Sit-Stand Storage Solutions

Final Report

May 4, 2018

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Prepared for:
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Sit-Stand Storage Solutions
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May 4, 2018

James Intriligator
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Medford, MA 02155

Dear Professor Intriligator,

We are excited to share our final report with you.

In this report, we summarize our entire design process, from user research to concept development to user testing to concept refining and testing to final design.

We have used our design expertise from numerous human factors design classes to come up with a feasible, usable, and aesthetic design. Additionally, we have each gotten certified to use the equipment necessary to construct our design. We feel we have successfully met the goals and requirements from the first stages our process; however, we also provide a final assessment of our design with future directions, should we choose to continue this project. We could not be more excited to show you our final, completed project.

If you have any questions, please feel free to contact our project manager, Lexie Kirsch, at akirsc01@tufts.edu.

We appreciated the opportunity to work with you, and we look forward to your feedback.

Sincerely,
Chad and Lexie
Sit-Stand Storage Solutions

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INTRODUCTION

Purpose

Sit-Stand Storage Solutions created a desk with sit-stand and storage functionality to improve productivity in college classrooms (refer to Proposal).

Our Team

Lexie Kirsch is a senior majoring in Human Factors Engineering at Tufts University. As the project manager of this team, she provided weekly updates on the progress of this project. She also applied her design expertise from various product design classes and her certification to use equipment at Bray Laboratory to create a functional and user-friendly physical product.

Chad Goldberg is also a senior studying Human Factors Engineering at Tufts University. His experience as a Human Factors research assistant at the Natick Soldier Research and Development Center prepared him well for his role as the design and manufacturing manager of the team. He has consulted on projects sponsored by Adobe, the MBTA, and the US Army Soldier Systems Center and he used his CAD and prototyping experience to contribute to the development of our final product.

DESIGN PROCESS

Our design process consisted of five steps: (1) user research, (2) concept development, (3) user testing, (4) concept refining and testing, and (5) final design, which are further elaborated below.

Step 1: User Research

We identified user preferences and needs by conducting a literature review, questionnaire, competitive analysis, expert review, and discussion with our client.

The **literature review** (see Appendix A) helped us collect background information to motivate our design. We explored sitting workstations, standing workstations, sit-stand products, and environments conducive to collaboration. The **questionnaire** (see Appendix B) helped us gather information about users' preferences directly. We asked our users about our themes of work environment preferences, collaboration preferences, desk and storage preferences, break desires, and thoughts about sitting compared to standing. The **competitive analysis** (see Appendix C) and **expert review** (see Appendix D) helped us compare our product concept with similar workstations and to identify the best and worst qualities to incorporate and avoid, respectively, in our designs. The **discussion with our client** (see Appendix E) helped us identify additional needs, themes, and goals to keep in mind before we started designing.

We used the data from this user research to identify the following list of goals and tasks for our three design concepts:

Goals:

- Lots of desk space.
- Sufficient and safe storage.
- Mobility.
- Ample legroom.
- Adjustable height.
- Accessible power supply.

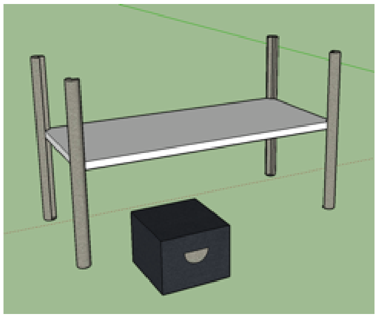
Tasks:

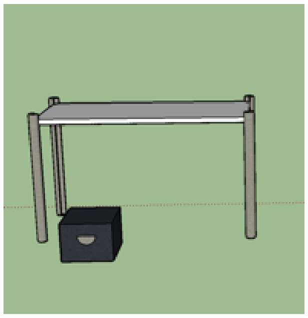
- Spread out their work to not feel cramped or confined.
- Securely store projects and materials in drawers.
- Move the product.
- Sit at desk without hitting knees.
- Adjust the height of the product to accommodate a sitting or standing position.
- Access a power supply.

Step 2: Concept Development

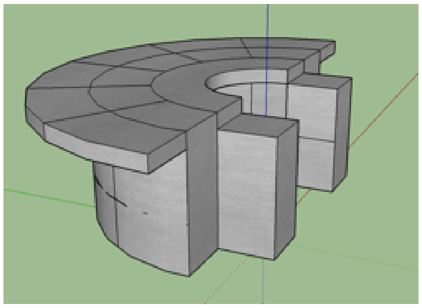
We developed three initial design concepts based on our user research, each with a different priority.

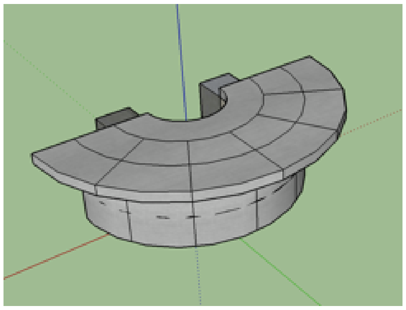
Concept 1: The Simple Desk
Our first design concept prioritizes **simplicity**. This design offers a large adjustable workspace, ample legroom, and chairs that function as storage bins—perfect for minimalists.



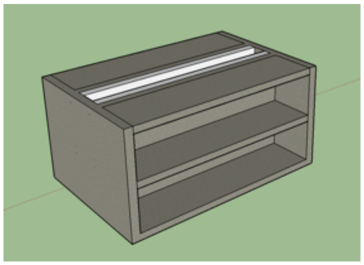


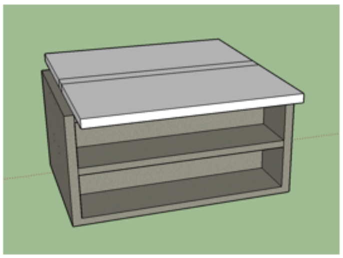
Concept 2: The Modular Desk
Our second design concept prioritizes **modularity**. Each desk is designed to fit beside other desks to form a large cohesive circle—perfect for group discussions. Additionally, each desk is adjustable and equipped with storage shelving below.

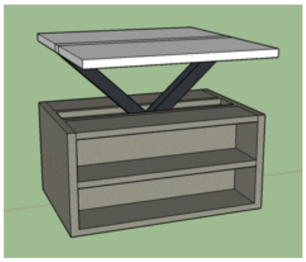




Concept 3: The Space Optimizing Desk
Our third design concept prioritizes **space optimization**. At its most compact level, this product is a cabinet with storage shelves on each end. Between these shelves is a whiteboard that can be pulled out and used as an adjustable desk surface—perfect for tight spaces.







Step 3: User Testing

We used user interviews and focus groups to gather feedback on our design concepts from members of our user group (see Appendix F).

We asked potential users to answer the following questions for each design:

- What do you think about this product?
- What do you think are its best qualities?
- What do you think are its worst qualities?
- How would you improve this design?

Then we asked potential users to rank the designs, and we calculated the following scores:

- Design 1: 18 points
- Design 2: 15 points
- Design 3: 27 points

This means that the third design was the most popular, followed by the second, and lastly the first.

Based on this feedback and the rankings, we chose to pursue our third concept, the space optimizing desk, for our final design. This concept was deemed most popular for its practical multifunctionality and aesthetic design. However, potential users also expressed concerns about the design's weight bearing capacity, mobility, and ease of transition between states. We took these concerns into account during the iteration process.

Step 4: Concept Refining and Testing

Prototype 1: Mini model

We created our first physical prototype of our chosen design using the laser cutter at Bray Laboratory.



To assess the usability of this design, we conducted a usability assessment with prospective users.

Method: We approached students in the Science and Engineering Complex of Tufts University and asked them to participate in a usability test. When participants agreed, we showed them our prototype and asked them to complete two simple tasks. We assessed their performance, and when necessary, we explained the expected procedure. Finally we asked them follow-up questions and thanked them. Participation was voluntary and participants did not receive any compensation.

Participants: We approached 7 students who appeared to be within our target user group age range, which is between 18 and 25 years old. We chose to conduct our usability assessment in the Science and Engineering Complex of Tufts University because that is a popular spot for students of that age group.

Stimuli: We used the to-scale prototype that we built in Bray Laboratory for our usability assessment. We placed the desk in its storage/bookshelf mode for the beginning of each assessment.

Task Flows: We asked each participant to complete the following two tasks:
1. Transition the desk from storage/bookshelf mode to sitting mode.
2. Transition the desk from sitting mode to standing mode.

Assessment Protocol: We assessed whether or not users were able to correctly complete each task without needing any assistance. Completion of the first task was considered successful if the participant used the slots to place the desk surface on top of the shelves and in the correct orientation. Completion of the second task was considered successful if the participant removed the desk surface, moved the ladderlike side components in any of the higher slots, and placed the desk surface back on top and in the correct orientation.

Results: Of our seven participants, six (86%) successfully completed both task flows.

Discussion: After the usability assessment, we conducted user interviews to find out what participants liked and didn't like about the desk.

Here's what participants liked:

- Most participants commented on the practicality of the storage shelves.
- Many others remarked on the large amount of desk space.
- Some participants were also impressed by the design's multifunctionality.
- Additional comments include:
  - The design was described as "pretty cool," "compact," "simple," and "a great option for a student." It was also perceived as inexpensive.
  - The quality of the material (wood) was admired.
  - The act of transitioning between states was described as "intuitive" and "easy." One participant even commented that our pieces were similar to Legos and were fun to assemble.

Here's what participants didn't like:

- The most popular concern was that the full-sized desk would be too heavy.
- Many participants were also concerned that the procedure for transitioning the desk between states was "too much effort" or "too manual."
- Other participants also noted that the desk surface appeared unstable and "might tip over."
- Additional comments include:
  - The transition was considered too time-consuming.
  - Participants wondered if wheels could be added to ease mobility.

Conclusions and Design Recommendations: Based on this feedback, we decided to make the following changes:

- In order to address concerns of weight, we decided to use a more lightweight material.
- In order to address concerns of stability and simplify the transition between states, we developed an entirely new means of raising the desk surface--one that involves less manual effort but is still intuitive and enjoyable to the user.

Prototype 2: Full-size model

Based on the feedback from the first usability assessment, we created a second, full-size physical prototype. To account for previous concerns of weight and stability, we decided to use telescoping shafts to transition the desk between sitting and standing states.

To assess the usability of *this* design, we conducted another usability assessment by demonstrating our prototype to prospective users and assessing their reactions. We also used this usability assessment to identify locations on the telescoping shafts to drill holes so the desk could be raised and lowered to various heights.

Method: We approached students in the Science and Engineering Complex of Tufts University and asked them to participate in a usability test. When participants agreed, we showed them our prototype and asked them to position the desk at a comfortable standing height. We made a note of this height on the model. Participation was voluntary and participants did not receive any compensation.

Participants: We approached 8 students who appeared to be within our target user group age range, which is between 18 and 25 years old..

Task Flow: We asked participants to indicate a comfortable desk height for standing work.

Results: We gathered the following data about user's standing desk height preferences:

Height of user	Standing desk height preference
5'2	40"
5'5	41"
5'10	42"
6'1	43"
6'2	48"

Conclusions and Design Recommendations: Based on these results, we decided to drill holes on the PVC pipes at every inch from 40" to 48" to account for the range of preferences.

Step 5: Final Design

Our design process culminated with a refined physical product, which we constructed in Bray Laboratory according to a defined list of specifications (see Appendix G).


Task Workflow: To raise the desk platform, pull out the peg from the PVC pipe while holding the desk platform, raise the pipe to the desired height, and reinsert the peg. To lower the desk platform, repeat the previous steps, replacing the word “raise” with “lower.”

DISCUSSION

Final Design Assessment

Overall, our final design met a majority of our project goals. As a reminder, our goals were to have lots of desk space, sufficient and safe storage, mobility, ample legroom, adjustable height, and accessible power supply. To ensure that we met these goals, we assessed whether or not a user could perform the following tasks:

- Spread out their work to not feel cramped or confined.
- Securely store projects and materials in drawers.
- Move the product.
- Sit at desk without hitting knees.
- Adjust the height of the product to accommodate a sitting or standing position.
- Access a power supply.

The user was successfully able to spread out work without feeling cramped due to the large surface area of the desk. The user was also able to store materials on the shelves below the desk, but this means of storage was not considered secure, since we opted to use shelves instead of drawers for aesthetic reasons. In terms of mobility, we did not incorporate wheels below the desk because the desk can be moved without much difficulty due to its lighter weight. The user can sit at the desk without hitting their knees on the bookshelf because the desk surface protrudes beyond the bookshelf. Additionally, if the user decides to stretch their legs, they can do so by transitioning the desk from a seated desk to a standing desk. Finally, we did not add a back to the bookshelves to allow users to easily access a power outlet behind the desk.

Future Directions

Moving forward, we plan to eliminate our designs three main limitations.

First, the material we used for the desk platform, PVC, is flimsy, making the desk less user-friendly. In a future iteration, we would use an alternative material, such as wood or lightweight plastic.

Second, due to the width of the flanges on the desk platform, the desk platform is not flush with the 30” planks, making the desk platform less stable. We resolved this issue by placing the flanges farther apart; however, this solution introduced a new problem: the PVC pipes were no longer flush with the sides of the 30” planks, causing the PVC pipes to slant. To resolve this second issue, we attached an extra piece of wood to the outsides of the 30” planks so the PVC pipes would be flush with that surface. Looking back, a simpler solution would have been to cut out the part of the 30” plank that the flange was intercepting from being flush with the desk platform. We would incorporate this simpler solution in future iterations of our design.

Third, our PVC pipes are only 48” long, so the desk can only be raised by that height. This makes our desk less user-friendly for users who require a taller desk height for standing work. In a future iteration, we would either (1) raise the seated desk height (above 30”) to afford for longer PVC pipes, or (2) maintain the desk height at 30” but change the two 1” diameter pipes with a length of 24” for two 1” diameter pipes with a length of 30”.

We believe that these changes will allow our sit-stand storage solution to be not only more functional and aesthetically pleasing but also more user-friendly and enjoyable to use.

REFERENCES

Kirsch, A., and Goldberg, C. (2018). *Design Specifications Report*. Unpublished design specifications report for ENP120. Medford, MA: Tufts University.

Kirsch, A., and Goldberg, C. (2017). *Proposal for Sit-Stand Storage Station*. Unpublished proposal report for ENP120. Medford, MA: Tufts University.

Kirsch, A., and Goldberg, C. (2018). *Usability Assessment 1 of 2*. Unpublished usability report for ENP120. Medford, MA: Tufts University.

Kirsch, A., and Goldberg, C. (2018). *Usability Assessment 2 of 2*. Unpublished usability report for ENP120. Medford, MA: Tufts University.

Kirsch, A., and Goldberg, C. (2018). *User Research Report*. Unpublished user research report for ENP120. Medford, MA: Tufts University.

APPENDIX A

User Research: Literature Review

We read six articles, which we have summarized using bullet points below.

Thorp, A. A., Kingwell, B. A., Owen, N., & Dunstan, D. W. (2014). Breaking up workplace sitting time with intermittent standing bouts improves fatigue and musculoskeletal discomfort in overweight/obese office workers. *Occupational and Environmental Medicine*, 71:11, 765-771. http://dx.doi.org/10.1136/oemed-2014-102348

- Self-report of fatigue is significantly higher amongst sitting participants than those who alternate between sitting and standing every 30 minutes.
- Sitting is associated with significantly more lower back musculoskeletal discomfort, slightly more focus, and less overall work productivity than alternating between sitting and standing every 30 minutes.

Deros, B. M., Senin, N., & Khamis, N. K. (2013). A Study on Ergonomic Workstations for standing operators at a manufacturing factory in Malaysia. *Applied Mechanics and Materials,* 471, 172-177. http://dx.doi.org/10.4028/www.scientific.net/AMM.471.172

- Holding a static standing posture for a prolonged duration can lead to musculoskeletal disorders.
- Common musculoskeletal disorders for standing participants are shoulder pain, leg pain, and upper back pain.

Toomingas, A., Forsman, M., Mathiassen, S. E., Heiden, M., & Nilsson, T. (2012). Variation between seated and standing/walking postures among male and female call centre operators. *BMC Public Health*, 12, 154. http://dx.doi.org/10.1186/1471-2458-12-154

- More and more occupations involve extensive periods of sitting.
    - This primarily affects people between the ages of 18 and 65 who spend a large amount of their wake time at work.
- Extensive computer use is a risk factor for musculoskeletal disorders.
- Public health research indicates that sedentary behavior (extensive seated work) is associated with several potentially serious health problems.
    - Health risks include obesity, hypertension, type II diabetes, metabolic syndrome, venous thromboembolism, cardiovascular diseases, cancer, and increased mortality.
    - Health problems are mainly of a cardiovascular and metabolic nature.
- These health problems persist independent of the individual's physical activity!
- Physical variation is important to break up this sitting time.
- The ergonomic recommendation is that workers should take a break from sitting for at least 5 to 10 minutes every hour.

Deros, B. M., Senin, N., & Khamis, N. K. (2013). A Study on Ergonomic Workstations for standing operators at a manufacturing factory in Malaysia. *Applied Mechanics and Materials*, 471, 172-177. http://dx.doi.org/10.4028/www.scientific.net/AMM.471.172

- Collaborative learning (CL) has numerous benefits and typically results in higher achievement and greater productivity, psychological health, social competence, and self esteem.
- CL promotes positive societal responses to problems and fosters a supportive environment within which to manage conflict resolution.
- CL helps students resolve differences in a friendly manner.
- CL teaches students how to challenge ideas and advocate for their positions without personalizing their statements.
- CL develops higher-level thinking, problem solving, and oral communication skills.
- CL actively involves students in the process of learning.
- CL reduces classroom anxiety created by new and unfamiliar situations faced by students.

Karakolis, T., & Callaghan, J. P. (2014). The impact of sit–stand office workstations on worker discomfort and productivity: A review. *Applied Ergonomics*, 45:3, 799-806. https://doi.org/10.1016/j.apergo.2013.10.001

- Prolonged seated work has been shown to result in increasing worker discomfort with respect to time.
- Adjusting posture at an increased frequency throughout the workday is a proposed strategy used in an attempt to reduce discomfort.
- Sit-stand workstations are effective in reducing local discomfort reported in the low back.
- Sit-stand workstations are associated with increased productivity.
- Ideal wrist position while standing is different than ideal wrist position while sitting.
- Less upper limb discomfort is experienced while standing.

Laal, M., Naseri, A. S., Laal, M., & Khattami-Kermanshahi, Z. (2013). What do we Achieve from Learning in Collaboration? *Procedia - Social and Behavioral Sciences, 93*, 1427-1432. http://doi.org/10.1016/j.sbspro.2013.10.057

- Collaborative learning (CL) increases performance by creating a supportive environment in which members help each other.
- CL increases self-esteem and significantly reduces anxiety in students.
- CL improves class attendance of students.
- CL promotes innovation in teaching and techniques.
- CL improves productivity.
- CL improves the skills of problem solving and higher-level thinking.

APPENDIX B

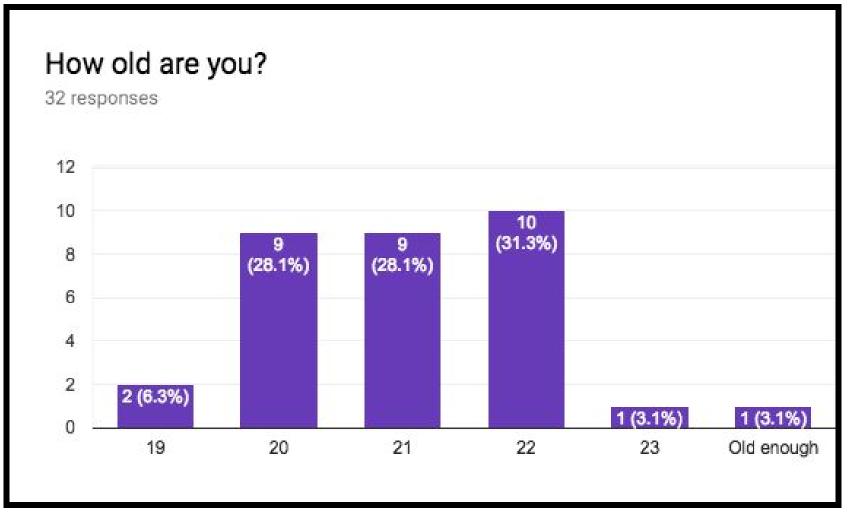
User Research: Questionnaire

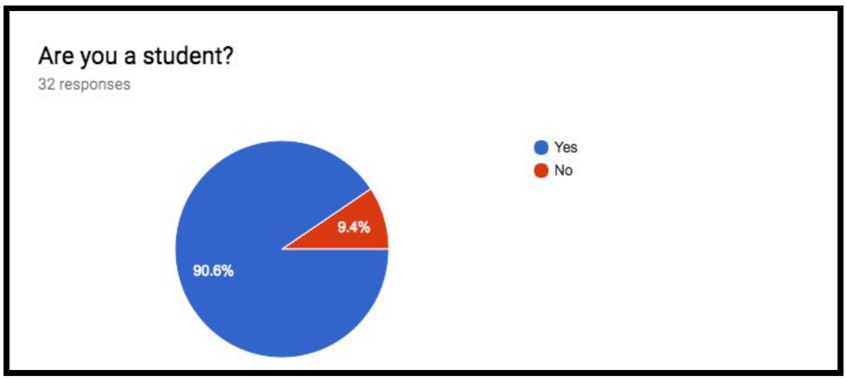
Thirty-two people completed the questionnaire, ranging in age from 19 to 23. Twenty-nine of these responders were students, and three were not.

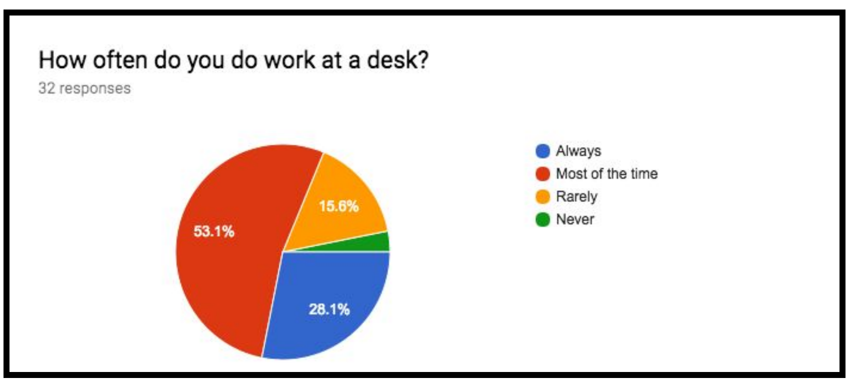
In addition to questions of demographics (i.e., “How old are you?” and “Are you a student?”), the questionnaire consisted of the following ten questions:

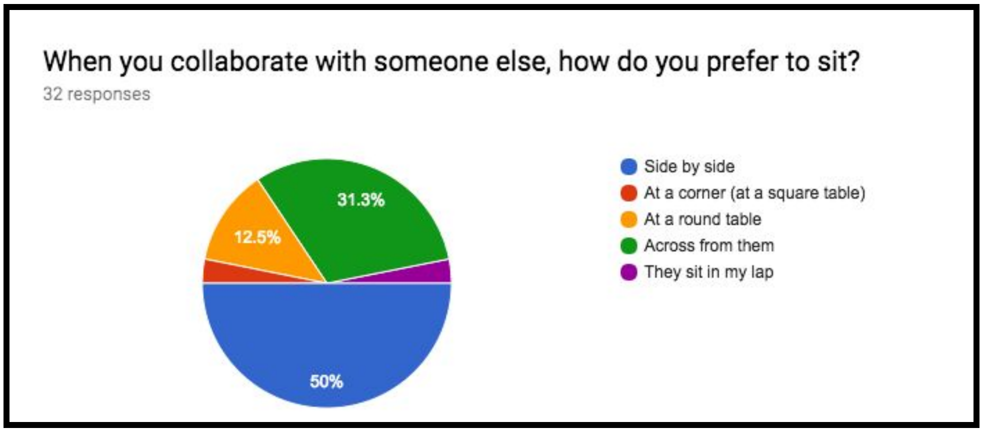
- How often do you work at a desk? (Always, Most of the time, Rarely, or Never)
- When you collaborate with someone else, how do you prefer to sit? (Side by side, At a corner (at a square table), At a round table, Across from them, or Other)
- How many hours do you spend sitting at a desk in class each day? (1-3 hours, 4-6 hours, 7-9 hours, or 10+ hours)
- What do you appreciate in a good desk? (Lots of space, Drawers, Mobility, Legroom below desk, Other)
- Do you get tired of sitting during class? (Often, Sometimes, Rarely, Never)
- Are you familiar with the concept of a sit-stand desk? (Yes I have one, I have heard of it, or What’s that?)
- If you had a sit-stand desk, would you use the stand option? (Yes, No, or Maybe)
- If you could (safely) store physical projects or materials in the classroom, would you? (Yes, No, or Maybe)
- Where at a desk would you prefer to store work supplies? (Drawer above my desk, Drawers on the sides of the desk, Drawers on the sides below the desk, or Other)
- Is there anything else you would like to add regarding your work preferences?

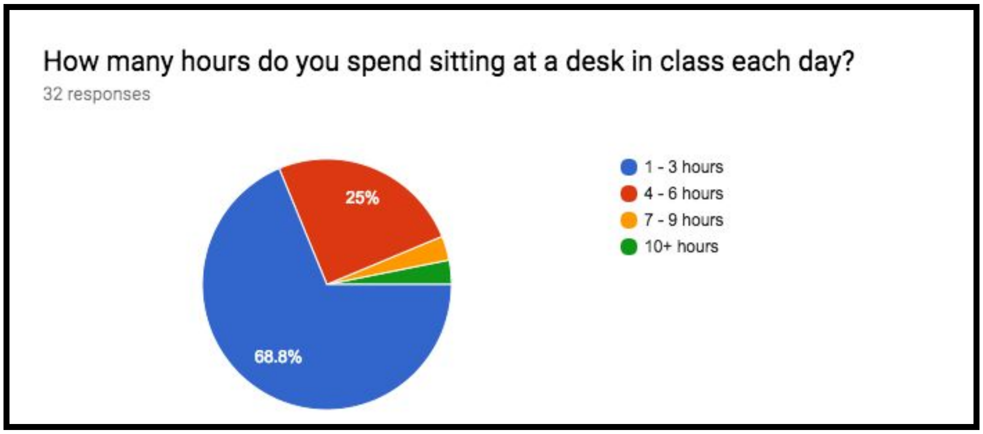
Questionnaire Response Data

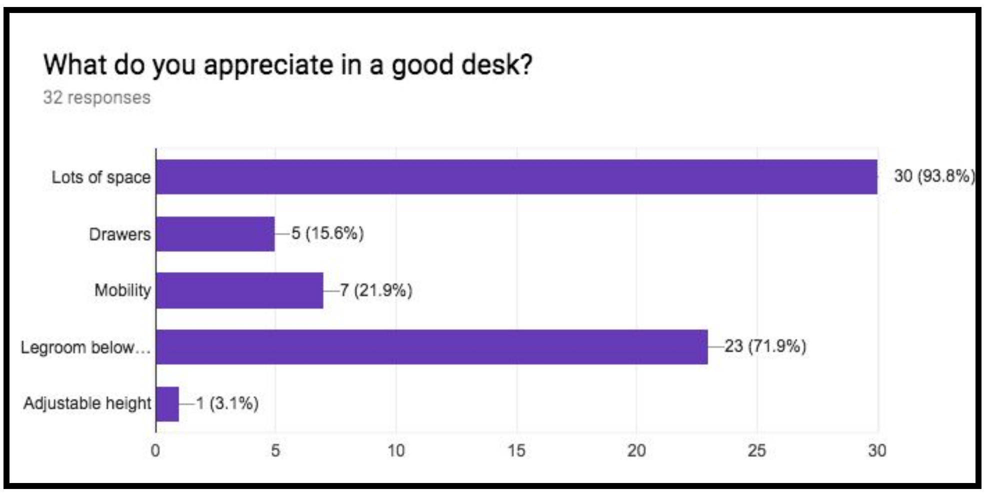






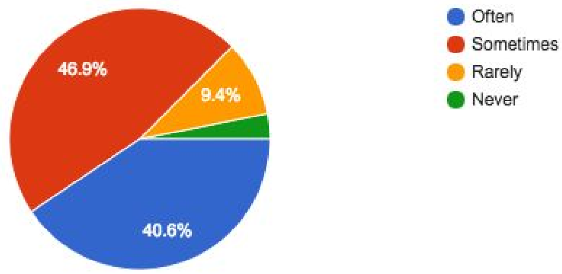

When you collaborate with someone else, how do you prefer to sit?
32 responses
31.3%
12.5%
50%
Side by side
At a corner (at a square table)
At a round table
Across from them
They sit in my lap


How many hours do you spend sitting at a desk in class each day?
32 responses
25%
68.8%
1 - 3 hours
4 - 6 hours
7 - 9 hours
10+ hours


What do you appreciate in a good desk?
32 responses
Lots of space
30 (93.8%)
Drawers
5 (15.6%)
Mobility
7 (21.9%)
Legroom below…
23 (71.9%)
Adjustable height
1 (3.1%)
0
5
10
15
20
25
30

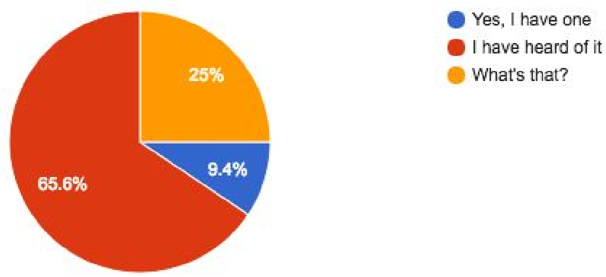
Do you get tired of sitting during class?

32 responses



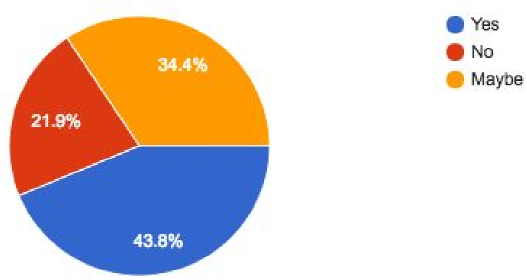
Are you familiar with the concept of a sit-stand desk?

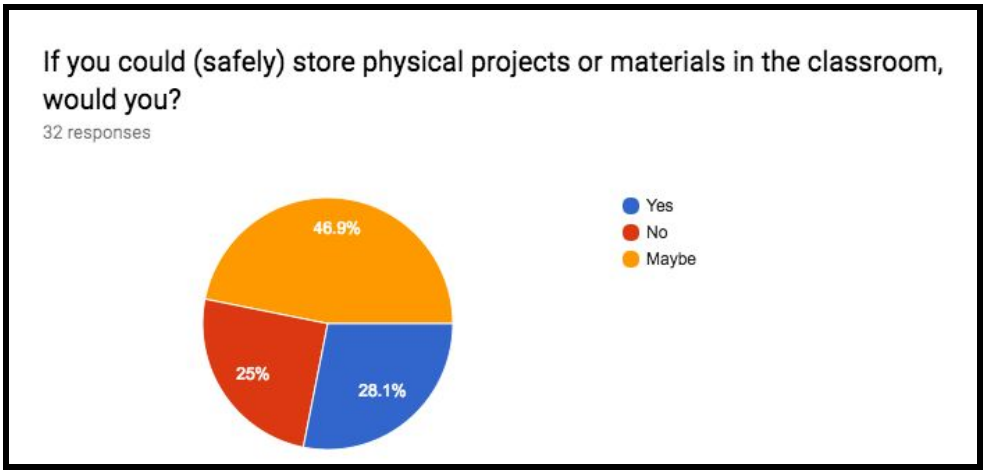
32 responses

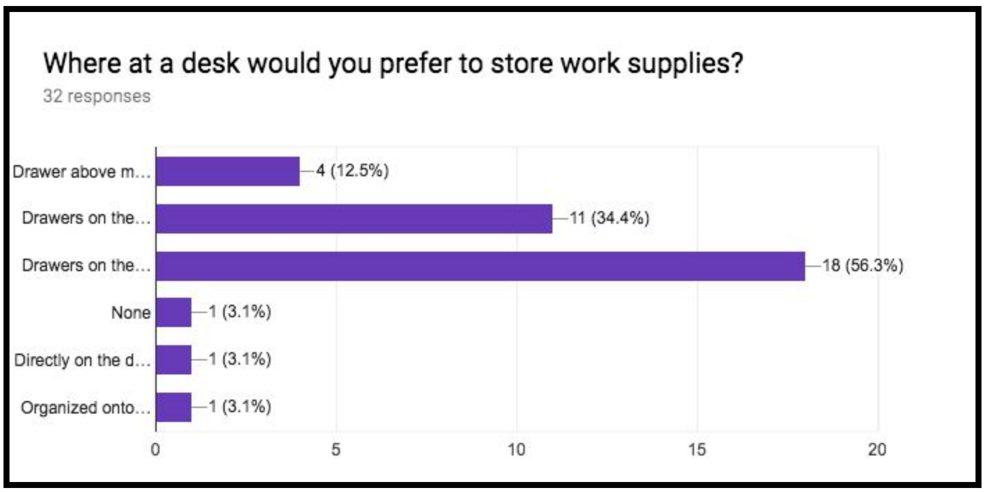


If you had a sit-stand desk, would you use the stand option?

32 responses




If you could (safely) store physical projects or materials in the classroom, would you?
32 responses
Yes
No
Maybe
46.9%
25%
28.1%


Where at a desk would you prefer to store work supplies?
32 responses
Drawer above m…
Drawers on the…
Drawers on the…
None
Directly on the d…
Organized onto…
4 (12.5%)
11 (34.4%)
18 (56.3%)
1 (3.1%)
1 (3.1%)
1 (3.1%)
0
5
10
15
20

Questionnaire Analysis

In our analysis of results, we found the following themes:

- Most respondents work at a desk “Always” (28.1%) or “Most of the time” (53.1%).
- Most respondents prefer to collaborate with someone else while seated “Side by side” (50%) or “Across from them” (31.3%).
- Most respondents spend “1-3 hours” (68.8%) or “4-6 hours” (25%) sitting at a desk in class each day.
- Most respondents appreciate “Lots of space” (93.8%) and “Legroom below desk” (71.9%) in a good desk.
- Most respondents get tired of sitting in class “Often” (40.6%) or “Sometimes” (46.9%).
- Most respondents are familiar with the concept of a sit-stand desk (75%).
- If provided a sit-stand desk, most respondents would use the stand option (43.8%) or consider using it (34.3%).
- Most respondents would store materials in the classroom (28.1%) or consider storing them there (46.9%).
- Most respondents prefer to store work supplies in the “Drawers on the sides below the desk” (56.3%) or in the “Drawers on the sides of the desk” (34.4%).
- Finally, one respondent added a preference for desk strength and stability, and two respondents mentioned preferring enough desk space for one or more computer monitors.

This data suggests that our target users are between the ages of 19 and 23, though we can classify them more broadly as college students. More than 75% of those questioned do the *majority* of their work at a desk, and 31% of respondents report spending *four or more* hours sitting in desks in class each day. Additionally, 41% of respondents reported that they *often* get tired of sitting during class. This data, coupled with studies from the literature review that point to health risks associated with extended sitting, motivates the need for a sit-stand desk.

APPENDIX C

User Research: Competitive Analysis

In order to differentiate our product from the competition, we felt it necessary to compare and contrast systems currently available on the market. We compared the top four standing desks, as decided by Reviews.com. The desks were chosen as top performers based on desk height, ease of assembly, wobble factor, and convenience of conversion (see User Research Report).

Overall, many of the industry leaders incorporate similar designs effectively. The top products offer large work desks, capable of accommodating many projects and items at once. We will be sure to consider similar-sized desktops when designing our product. With regards to electric or mechanical conversion systems, we will consider all possible options during preliminary ideation and conceptualization.

Additional important aspects to consider that were not present in competitive products are mobility and storage capabilities. None of the top products examined utilize a mobile or wheeled base to enable convenient relocation. Similarly, none of the explored products offered any type of storage capability. We will consider incorporating mobility and will be sure to incorporate storage in our design.

APPENDIX D

User Research: Expert Review

We conducted an expert review by interviewing James Intriligator, who owns and operates a sit-stand station. Our goal for this interview was to identify the best and worst qualities of the sit-stand station since it incorporates similar attributes of our design.

Intriligator's sit-stand station is adjustable using buttons on the right side, and these buttons also allow Intriligator to program his height preferences (i.e., a specific height for sitting and a specific height for standing).

Intriligator noticed that sitting for a prolonged duration would cause grogginess and a hunched posture, whereas standing would sharpen his focus, keeping him more alert, clear-headed, energetic, and less stiff. Standing also made Intriligator feel better because he was familiar with research on how standing burns more calories and is better for circulation. However, Intriligator also noted that it was tiring to stand for a prolonged duration.

The good points of this sit-stand station are the following:

- The height is easily adjustable using the buttons, which store the user's preferences.
- There is a built-in powerstrip.

The bad points of this sit-stand station are the following:

- Standing is better on a mat, but it is a hassle to move the chair and take out the mat, and leaving out the mat interrupts the mobility of the chair.
- There is no incentive or reminder to alternate work positions from the station.
    - I.e., it would benefit from a timer that indicates when to switch positions.
- The powerstrip on the bottom of the desk is only accessible by climbing under the desk. And the wiring would be better located along the legs of the station.
- The desk does not provide storage space, so it is cluttered.
- It is uncomfortable to have a conversation with someone who is sitting while you are standing.

APPENDIX E

User Research: Discussion with Client

Our client, Ryan Koch, is a student at Tufts University who uses a sit-stand station. Before we continued our design process and created our three initial design concepts, we consulted with Koch to identify any other needs, themes, or goals to keep in mind.

He provided the following recommendations:

- It should be easy to move from sit to stand.
- Storage shouldn't interfere with the sit-stand feature or the tabletop real estate.
- Storage should have a lock of some sort if it's in a public space, so only designated collaborators can gain access.

APPENDIX F

Design Feedback

1: The Simple Desk

This concept had the following positive feedback:

- Inexpensive
- Simple assembly
- Minimalistic design
- Integrated storage seat is practical and efficient
- Mobile/easily moved

And the following negative feedback:

- “Concern of impalement on poles”
- “Not very aesthetically pleasing”
- “Does not seem durable”
- Very limited storage space
- 4 attachment points may make it difficult to change height

2: The Modular Desk

This design had the following positive feedback:

- “Aesthetically pleasing” and “cool” and “modern” and “interesting”.
- Good for small groups.
- Good for tutors working with multiple students.
- I like that it’s modular.
- I like that there’s a large workspace.
- I like that everyone can choose their own height preferences.

And the following negative feedback:

- This doesn’t seem more effective than just pushing tables together. Why do the desks need to connect?
- The desks seem too small.
- There is not enough leg room.
- What if things fall through the cracks?
- I’d prefer working at a concave desk than a convex desk.
- This is better for an office, not a classroom.
- I’m concerned about the hassle of transitioning between a personal desk and a group desk. Is this mobile?
- I don’t like that the sides of the desk are angled.

3: The Space Optimizing Desk

This design had the following positive feedback:

- This desks seems the most functional.
- “Versatile” and “practical” and “compact” and “aesthetic”.
- “Very cool” and “dope” and “definitely my favorite so far”.
- “Would love to use one”.
- Good amount of storage and desk space.
- I like the shelf underneath. Nice for book storage.
- I like the folding whiteboard.
- Good for collaboration.
- Space saving.

And the following negative feedback:

- I’m not sure how this desk would work.
- It doesn’t look like it will support much weight.
- Not aesthetically pleasing.
- Seems expensive.
- Seems difficult to move around / heavy.
- I’m concerned about legroom.
- The whiteboard is unnecessary. I prefer a vertical whiteboard. I wouldn’t want to scratch the whiteboard while using the desk surface for other work.
- I’m afraid of hitting my head reaching for the items on the shelf.
- I don’t like that I would have to move all my stuff in order to transition from the most compact level to the desk level.
- The folding mechanism seems complex, and I’m concerned about straining my back pulling out the whiteboard.

APPENDIX G

Design Specifications

The desk shall include two shelves for storage, one desk platform, and two telescoping pipes to raise and lower the desk platform. Listed below are the materials and measurements we used to build our model. For more information, refer to the Design Specifications Report.

Plank Specifications

Type/Quantity: 4 planks (2 planks for shelves and 2 planks for support)
Material: Wood
Original dimensions: 12” x 48” x 1”
Final dimensions: 12” x 40” x 1” (x2) and 12” x 30” x 1” (x2)

The two 40” planks will be attached perpendicular to the two 30” planks. The planks will be attached using four 2.5” L-brackets approximately 3” from the edges of the 30” planks.

Desk Platform Specifications

Type/Quantity: 1 platform
Material: PVC
Final dimensions: 24” x 48” 0.5”

In order for the desk platform to hold the PVC pipes (involved in the raising and lowering of the desk), the desk platform will have two 1.5” flanges. These flanges will be located approximately 3” from the 24” side (so the hole of the flange is flush with the sides of the 30” planks) and 6” from the 48” side (so the 30” plank is centered).

Pipe Specifications

Type/Quantity: 4 pipes (2 pipes with 1” diameter and 2 pipes with 1.25” diameter)
Material: PVC
Dimensions: 24” long

The 1” diameter pipes will rest inside the 1.25” diameter pipes, which will be attached to the 30” planks using two 1.25” two-hole straps. The straps will be placed 12” from the base of the planks and 6” from the sides.

The 1.25” pipes will each have two holes drilled 1” from their tops, so a peg can be placed through one hole and out the other. The 1” pipes will have a series of holes drilled along the lengths of the pipes to allow the desk to be raised and lowered to different heights. These holes will be drilled at 1” intervals, starting at 6” from the top of the pipe and going to the bottom.