Double Leaflet Desk

Improving Sustainability and Student Happiness

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Client: Rose-Hulman Institute of Technology
Course: EM103 Introduction to Design
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Introduction

Purpose

In partial fulfillment of the requirements of EM103 Introduction to Design, we have identified an on-campus problem and used “design thinking” to develop a solution that satisfies Rose-Hulman Institute of Technology’s standards in sustainability, student and faculty needs, and economic costs. In this report, we describe the design problem, propose a solution, and evaluate the extent to which the design addresses the stakeholder need areas.

The basic problem we are addressing are the ineffective GM room desks. In doing so we want to make sure we keep Rose-Hulman's mission statement in effect which states, "The mission of Rose-Hulman Institute of Technology is to provide our students with the world's best undergraduate science, engineering, and mathematics education in an environment of individual attention and support."

Problem summary

In the process of interviewing our stakeholders, we identified several problems with the GM room lecture desks. The stakeholders we considered were students, professors, facilities, visitors, and administration.

The problems in which students encountered was a lack of desk space due laptop requirements, a lack of accessibility for left-handed students, and misaligned and defective desks.

The professors are concerned with the changing technology needs, disturbances in the lecture halls, and easy access to the rows to help students.

We want to keep the desks easy to clean for the housekeeping staff, low maintenance, low cost, and the desks to be resistant to damage. We also want the desks to provide visitors with a good impression of Rose-Hulman and for them to be comfortable with the properties of the desk.

Administration is concerned with the appearance, cost, safety of the materials, and the environmental impact of the desk.

Prior art

One of the largest companies associated with the lecture hall seating systems is KI. The desks and chairs in the Meyer’s lecture hall are products of this company, along with

most of the other seating and tables throughout classrooms here at Rose-Hulman Institute of Technology.

There are two main lecture hall desk designs. They are the long fixed tables with detached or attached chairs shown in Figure 1 and Figure 2 or the desks that are installed in the Meyer's lecture hall. The problems and benefits of the Meyer's design will be discussed later, as they are the item we are redesigning. The long tables also have a variety of advantages and disadvantages.

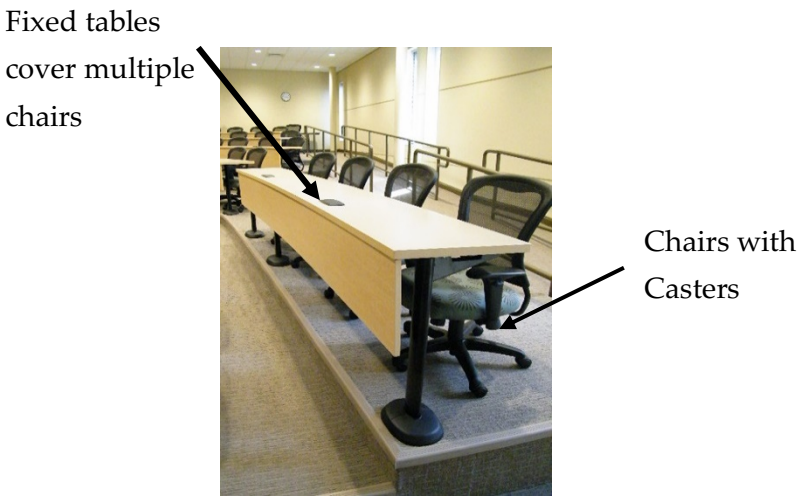

Figure 1: ("Furnishing Knowledge : KI," 2018)

The long desk designs, the KI Seminar Tables in Figure 1 and the University Fixed Seating in Figure 2, have many benefits but also many drawbacks. From students who attend colleges that use the long desk lecture desk design, they agree that the desks are spacious and comfortable. Since the desk is continuous, there is enough space for laptops, exams, notes, textbooks, and other supplies. If auditoriums are designed for long tables, the stands will be wide enough for people to pass through easily. The attached swinging chairs in Figure 2, however, pose an additional problem. Dr. Dee of Instructional Technologies accounted from her visit to Tulane University that while these chairs makes housekeeping very easy, the chairs tend to swing out while students are sitting in them. She said, "Those chairs are great for cleaning the room but a bad idea for human beings… There were students trying to take a test and students would reach out and grab the table because the chairs wanted to swing back, and so they would grab

the table and be writing and it was very frustrating for them" (Dee, 2018).The students had to grip the edge of the table and pull themselves in while taking an exam. With fixed seating, this problem can be avoided. If instead of swinging chairs, detached chairs were used, the chairs would then pose a problem for housekeeping since they would have to move them out of the way to clean.

Figure 1: ("Furnishing Knowledge : KI," 2018)

In Figure 3, the setup is designed with a pocket-styled desk. This design helps save space for getting through the aisles and makes for easy storage of the desk. The desk shown in Figure 4 is the same design that is currently in the Meyer's lecture hall. This is a feasible design because it allows for easy storage of the desk, but the desk is also not big enough to meet the needs of the students. Also, Mike Taylor, Senior Director of Facilities and Operations, gave us the estimate that each KI lecture seat and desk costs around 1500 dollars.

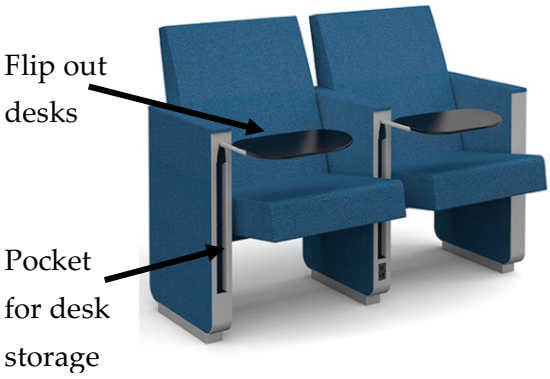

Figure 3: ("Lecture Hall Seating," 2017)

Figure 4: ("Furnishing Knowledge : KI," 2018)

Another company that produces desks is School Outfitters. While not specifically made for lecture halls, they have a chair design called ReadyLink Add-On Seating.

The benefits of the ReadyLink Seating design in Figure 5 is that like the auditorium seating, it chairs can be flipped up when not it use to make access to the rows easier and make the rows easier to clean. In addition, by using a “Starter” chair to start a row, “Adder” chairs can be added on to increase the row length in Figure 6. This means that the amount of chairs in a row can be changed easily, and these chairs can also be moved and used in different locations. At 26 pounds, the chair is relatively mobile.

Figure 5: ("OFM ReadyLink Row Starter Seat with Tablet K212T Charcoal," n.d.)

Figure 6: ("OFM ReadyLink Row Starter Seat with Tablet K212T Charcoal," n.d.)

There are also issues with this setup. The desk size is smaller than the current desk size. It is geared for a technology-oriented classroom, but it may be hard to fit a large laptop on the desks. Also, the plastic desks don’t look aesthetically pleasing, which would be detrimental to RHIT’s image. The main materials of the desk are PVC and 15-gauge

steel. PVC is not environmentally friendly; both the manufacturing and disposal process is harmful to the environment. In the event that PVC burns, hydrogen chloride gas and dioxins are formed. At 460 dollars per starter seat and 330 dollars per adder seat, the seats would be costly to replace, especially if replacements to individual parts is not offered. However, it is a cheaper option than the KI auditorium seating.

Design goals

The design goals for our project is to satisfy our stakeholder needs as well as to address Rose-Hulman's sustainability goals for design in accordance to their mission statement. For the students and the professors, we have endeavored to design a solution that could address the needs of a technologically involved learning style and still allow for easy professor-student interaction. For the housekeeping staff, we want to continue to keep the desks and rooms easy to access and clean. We also want to fulfill the administration's goal of keeping a reputable image and having the rooms and desks available and adjusted towards event usage. Overall, we also want to increase the life expectancy of the desks, keep them relatively easy to manufacture and replace, keep the manufacturing costs of the desk low but also use a recyclable material that is conducive towards the safety of the students, and meet Rose-Hulman's green credentials. Having better desks would attract more potential students, which would in turn bring in more money for Rose-Hulman.

The problem

Precis

The current desk lacks the space that a student needs to work on more than one thing at a time. We discovered that this problem exists at other universities also, which was part of our research for this project. We also conducted an interview with Instructional Technologies here on campus to see what they would want in a new desk setup. We then chose five need areas to include usability, life expectancy, row access, cost, and space. We identified the students of our main stakeholder and conducted a survey with them to see if they had the same views about the desks as we did. We made sure to include our need areas and what our stakeholders wanted to see in our proposed desk designs.

Background

The biggest problem needing to be addressed is the lack of workspace for students. With the current desk situation, students are only able to have one item out on their desk at a time. However, some professors require a student to be using their laptop and filling out a paper simultaneously. We conducted a survey asking students if they agreed that the desks need to be bigger and sure enough, the answer we received agreed with what we thought. The GM room, which is one of Rose-Hulman's lecture hall style rooms, hosts about 4 classes per week, per quarter and around 21 clubs, organizations, or other reservations per week, per quarter. This means that the desks need to be useful and durable for the extensive use that they will be put through.

Once finding this problem, we were curious if other universities dealt with the same issue. During our research, we were able to reach out to other colleges to see what type of set up they currently work with in their lecture halls. Most colleges we contacted have a similar setup to the GM room and the students were not satisfied with the desks. In Figure 7, you can see a desk from Saint Mary-of-the-Woods College in Indiana, which is very similar to the design and size of the desks that we have here at Rose-Hulman. Figure 8 is a picture of a lecture hall desk from Ball State University in Indiana. In Figure 9 is a lecture desk from Bethany College in West Virginia, the setup of this desk is very similar to the desks we use minus the chairs. Lastly, in Figure 10, pictured is a lecture hall desk that is from Purdue University in Indiana and their setup is like that of the GM room. Based on this we want to design a desk that helps to better satisfy the needs of current and potential students.

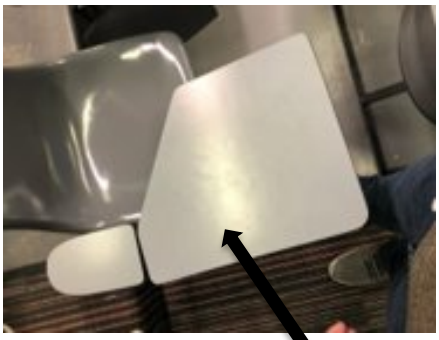

Figure 8

Figure 7

Other colleges have similar designs to Rose-Hulman

Figure 9

Figure 10

We also got some other results from colleges, but they did not meet the needs for our stakeholders want in the lecture hall desks, as evidenced from our student surveys, correspondence with Rose-Hulman offices, and interview with Instructional Technologies. Some other lecture rooms consisted of long tables with fitting chairs, pictured below in Figure 11, Figure 12, and Figure 13. However, we concluded that these designs are insufficient to meet all our stakeholder needs.

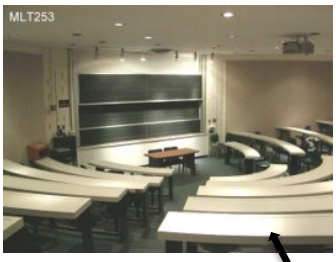

Figure 11

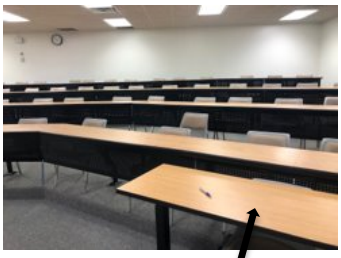

Figure 12

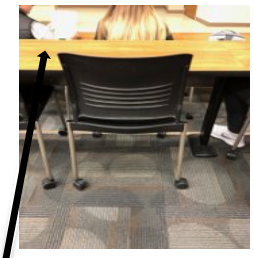

Figure 13

Long desks create a lot of desk space but also creates multiple problems for stakeholders

When trying to figure out what Rose-Hulman wanted in a lecture hall set up we reached out to IT and they were able to answer our questions, which helped us come up with our solutions to the current problem. Since the lecture halls are so old, the space provided by each seat, 13 square feet, is below the current industry standard of 15 square feet. Instructional Technologies wants the new seats and desks to reach this standard. This was included as a design constraint in our new design.

One of our main design goals is to increase the overall space available to each student. In addition, movement in between the rows should not be impeded, which was another stakeholder concern. Increasing the size of the desks will allow for the usage of multiple objects at the same time. Since Rose-Hulman's curriculum involves intensive use of a laptop, the objective is to allow enough room for both a laptop and notes or papers. While figuring out to integrate more surface area to the current setup of the lecture halls, we came up with over 100 ideas ranging from magnetic levitating desks to completely getting rid of the desks.

After coming up with several main needs and removing technologically impossible ideas, we were able to narrow our selection down to five main design concepts. We first came up with five need areas in which we thought would be important to fulfill. The five need areas we chose include usability, life expectancy, row access, cost, and space. With each of our designs, we tried to focus on at least one of the needs we established.

Need areas

To find out what the need areas were for the lecture halls, we first considered who the stakeholders were in our project. We then contacted these stakeholders to learn what they thought about the Rose-Hulman's lecture halls. We first reached out to the students because they are one of the more frequent utilizers of the lecture hall desks. To get the quantitative data we were looking for, we conducted a four-question survey. The overall feedback we received from this survey was that eighty-seven percent of students believed that the lecture hall desks were too small. This means the students main need is to have a desk that is big enough to hold the various things they use during class and exams. A problem that a couple students also brought up is that there are not enough desks for left-handed people. With 10% of the US population being left-handed, at least ten percent of the desks in these lecture halls should cater to left-handed people (Hardyck & Petrinovich, 2018).

Another important stakeholder that we reached out to was the Associate Dean of Learning and Technology Dr. Kay Dee, in the instructional technologies office to ascertain the needs of the administration. In a meeting, we so discussed their needs for the desks. One of the biggest areas she emphasized was that Rose-Hulman would like to keep cost as low as possible for a desk redesign.

Another stakeholder is Rose-Hulman's administration. For this, we considered the needs of the maintenance staff. Their biggest need is to keep the desks and hardware as simple as possible to cut down on maintenance over time and increase the durability of the desks. Considering this, we can design a desk that has a very little amount of moving parts. Administration would also like the desks to be aesthetically pleasing to maintain the good image of Rose-Hulman and look encouraging to visitors.

When it comes to cleaning the rooms, the housekeeping staff is another one of our stakeholders. Their biggest need is being able to clean as fast and as easy as possible. The desks need to be able to be stored away so the housekeeping staff can vacuum the floors, but also easy to fold out so that they can clean off the desks with ease.

The last of our stakeholders includes the professors who teach in these rooms and the visiting speakers who are giving talks, proposals, or presentations. These stakeholders want to get a point across, propose a new idea, or teach the listeners something they might not have known before. In pursuance of doing those things, they want as little of distractions as possible while they are there. This means that students or other listeners need to be able to move down the aisles as easy as possible with minimal distraction. By making desks that move out of the way easily or that do not protrude out into the aisle, the needs of the professors and speakers are met.

The needs of our stakeholders include more space, left-handed accessible, low cost, minimal maintenance, easy storage, and large aisle space for lack of interruptions. With these need areas established, we will keep all of them in mind when designing a desk that meets the needs of most to all of our stakeholders.

Conceptual Designs

For our first design we kept the same desk design that there currently is except we made the surface area of the desk slightly larger. This design mainly addresses the need of a long-life expectancy seeing as though the current desks have lasted over 30 years. This design would continue using the same hardware as the current desks do shown in Figure 14.

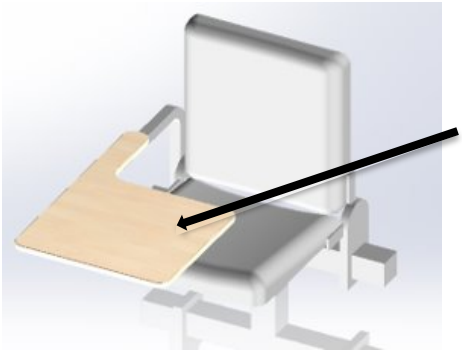

Figure 14

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For our second design, we came up with a desk that had extendible leaflets to allow each student to have more workspace. The main need met by this desk design is space as shown in Figure 15.

Two leaflets allow for more space and small storage area

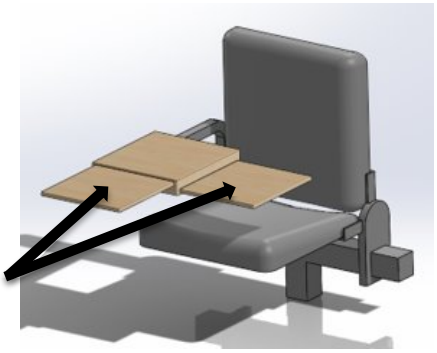
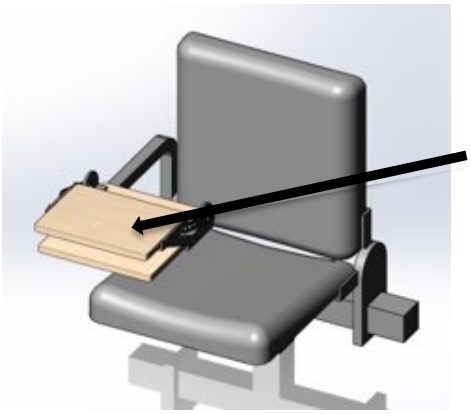


Figure 15

For our third design, we designed a double decker desk that allows each student the ability to work with a two-tiered setup. This desk focuses on easy access to the rows. If a student needs to pass through an aisle during class, they can easily get through without causing much distraction, shown in Figure 16.



Double decker allows for double the desk space

Figure 16

Then for our fourth design, we came up with an idea that would allow each chair to have a left and right-handed desk. This idea would allow for people who are left-handed to be included within their friend groups and not be secluded to the aisle seat. The main need met by this desk is accessibility, shown in Figure 17.

Two desks accommodates left-handed people and gives more space

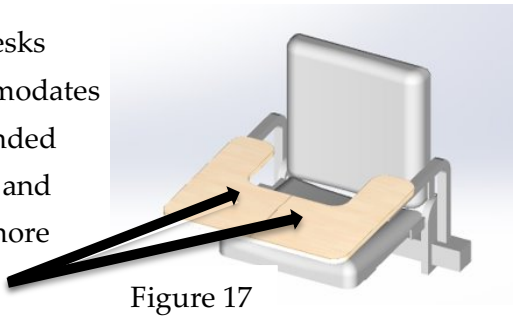


Figure 17

For our final design, we came up with a design that is set up like a reversed keyboard. This design allows students to get more space out of their desk, shown in Figure 18. This desk focuses on the main need of cost, seeing as though it acts as an attachment. This would also make upkeep similar to the desks we currently use.

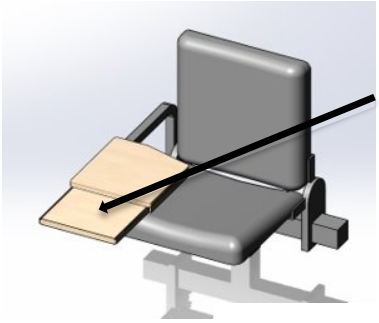


Figure 18

Research Findings

Interview between Dr. Kay Dee of RHIT Instructional Technologies and Noelle Hale and Dustin Gurley of Team 41

The interview was concerning lecture desks as well as the GM room in general. We started with asking what was the purpose of the GM room, since it is used as both an assembly room and as a classroom. To this, Dr. Dee replied that the GM room's primary purpose is to be an assembly room, but currently there are not enough rooms so now auditorium rooms are used as classrooms. In addition to this, there are plans to add another academic building, but no more auditoriums are planned to be constructed.

Additionally, Dr. Dee would like to integrate more technology into the lecture halls. Since the lecture hall is used for events, she would like stage lighting, a nicer projector, and outlets throughout the room. She does however, acknowledge that the desks need to be larger to accommodate. To corroborate this, we found that there is currently an average of 12 different classes per quarter held in the GM room. Dr. Dee would also like the entire room to be more accessible, since visitors often access the room. Since we would like to meet sustainability standard, we also asked about any considerations in material we should make. While Dr. Dee replied that sustainable material was not a big concern since financial considerations were more important due to the small budget available, we will labor to use recyclable and safety-promoting materials.

We conducted a survey with students to find out what they thought about the size of the desks in the lecture halls. The first question asked was whether students had a class, club meeting, or attended a talk in any of the Rose-Hulman lecture halls. Eighty-eight

percent of respondents said yes. The second question asked was when in one of these lecture halls, did you use the provided fold out desk? Ninety percent of respondents also said yes to this. The third question we asked was when using the provided fold out desk, what were you using it for? Seventy-two percent of respondents said that they wanted to use two or more items at one time. The final question of the survey asked what students thought about the size of the desks. Eighty-seven percent of respondents said that the desks provided were too small.

In our interview with Mike Taylor, Senior Director of Facilities Operations told us that the Meyers lecture hall was remodeled two years ago. The renovation included changing the layout to include two isles to allow for easier entry and exit of the rows and room as a whole.

Taylor also informed us that the amount of money required to update the E103 and GM rooms is not currently in the budget. However, in the upcoming year a new academic building will be constructed and in the budget for that project has these rooms listed to receive updates. The biggest issues are the structural problems in these rooms, but while these are being fixed, the desks and chairs will replaced as well.

Taylor talked with us about when he initially received his position; one of his priorities was standardizing the furniture used throughout campus. He talked about how there used to be numerous different types and brands, and along with input from students and faculty, facilities decided on six standard designs to use. All of the six were from KI. Deals were made with KI to ensure continued product maintenance support as well as a lower cost.

This standardization continued when the Meyers room M137 was renovated and KI products were again used approximately two years ago. Taylor also explained that the GM room and E104 will be renovated as part of the projects of building the new academic buildings. He also mentioned that, at this time the, the plan is to use the same lecture hall desk and seating system from KI.

On average, cleaning the GM room costs Rose-Hulman $70 per week. This value is calculated by using one worker getting an hourly rate of $14 and working one hour a day for five days each week. The cost of maintenance and general upkeep can be estimated as $1456 per a year. This value is based on two workers doing two hours of work every other week.

The proposed design

Precis

The main feature of our new design is two small telescoping desks that protrude out of the front and the left side of the desk. With these two small telescoping desks, the needs of students, professors, housekeeping staff, and the administration are met. To keep the new design lightweight yet durable, the material of bamboo was selected. With it being a renewable resource that is easy to grow and can be down cycled after use, it not only fulfills the needs of a desk, but it also helps Rose-Hulman's green credentials. This new design meets the needs of most of its stakeholders and fulfills its role as desk.

The Overall Design

The initial footprint of this design is the same as the current GM room desks. By keeping the same footprint, the overall change of the room is minimal. The desk has one main

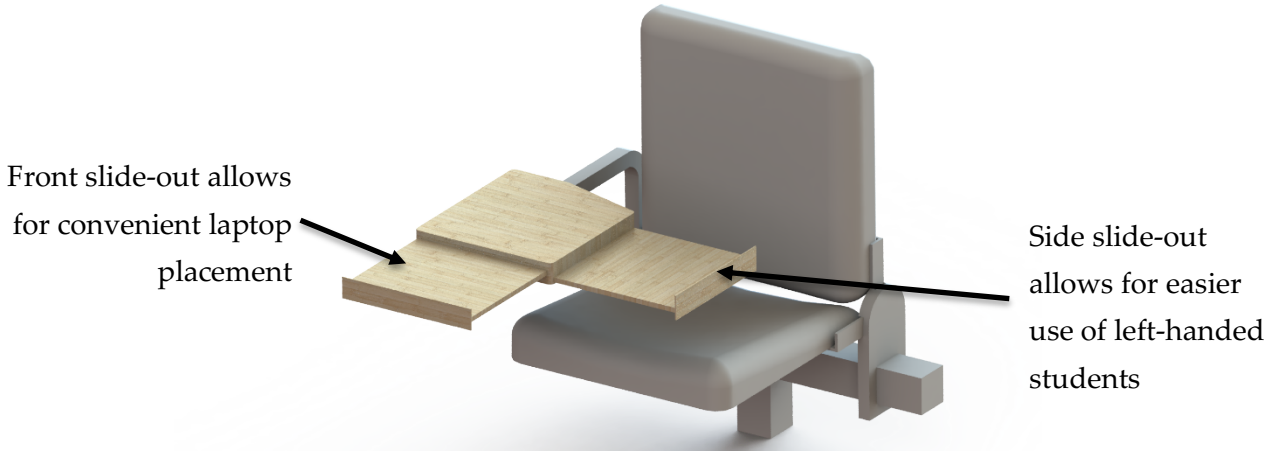


Figure 19

desk area and two leaflets, shown in Figure 19, that telescope out of the front and the side of the main desk in order to allow more workspace. Since the two leaflets are not permanent, this allows for easy storage of the desk. It takes up the same area as the old desk but is a mere 0.855 inches wider than the old desks to accommodate for the two leaflets. This extra thickness still fits into the original storage space that was provided. This new design keeps the originality, ease of use, accessibility, and easy storage of the old desk and at the same time adds the much-needed workspace that students need.

Features that address the need areas

When addressing the need areas of the Rose-Hulman lecture desks, the main stakeholder we focused on was the students. However, some of the features on our final design still address the need areas of other stakeholders without putting a full emphasis

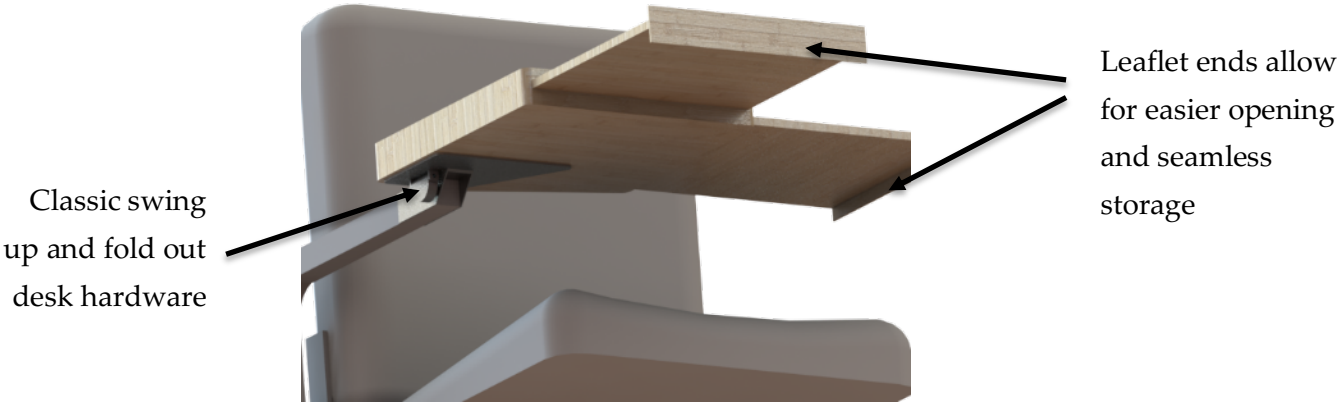


Figure 20

on their need area. Since we are mainly focusing on the students, the main area we addressed in our final design was getting the students more usable desk space. The main feature on our final desk design, shown in figure 20, is two telescoping leaflets that pop out from the front and left side of the small square desk that is in the position of the current desks. By having a telescoping desk on the front and left side, this meets the needs of the students by catering to left-handed students as well as giving the students more desk space by giving them almost three times the space they originally had. The telescoping features of our desk also accommodates the students by giving them a place to put a laptop or textbook on the desk without taking away the area needed to take notes, an exam, or do homework.

Other stakeholders that our desks take into account are housekeeping, professors or presenters, and administration. By keeping the desks to a similar size of the existing desks, they are able to fold over and store just as easy as before. This benefits the housekeepers in the fact that they are able to clean the aisles without having to maneuver around a permanent fixture. By adding a telescoping desk to the left side of the main desk, this will give the students more room to put stuff without protruding out into the aisle. This will in return cause less distractions or interruptions for professors or presenters when they are giving a lecture or presentation. The final stakeholder our new design addresses is the administration and the maintenance crews. By selecting the material of bamboo for our desks, we are making their lives easier. This helps the administration and the university as a whole by improving green credentials and keeping the cost relatively low. It also helps the maintenance crews by being a very durable and renewable material.

The main feature of our desk is two telescoping leaflets that extend out from the front and left side of the main desk. These two leaflets not only provide extra space to the students who need it, it also caters to those left-handed students, the housekeeping staff, the professors or presenters, and the administration. By adding these two simple features, we have addressed a majority of each stakeholders need.

Materials selection

For our material, we chose bamboo. It is a rapidly renewable material with properties comparable or surpassing that of timber. Bamboo forests have up to four times the carbon density per hectare of spruce forests due to its faster growing rate and shorter harvesting cycle (Sharma, 2015). In addition, bamboo is ready to harvest in 3 – 4 years compared to traditional wood such as kail and teak that have a harvest cycle of 30-40 years. Since bamboo is a rapidly renewable resource, it can help reduce deforestation by replacing woods with a longer growing cycle. In addition, since bamboo in widely available in developing countries, the use of bamboo fabrication and technology could improve the economy of rural people (Verma, 2012). Additionally, based on the standards of the disposal of bamboo and if production parameters were optimized, industrial bamboo products can have a negative carbon footprint over their full life cycle (Vogtlander, 2014).

We used plywood as a standard to compare to bamboo as plywood is used in most desk construction and is the material in the current desks. Bamboo is more expensive at 0.912 USD/lb. compared to 0.277 USD/lb., but we feel the eco-benefits outweigh this higher cost. According to CES EduPack, the mechanical properties are somewhat weaker than plywood. However, if the bamboo is laminated or made into bamboo scrimber, these mechanical properties should improve to be comparable to or even surpass the mechanical properties of teak. Furthermore, the manufacturing costs of laminated bamboo is less than that of the manufacturing costs of teak wood (Verma, 2012). Laminating the bamboo would also protect it against moisture from spills and cleaning.

Evaluating the design

Meeting the design goals

In our final design, we made sure to focus on the needs of the students. We came up with a desk, which increases the ability for left-handed people to be included in with the class instead of them having to sit in an aisle seat. Our design allows students to use a right-handed desk with a forward slide out and a slide out that pulls out towards the

left. We will also have left-handed versions on the aisle like the current setup in case a student feels more comfortable with them. This focuses on the need of space and while we focused on extending the desk forward and to the side. We made sure to keep plenty of aisle space to allow for easy access during class. Having a design setup like this still allows professors to have a functional class with minimal interruptions when students come in late.

We decided to go with a desk that made from bamboo, which focuses on not leaving a huge environmental impact. Bamboo is available in abundance, so using bamboo will not affect the environment too tremendously. Bamboo is also very durable which will help address the need of a long-life expectancy. All these qualities help to reach administrations goals of having a reputable image and meeting their green credentials. The desk is also going to have a similar setup to the current desks, which will help to keep housekeeping's job simple and not strenuous. The slide out feature of this desk will act as an attachment that makes replacement and repair easy for maintenance. With these better desks more, students will want to attend Rose-Hulman, which will bring in more money for the school. With newer desks, Rose-Hulman would save money because they would not have to be paying workers to fix the broken desks constantly.

Comparing the design to prior art

Our design fixes the need areas addressed by the long fixed tables by KI as well as the downfalls of that design. Our final design allows students to have a computer and textbook and a pad of paper similar to the long desks. It also addresses the accessibility of students that write with their left hands.

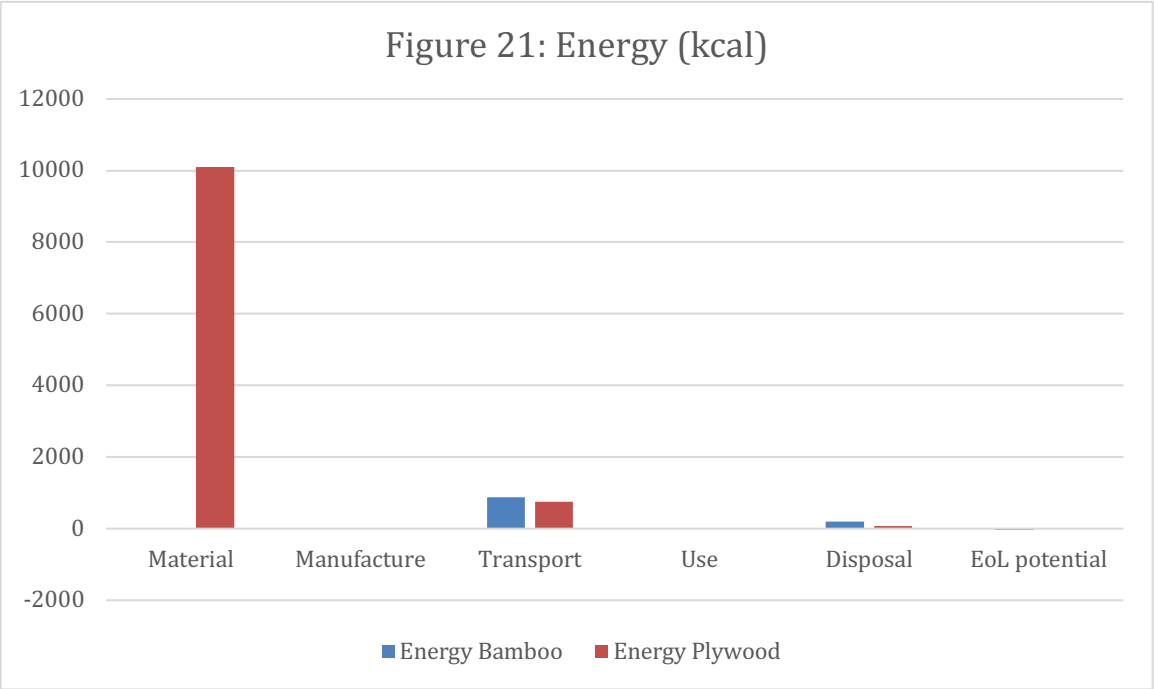
However, our final design does not cause the housekeepers an inconvenience like the long tables, nor does it have the seating issues. The new design stows away beside the fold up chairs so the housekeeping staff does not have to bend down more or take more time folding down all of the tables. It also uses the preexisting flip up auditorium seating, and this avoids the need for chairs on casters or the swing out chairs that Dr. Dee highly recommended against using.

Improving RHIT's green credentials

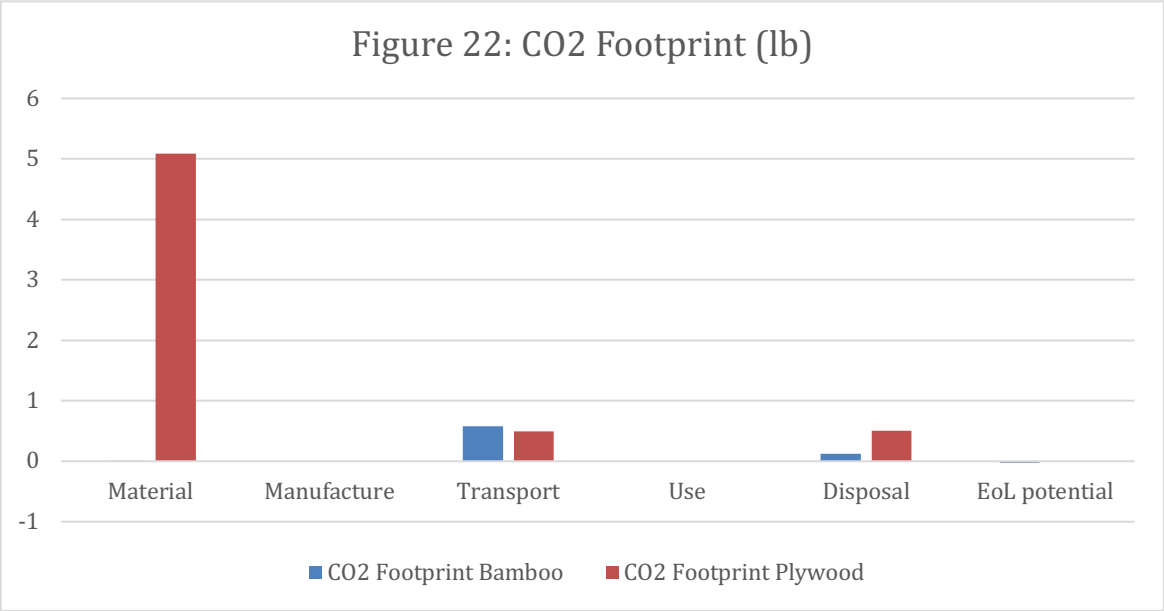
Bamboo is a very fast-growing plant in different parts of the world. Rose-Hulman focuses on being green and since bamboo can grow so quickly, there would be hardly

any environmental impact occurring. The bamboo used to make the desks could easily be replanted and able to reproduce within a short amount of time. Bamboo can be down cycled at its end of life, meaning it puts energy back into the environment. Whereas, plywood must go to a landfill, which makes it inferior to bamboo. When looking at an eco-audit comparing plywood to bamboo, you can see that bamboo has a CO2 footprint of 0.771 lb. per year while plywood has a CO2 footprint of 5.63 lb. per year. In the first year, plywood requires 1.09e4 kcal of energy while bamboo only requires 1.08e3 kcal of energy to produce. This helps Rose-Hulman be environmentally friendly in making the decision to go with bamboo.

As seen in Figure 21, there is a considerable amount of energy required to produce the plywood desks when compared to the bamboo. However, the bamboo requires slightly more energy to transport because of the easier accessibility to the plywood, but this more than offset by the material energy cost.



As seen in Figure 22, the trend continues with bamboo being better in every way than plywood other than the transportation for the reason stated above. The bamboo even has an end of life potential to be better for the environment because of its biodegradability and potential to be down cycled.



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