hive, Hub: Community Living Room", and a "a dynamic, integrated high tech hub for open communication and cross-pollination" (Payette, n.d.). They designed the atrium of the SEC to be a transient yet bustling and collaborative space, intended to be used by many individuals in the Tufts engineering community. Though more removed now than their prominent stake when the building was constructed, the company still has the space on their published portfolio, and

evidently attest their conscientious design process: “We are at our best when we engage our clients at all levels of development and execution, starting with master planning and programming, then moving to concept formation, and ultimately stewarding the project through the careful craft of design and construction” (Payette, n.d.). Any alterations to the space would come off as the company coming up short on this process.

USGBC. The US Green Building Council granted an official gold-star LEED certification for Payette’s sustainable design of the SEC. “LEED certification provides a framework for healthy, highly efficient, and cost-saving green buildings, which offer environmental, social and governance benefits” (U.S. Green Building Council, n.d.). Along with Payette and the Tufts Administration, this group may be concerned with any alterations to the building, especially if it consumes more energy, as it might cause a decrease in a LEED score. This reputation would hurt the reputation of Tufts and/or the design firm.

Kindlevan Café Workers. This group is currently not as applicable to the usage of this space, because the café is currently closed for reconstruction. Because I was not present when the café was operable, I was not able to collect observations on my own. However, they also interact with the space, for breaks if they choose to sit here, and pass through and it is in front of the café while they are working.

Visitors. This group includes people that can be parents/family/friends of prospective/accepted/enrolled students, alumni, or staff. For visitors interested in the school as part of their/someone’s future, they may consider the space as part of their holistic impression of the school and may consider all these impressions when deciding on how it fits in with their journey. They could be anywhere from impressed with the space’s aesthetics to detracted by construction amongst other surface-level impressions with the space.

Event Space Personnel (Tufts or Visiting). This group can include visiting or internal technicians or A/V personnel who set up furniture/gear/tech for events. They would be interested in the outlet receptable availability and locations when setting up, and the area of the spaces when considering which gear/equipment to use for events. This equipment can include microphones, speakers, projectors, screens, banners, tables, chairs, etc.

Residents of Somerville/Medford. Because this space is in the entry of the SEC, which does not have blocked entry, it is a very public, general area, so the space can technically be visited or used by anyone else that walks into the building. If any outside individual ever enters the space, they will likely see the space as part of the academic institution and recognize the "nice" or "fancy" aesthetics, or as "science-y". If a project were to be done here, this stakeholder group would likely not be affected, unless there are construction vehicles that park and crowd the public street that the entrance to the building is on, where some of these non-Tufts residents live.

III. User Needs & Gap Analysis

Aside from the referenced material, my personal observations of this space are anecdotal, summing to roughly four weeks/four days a week/one to three hours a day. Additionally, I approached a total of 5 students throughout these four weeks for my brief observations, who were chosen usually due to proximity to my spot, including three individuals and one group of two. My own position as a student is also influential on these conversations and observations.

I chose the lobby in the SEC because of a few reasons. First, I have spent most of my time since beginning classes at Tufts in this space to do independent study/work, group work, sitting with friends, and casual dining, and have witnessed the space used for a couple faculty events.

From these observations, I realized that the space is most often used by students for independent work/study. Often, only one student at a time tends to occupy the large round tables meant for 4-5 people, because this occupation deters other students from sitting in the chairs next to a stranger at the same table, due to what seems like an unspoken social barrier. This may stem from many reasons, including not wanting to disrupt someone you don't know, or avoiding the awkward interaction of sitting in such close proximity with someone you don't know. For whatever reason(s) it may be, this phenomenon results in many chairs, tables, and space unattended.

A photo I took of the atrium (September 2023). A few students are sitting at the tables against the wall.

On top of this, I observed that the spots by the wall are more desirable, as assumed by the observation that the spots by the wall are chosen first if a student is given the choice. It seems that this is because the wall side has the only outlet receptables in the lobby (of which there are four sets of paired, triple-pronged outlets), besides one functioning receptable in the middle of the floor, accessible only when a student investigates by lifting one of the metallic circular fixtures (the other middle-of-the-floor receptable does not have an outlet).

In a few instances, I have observed students attempting to drag the heavy tables (makes a loud, disruptive scraping noise usually because of how heavy and awkward this is) closer to the walls for this reason (assumed because student is wandering with a charger), regardless of where the table was originally oriented. On occasion this is successful, but usually the student gives up or leaves the space.

Although the space was originally intended for a collaborative space for "cross-pollination" (Payette, 2015), many students can be seen studying here independently. From speaking to a few random students in the space at different times of day (morning/afternoon/evening), I have found this is sometimes because many students find spaces to work on their own when in-between, before, or after classes, which have proximity to their classrooms. Many of the students are in the engineering department. All the students I have talked to have described their frustrations with the space lacking outlets.

As a result of its apparent usage, this space is not effectively used, and must be re-designed to accommodate this design gap by introducing more/spread out outlet receptables, and more effective seating options.

Additionally, because the space is also still used as a place to eat, a casual meeting area, and as a space for events that have alternative seating, it must not be restricted to the design for independent work/study; rather, it should still cater to these other applications.

Listed User Needs:

- More outlet receptables
    - Ability to charge devices
    - Accessible regardless of seating choice in atrium
    - Connection to original electrical wiring source to mitigate invasive renovation
- Event space adaptability
    - Tables and chairs must have ability to be either rearranged relatively easily/impermanently, or must be oriented in a manner suitable for wide variety of events
- Optimized seating
    - Choices that promote spaces for both independent work and group collaboration
    - Facilitates seating choices that would encourage efficient use of space that mitigates any deficiencies in choice caused by social barriers
- Relatively transient, public seating that can be used readily/reusable by next user
- Accessible to handicapped users
- Aligned with existing science/community aesthetic of SEC
- Affordable for administration-allocated budget

IV. Model Description

The modeled concept of the re-designed SEC lobby shown (Figure 1) is measured with scale ratio of 1:30 (model to life-size). The dimensions were taken of the lobby using the iPhone "Measure" app, which uses a camera to measure in real-time.

The real-world measured dimensions are as follows:

- Short side = end of support beams to the art wall (19')
- Long side = along the edges of the art wall (58')
- Height = floor to the bottom of the fluorescent lights along the top of the art wall (10'8")

The model of the redesign is scaled down to a 30th of the original room dimensions. The acrylic barrier which divides the room exists only to divide the displays of the two possible re-designs, one on either side. It is important to note that if either of these designs are chosen, the seating that differs between them (each design described below, in more depth) will be repeated throughout the entire room.

The half-room model design was created for visual juxtaposition of the two designs, and for convenience when modeling, as each of the seating options are intended to be repetitive throughout the length of the room. Furthermore, any receptable outlets mentioned are not explicitly modeled, due to modularity in placements and amount. This detail is more granular than the larger structures, but these fixtures will allow for the important detail to include more outlets, one of the pertinent aspects of this re-design.

Design #1 (Figure 3a and 3b). Stair/bleacher-like wooden seating/tables (will be referred to as "stair seating") with more outlet receptables along the entire length of the art wall. This fixture is situated here, because it allows connectivity to the original electrical wiring, therefore allows more receptable outlets along the entirety of the fixture, while also allowing for

more seating without disrupting the flow to the rest of this floor of the SEC (away from the art wall).

The protruding, "swingable" tables along this fixture also have more outlets situated on the tabletops. These tables are retractable for the case of events where the space needs to be modulated to a more open concept (Figure 3b). There is enough space here to accommodate the need for more seating and outlets, without compromising the uses as a collaborative space and an event space.

One physical drawback of the protruding tables is the potential difficulty and/or hazard of putting them away. Because they need to be swung back onto the wall, these tables may pose a safety risk, depending on how heavy the full-scale fixtures may turn out, and any precautions taken to avoid this (such as warning signs or locking mechanisms that restrict the tabletop movement when not being converted).

Design #2 (Figure 4). The wooden stair seating is continued with a one-level version, which also includes more outlet receptables along the fixture. These are arranged into "T" shapes that allow for maximum division of individual/semi-private spaces, while keeping an open seating concept that can enforce collaboration. Instead of distinct seats, these can be thought of as continuous benches, which is useful for increasing tabletop/seat surface area in casual settings. They are still low enough that they can be seen over, which is useful for when events are taking place.

One drawback to this design is that they do not allow for as much modulation as the first design concept, since they are fixed to the floor. This would prevent the ease of events that necessitate an open, even space. Furthermore, the comfort of sitting on blocks, especially if not along the seat choices along the wall, is likely much less compared to that of sitting on individual seats.

Both Designs. These re-designs are largely interior and non-invasive to the building besides any minor electrical wiring to new outlets, but the minimal construction needs allow for a redesign that is not a major, disruptive project to the SEC as an entirety.

Because these fixtures are already interior within the original dimensions of the existing room, they would not incur as much expense as more invasive renovations. However, the school will still need to invest more in these furniture pieces for a space that was very recently re-designed.

The installation of these fixtures will disrupt the space for the duration of installation, which may pose problems to students, faculty, and staff that use or pass through the area for studying, meeting, and/or classes. This drawback is ephemeral, however.

One drawback will be that re-designing a newer space may have negative connotations against the original architectural firm. The relationship between Tufts and Payette may be harmed as it comes off as an insult to the company.

V. Design Process Discussion

Approaching this engineering project as someone who has previously worked in the science, medical, and art industries, I found that regardless of industry, the process of ideating a creative yet practical endeavor is always a process of continuous, re-evaluation and re-implementation of earlier steps.

I found that using a feedback loop to rework my ideas, like the iterative process of re-working steps in the design process described in Pahl et al (2007), to be akin to my personal ideation method. During the process, I repeated the very first step: the situational analysis of finding a design. Because of the extreme open-endedness of this assignment, I was overwhelmed

with an abundance of ideas. I realized that, when formulating the problem definition, I did not want to be hindered with too wide or too narrow of an issue, both conceptually and physically.

The second step was re-evaluated several times; my search strategies included wandering around campus and perusing different areas, going to a non-profit, and literature searches of re-design, aimed at educational learning environment design.

Also worth mentioning: During this project, I coincidentally met the math department head of Milton high school, who explained that she was periodically meeting with an architectural firm that was re-designing the school's math department classrooms in a new building.

I told her about my project, and I asked her about the process: what degree of involvement she had in the design process as a department chair, if other department chairs, non-chair teachers, students, or parents had any contribution to feedback, and examples of types of feedback she gave. One example was that the new building was made of transparent glass walls on all sides. The teachers noticed several issues with this: that they would likely have things (books, student items, etc.) pile up against the walls, which was unsightly; taking cover would be more difficult if the rooms were no longer visually secluded, posing a safety issue; and, many students would be distracted in an environment where they can see other students through the walls (Brash, 2023).

This opened my eyes to the concept of visualizing the implementation; hence, I decided to build a scale model and try to understand through a small scale of implementation whether the design would be feasible.

Initially, for the first few days after this project was assigned, I observed my own and others' usage of the physical spaces around campus, but most notably in the SEC. It is here that I

spent most of my time since enrolling at Tufts this fall, and because of this consistent exposure, I realized a design gap in the recently renovated lobby.

I ran into several issues from my initial idea, which was to make tables that folded into the wall. When I made the wooden models, I realized that the idea of folding tables up would be a difficult task in practice due to their weight and the hazard of lifting/folding heavy components into the air. Suddenly, I found myself going back to the search strategy step.

I found that "S", "C", "A", "M", & "R" within the SCAMPER technique to be useful when I hit this creative block. I found this method particularly useful to organize my ideas, which were largely nebulous until I was able to define them as shown below:

Substitute. The lateral direction substitutes the longitudinal direction. In the first model, the modular table components move laterally instead of the original idea, where they fold up and into the wall.

Combine/Mirror. The wall stair seating in the second model is mirrored by/combined with the seating in the remaining floorspace, which also gives more cohesion to the elements of the room.

Adapt/Combine. In both models, we can adapt the wooden stair/block seating fixtures to the solutions themselves for the issue of a lack of outlet receptables. This also emulates the principle of combining. For the second model, instead of putting away the extra seating, I decided that the alternative seating would remain for the second design, but since they are low enough, one can still host events in the space as people can see over the low seating.

Reverse/Rearrange. While constructing the model, I ran into an issue with the shapes of the components in the first model. Originally, these half-rounded shapes were supposed to join into ellipses for tables. However, I realized that the rotation at the "joint" connected to the stair seating area would not complete without running into the other shape, so I flipped the shapes to

make the original "middle" parts as the outside. This also gave a more interesting aesthetic, and the flat edge posed a better solution for the outside of the table, as there would be more space at the ends for users to place items.

Finally, the ideas comparing experienced and novice design practices explained in Cross (1990) also helped my ideation process when I began to feel "stuck". Indeed, my early fixation on one design based on an aperiodic "monotile" shape (recently discovered in the mathematical world this year) was interesting, yet one of purely theoretical, impractical application and a solution approached with "depth-first", as Cross would describe. It was the description of the expert-utilized "breadth-first" practice and comfort in rejecting early design solutions which helped me start brainstorming fresh ideas.

VI. Model Figures

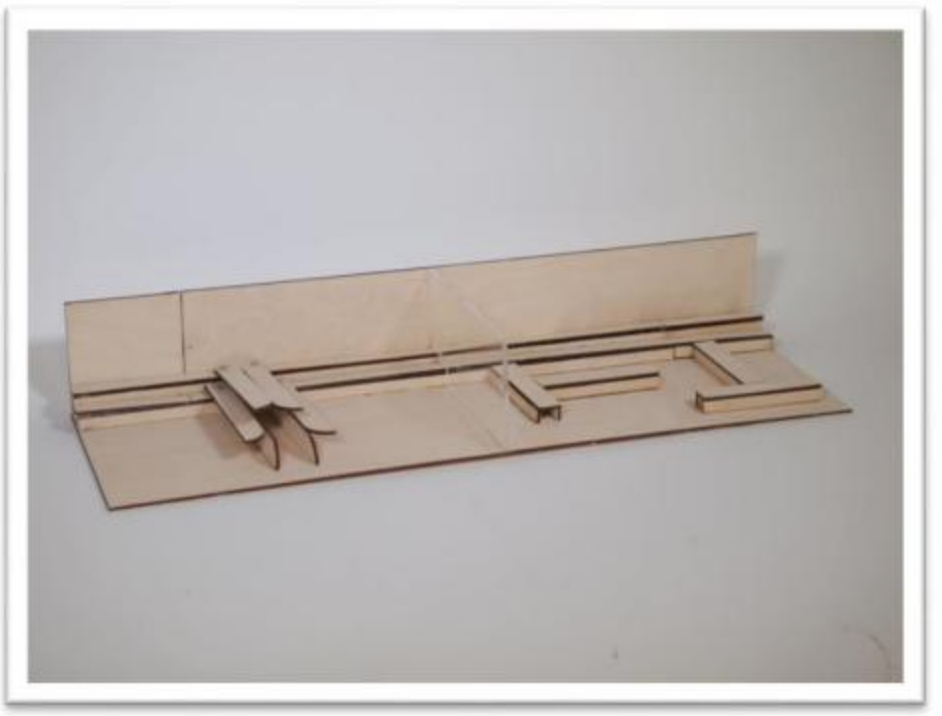

FIGURE 1. A PHOTO OF THE 1:30 SCALE MODEL OF THE DESIGN PROPOSAL.

Designed in Adobe Illustrator, each element of this model was laser-cut on plywood and adhered together with hot glue. The rotation joint on the left—which is intended to model a more robust, complex mechanism—was fashioned via a simple wood screw drilled into through two layers of plywood. The acrylic divider was also designed on Adobe Illustrator for laser cutting. The final design was sanded down with 120 to 240 grit sandpapers.

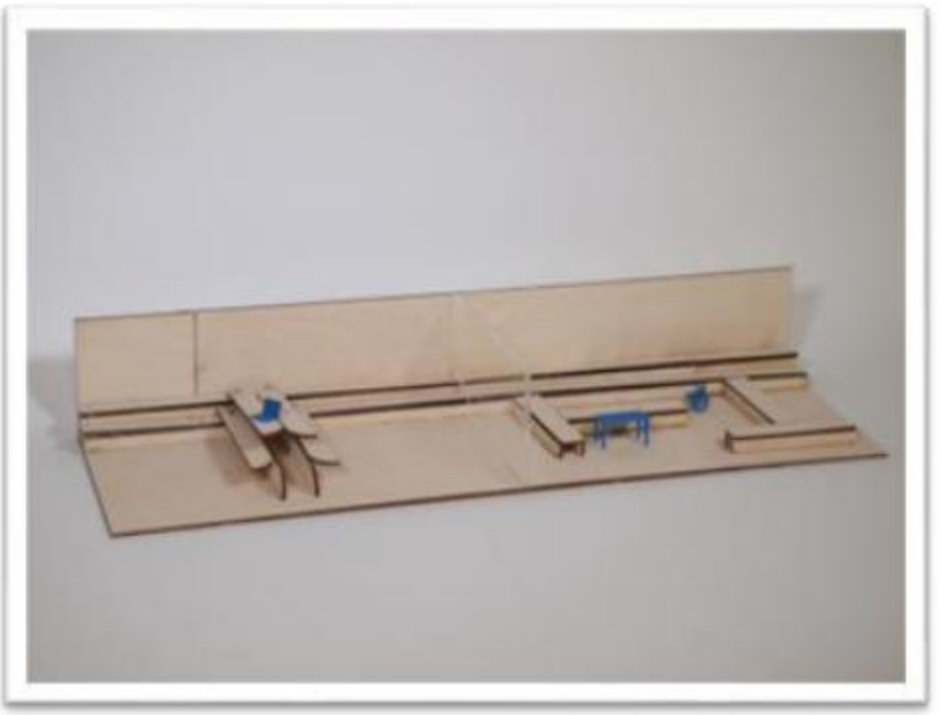

FIGURE 2. THE SCALE MODEL WITH 3D-PRINTED ELEMENTS FOR POSSIBLE USABILITY VISUALIZATION.

The 3d elements include: a laptop, which is shown to display what a user might typically utilize in the space; a table, which may be added to the second design for more tablespace options; and a wheelchair, to show the accessibility of the space.

(LEFT) FIGURE 3A. A CLOSER LOOK AT DESIGN #1, TABLE/SEATING OUT.
(RIGHT) FIGURE 3B. A CLOSER LOOK AT DESIGN #1, TABLE/SEATING RETRACTED.

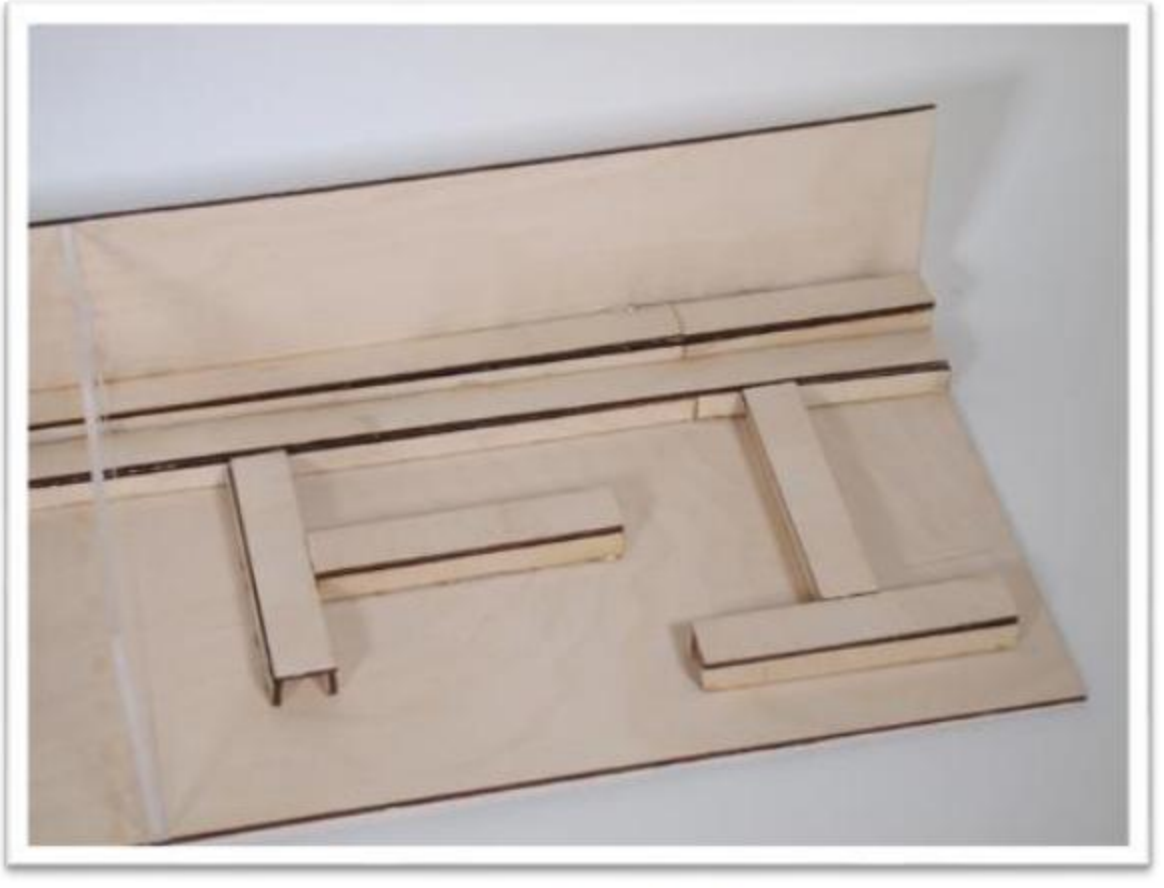

FIGURE 4. A CLOSER LOOK AT DESIGN #2.

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