NORTHERN ARIZONA UNIVERSITY

Department of Mechanical Engineering

ME 486c Engineering Team Design

Redesigning the Classic Teaching Lectern

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Client: Steelcase Inc.

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Abstract

A survey of university instructors revealed that a majority are unhappy with the accessibility and features of available lecterns. Some instructors with visual or lower-limb disabilities reported a complete inability to physically access lecterns. The project goal was then to design a teaching aid that appropriately integrates with today's teaching technologies and styles, and is universally accessible.

To achieve the project goal, further input from professors and the principles of Universal Design were applied to a multi-stage design lifecycle. The end result is a lightweight, height and tilt adjustable mobile lectern, usable in a variety of physical configurations. The lectern communicates wirelessly with a classroom PC and is re-locatable around the room.

A separate, stationary cabinet base houses necessary audio-video and PC equipment used by IT personnel. Docking the lectern into this base creates a larger desk-type structure. Finally, unique selection of power and data connectivity components further enforce the ideals of Universal Design. The project sponsor, Steelcase Inc., is considering the final functional prototype as a new product for manufacturing.

Table of Contents

1. INTRODUCTION

Lecterns are widely used in university classrooms by professors, students, and IT workers. The universal lectern capstone project was brought about when a professor at Northern Arizona University (NAU) suggested to Steelcase Inc. that some professors with disabilities have difficulty accessing available lecterns. Workers at NAU Facilities were unable to find a solution on the market that could provide accessibility to the instructor and integrate with the current infrastructure.

To illustrate this, three examples of typical lecterns are shown below:

Figure 1- Steelcase's Exponent Lectern **[1]**

Figure 2- Avin ED Lectern **[2]**

Figure 3- Swan SS Lectern **[3]**

In general, lecterns are not designed through a user-driven design process, and therefore are often not accessible by all people. Accessibility issues with current lecterns include:

- no height adjustment
- no seating options at the lectern,
- small work-spaces for the user,
- restricting teaching to one spot in the room
- being incompatible with improving technologies

Taken one step further, no height adjustment and no under-the-table leg room make it so people confined to wheelchairs cannot access lecterns. Also, for visually impaired users, touchscreen controls are difficult or even impossible to navigate and use.

With knowledge of the problem, the goal of this project was then to:

> **Design a teaching aid that appropriately integrates with today's teaching technologies and styles, and is universally accessible.**

For the purposes of the project, the design team has developed the following definition of a lectern:

Lectern: A structure or device which:
(1) provides access to current teaching technologies
(2) allows control of classroom media

1.1. BACKGROUND

The success of a product can be compromised if the end user's needs are not at the heart of the design process. Design processes which don't consider the user often fail since nobody wants to use the end product. An approach called Universal Design (UD) has been developed that can decrease the likely-hood that this will happen to a developed product. The Center for Universal Design at North Carolina University defines UD as, "*the idea that all new environments and products, to the greatest extent possible, should be usable by everyone regardless of their age, ability, or circumstance*" [4]. Not only should the design be "usable" by the widest range of people, but it should give users options that add to the overall desirability of the product.

The concept of UD becomes even more intriguing when it is possible that disabled users will be a large part of the user sub-group. On July 26, 1990, U.S. Congress signed into law the Americans with Disabilities Act (ADA). In summary, the act prevents discrimination based upon disabilities an individual may have. The act protects the rights of disabled people by making specifications that require buildings, public spaces, furniture and facilities to be designed in such a way that people with or without disabilities can access them. In 1991, the ADA released standards for accessible design. In this way, ADA compliant products would promote equality by ensuring that they can be accessed by everyone. In 2010, they updated the standards and released the 2010 ADA Standards for Accessible Design. As of now, the 1991 ADA standards are mandatory and the updated 2010 version are only recommended. However starting on March 15, 2012, all newly constructed facilities or products must comply with the 2010 ADA standards.

A 2006 Survey of Income and Program Participation (SIPP) estimated that 54 million individuals within the US alone have some type of limitation [5]. Figures like these justify that if the principles of Universal Design are followed in the design process, the product will be more desirable, viable, and sustainable to the greatest extent of consumers in a competitive marketplace. Furthermore, after March 2012, all manufactured furniture products must be compliant with 2010 ADA standards.

1.2. STATE OF THE ART RESEARCH

Prior to beginning concept development, the team conducted research by through knowledge bases, and also through interviewing current lectern users.

Knowledge based research encompassed:
- General and Steelcase furniture design
- General principles of Universal Design
- ADA and disability standards

User-centered research focused on:
- Observations of video lectures

- Interviews with university instructors
- Interviews with disabled users

1.2.1. STEELCASE, INC.

Key background knowledge about Steelcase was gathered during a tour of a furniture showroom in Tempe, Arizona. Firstly, Steelcase has a unique *"design language"* that is expressed in all of their products. Furniture is separated into distinct collections, which have similar geometric and surface materials. Secondly, Steelcase believes in producing sustainable products by practicing Life Cycle Assessments (LCA) on products [6]. These studies quantify the environmental impact inherent to a product by considering material selection, production, transport, use, and end-of-life. Finally, Steelcase stated that to qualify as a Steelcase product, the item must be (1) desirable (2) viable and (3) sustainable. Furthermore, products are fully customizable by the user, and it was noted that Steelcase does not manufacture a product until the base product is customized via Steelcase options and ordered by a client.

1.2.2. UNIVERSAL DESIGN

The Center for Universal Design [5], defines seven principles to follow when designing something that must accessible by a large majority of people. These are:

(1) Equitable Use - the product should appear comfortable
(2) Flexibility in Use - The product should be able to be used or accessed in a variety of ways
(3) Simple and Intuitive Use - The design should have a low standard of learning
(4) Perceptible Information - The product should be perceptible in a number of ways
(5) Tolerance for Error - Product incorporates components to reduce chance of user error
(6) Low Physical Effort - Product should not require unreasonable effort to use
(7) Size and Space for Approach and Use - Design should consider how the product integrates with surroundings

Considering the seven principles during the design process ensures that products are desirable, viable, and sustainable.

1.2.3. ADA STANDARDS

Americans with Disabilities Act (ADA) standards are set in place to control the design of specific features in order for them to be accessible by people with disabilities. ADA governs many areas including housing, business, restrooms, and much more. Displayed below are some examples from 2010 ADA standards that apply to this project.

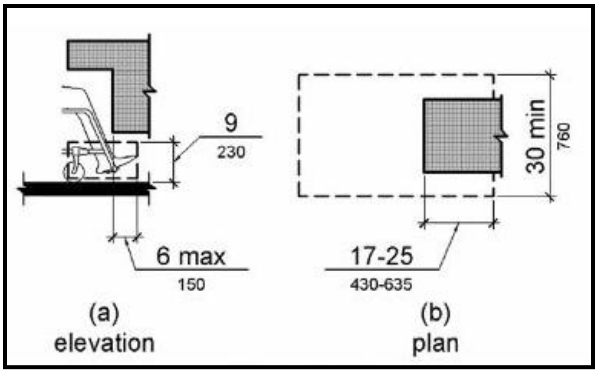


Figure 4 – Toe Clearance [7]

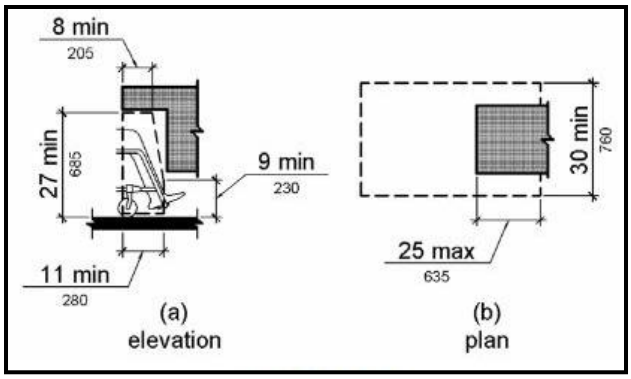


Figure 5 – Knee Clearance [7]

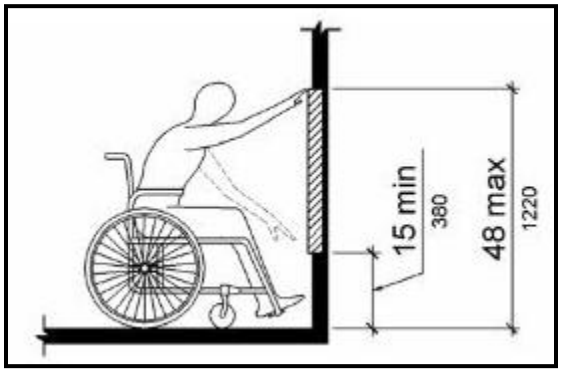


Figure 6 – Unobstructed Forward Reach [7]

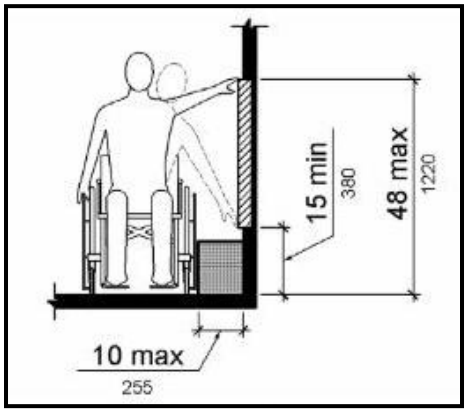


Figure 7 – Unobstructed Side Reach [7]

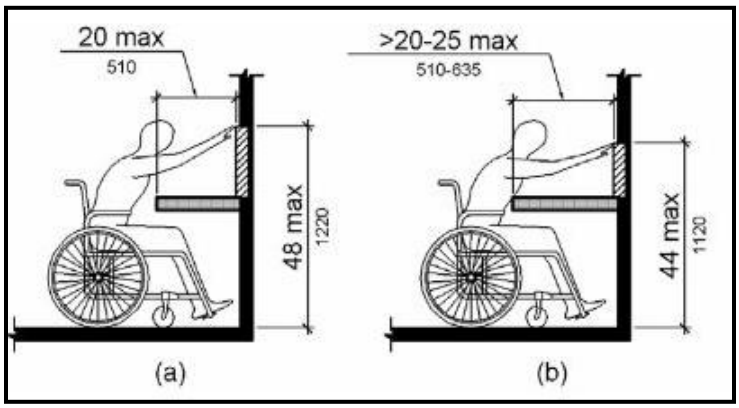


Figure 8 – Obstructed High Forward Reach [7]

Figure 4 shows that there must be toe clearance for wheelchair access. This allows the users feet to fit comfortably. Knee clearance, as seen in figure 5, illustrates the need for enough clearance for the legs of a person sitting in a wheelchair to fit under a desk. Figures 6 through 8 show the reach that a wheelchair user can access. If anything is outside of these parameters, certain users may not be able to access portions of the product, and it therefore cannot be deemed accessible or universally designed.

1.2.4. VIDEO LECTURE FINDINGS

To gain insight into common teaching habits regarding interaction with the lectern, video lectures were viewed on Youtube.com/education. Examples of teaching aids used in these real-life lectures are shown below:

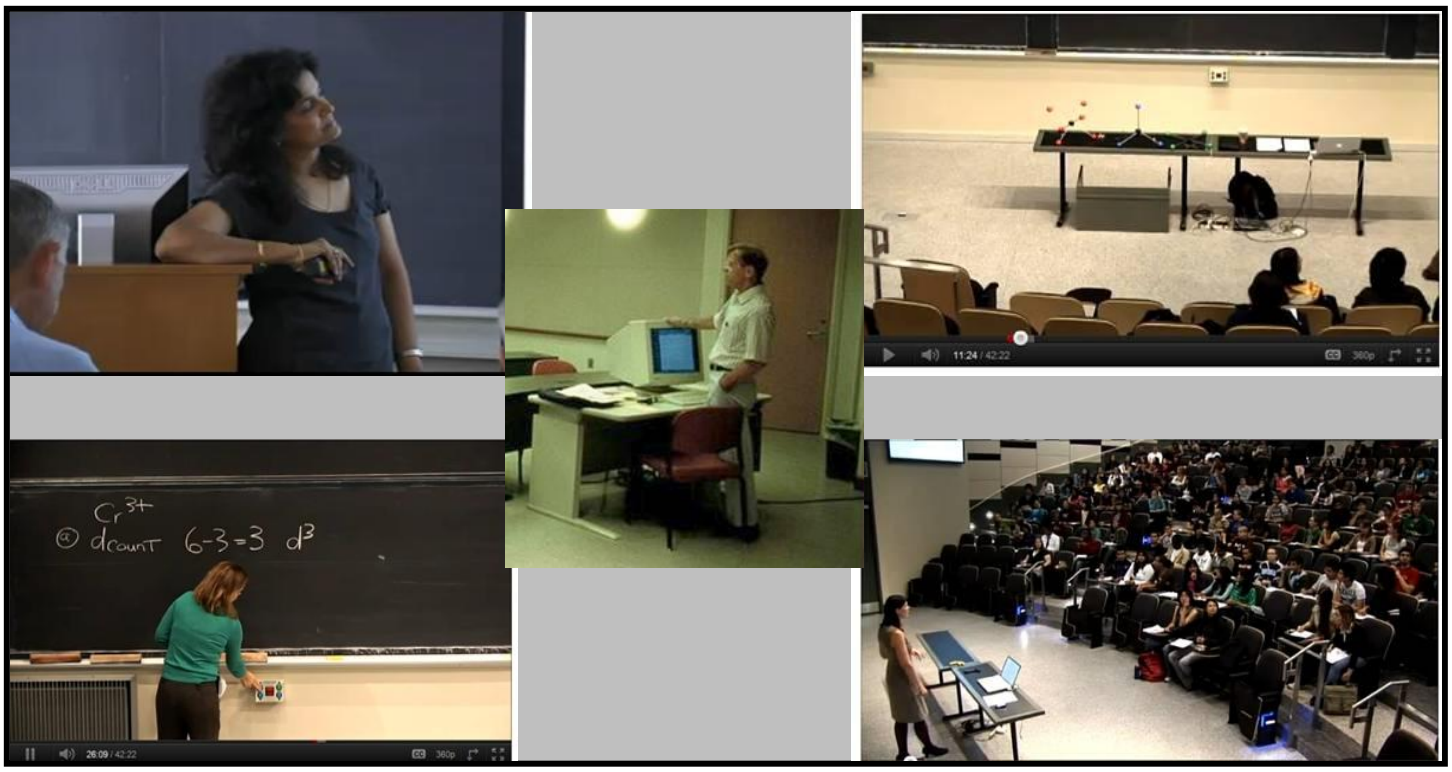


Figure 9 – Video Lecture Screenshots [8]

From the video lecture study, it was concluded that the use of a podium is entirely dependent on user preferences, rather than on provided features. For example, three teachers at MIT used the same lectern in three distinct and different ways, even though all three had access to the same features. Nonetheless, it is necessary to accommodate each instructors needs if the lectern is to be universally designed. In the majority of videos, the instructor used the lectern infrequently and when they did used only a few of the many features available. However accommodating the minority of users is important, such as those that sat frequently, or those that used the podium to interact electronically with students.

1.2.5. FALL 2011 PROFESSOR SURVEY

The team solicited input from instructors and faculty at Northern Arizona University to get a first person point of view on the state of current lecterns. Although any input was welcomed, some specific questions included:

1. *Typical class sizes taught? Sizes of classrooms? Subjects taught?*

2. *Describe your teaching style. (movement around the room, Powerpoints vs. writing on board, sitting vs standing, etc…)*
3. *How do you interact with podiums, lecterns, or tables at the front of the room?*
4. *If the podium included comfortable seating, or was adjustable to work with nearby chairs, would you sit and teach?*
5. *What features of available lecterns do you use the most? The least? How would you improve the lectern? (a/v connections, document cameras, touchscreen controls, portability/adjustability, etc…)*

Input from approximately 20 faculty members at Northern Arizona University was complied. The findings are summarized as follows:

A majority of users…

- Prefer standing *("Sitting does not engage students…")*
- Enjoy the freedom to move around the room
- Want easy electronic connectivity
- Need a computer (a dedicated PC)

A substantial amount…

- Want all room controls integrated
- Want less complexity
- Use *document cameras*, when available
- Complained of having to "*click slides*"
- Want more desk space

A few…

- Sit for the entire lecture

2. SPECIFICATIONS & REQUIREMENTS

The state of the art research were directly translated into design constraints. These are termed specifications. Separate from the specifications are general requirements provided directly by the client, Steelcase, Inc, at the onset of the project.

2.1. REQUIREMENTS

- Design a lectern that will conform to the principles of Universal Design. This implies that it will be easily accessible to people of all abilities and preferences.
- Meet 2010 ADA Standards for Accessible Design
- Follow design practices and themes typical to Steelcase
- Stay within an initial budget allocated by Steelcase, Inc. ($1000)

2.2. SPECIFICATIONS

The following specifications were set at the beginning of the design process. The middle column of Table 1 denotes whether or not the final product explained later in this report meets the specification.

Table 1 – Specifications for a universal lectern

Specification	Met? (Y/N)	Description
2010 ADA Standards [7]		
Toe Clearance Depth 17”- 25”	**Y**	Toe Clearance is defined as the space under an element that is between the floor and 9” above the floor. Toe Clearance should have a depth of 17”- 25”. ADA 306.2
Knee and Toe Clearance Minimum Width 30”	**Y**	In order to provide users with adequate leg room to access the lectern, a knee clearance width of 30 inches **minimum** is required. ADA 306.3
Knee Clearance Minimum Height 27”	**Y**	In order to provide users with adequate leg room to access the structure, a knee clearance height of 27” **minimum** is required. ADA 306.3
Work Surface Maximum Depth 25”	**Y**	The depth of work surface is to be a **maximum** of 25” if there is a high forward reach over an obstruction. Otherwise no depth requirement. ADA 308.2.2
Work Surface Height 28”- 34”	**Y**	The top of the work surface is to have a height between 28”-34” at some point in its adjustable range. ADA 902.3
BIFMA Product Standards [8]		
Work Surface Static Load Requirement 300 lb.	**N**	Concentrated load requirement for the top work surface of a desk. Intended to be tested on the final prototype completed April 11th.
Racking Test	**Y**	Must be able to successfully pass the Racking Test specified in the BIFMA Desk/Table Product Standards.
Steelcase Specifications		
Meets Budget - $1,000	**N**	We were given an initial budget of $1000 to complete the entire budget.

Promotes Sustainability	**client**	Steelcase is devoted to sustainability in their products, so they are requiring our design to promote sustainability throughout the lifecycle of the product. Our Steelcase sponsors will decide whether or not this requirement has been met at project completion.
Aesthetics Similar to Steelcase Products	**client**	Because of the possibility of manufacturing our design, Steelcase wants our lectern to have a similar style and theme to current popular product lines. This requirement will also be evaluated by our clients.
Allows for sitting and standing work	**Y**	This was specified by the initial Steelcase project request. This will simply be a yes or no at project completion.
Accommodates wire and utility management	**Y**	This was specified by the initial Steelcase project request. This will simply be a yes or no at project completion.

3. DESIGN DECISIONS

This section of the report is organized sequentially, as the project progressed from Fall 2011 to the end of Spring 2012.

3.1. INITIAL CONCEPT DEVELOPMENT

Following state of the art research, the team applied the summary of Fall 2011 professor interviews to develop three initial concepts, each meeting needs of current lectern users.

3.1.1. ROTARY LECTERN

This concept has two distinct physical features, as shown in Figure 10. Firstly, the team determined that motorized movement is the easiest way for a disabled individual to adjust the height of a lectern. Secondly, the lectern can be rotated about the cylindrical post. Rotation of the lectern top provides comfortable sitting and standing arrangements, allowing a user to face any direction.

A downside of this concept is its predicted weight and size. It would have to be a stationary lectern. Figure 10 shows how the electronic motor and controls of the lectern are located in the base. One version has an L-shaped arm attached to the bottom of the lectern. The L shape evenly distributes weight. The part hanging off the side of the lectern is designed to match similar products made by Steelcase, since a requirement was to work with Steelcase Inc.'s design language. Paper trays, cup holders, storage containers, homework turn in trays, and other similar components.

A second version shown in Figure 10 has the base bolted to the ground so there would be no need for the L-arm. This version has a compartment open on either side of the desk surface allowing for more than one person to sit or stand at the lectern if desired. The user could adjust the surface flat, or tilt it at an angle to account for multiple people.

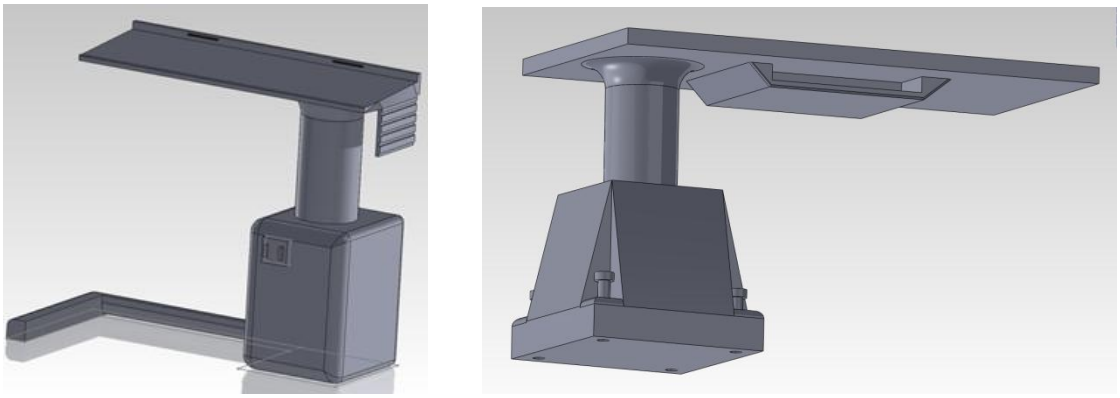


Figure 10 – Possible versions of a rotary lectern

3.1.2. MODULAR LECTERN

The second concept shown in Figure 11 was a modular lectern, which featured a removable top relocatable around the room. In its basic form, it is similar to a classic lectern with a height adjustable base that allows for sitting or standing use. It could also be equipped with casters that would make it easily re-locatable around the room. The top portion could be detached from the base and placed on any flat surface around the room that the instructor would like to lecture from, essentially turning any surface into a podium/ work surface. Steelcase previously marketed a standalone table-top lectern which received positive reviews, so this is a market-tested concept. The top portion could also be attached to a personal wheelchair if the user desired, giving them the ability to lecture from their chair. The modular lectern gives the instructor choices as to where and how they want to lecture, and its included features give them options that increase efficiency and comfort of use.

Figure 11- Possible form for a modular lectern

3.1.3. TWO-PART LECTERN

This lectern is broken up into two separate components which together provide access to a computer, room controls, electronic components while still incorporating a mobile lectern that can be relocated around the room. This design concept allows for a teaching style known as constructivist pedagogy, which is based on collaborative learning where the students work in groups. Constructivist pedagogy removes traditional lecturing from teaching and allows the instructor the freedom to move around the classroom and promotes interaction between students and instructor.

One component of the two-part lectern is referred to as a base. The base provides a structure to contain all the necessary electronics and technology that an instructor needs/wants to teach to a class. These electronic components include computer, light and screen controls, DVD player, power source and/or any other necessary items.

The other component of the two-part lectern is the mobile lectern. The lectern is lightweight and can be easily moved around the classroom. It could be considered a traditional stand type lectern with a surface to hold books, notes or any miscellaneous items. Two additional features of the lectern are the adjustable angle of the top surface and the adjustable height that allows for a wide variety of users to access it and set it to their personal preferences.

The base is typically located in the front of the classroom, where a traditional lectern would be located. If the instructor is going to give a traditional lecture, the base gives the instructor a central location to move the mobile lectern to where they can be seen by the entire class. For most classes, the mobile lectern will be located here, but whenever the instructor desires, they can move the mobile lectern to any location in the classroom that helps them in teaching. An example of when this would be useful is if the instructor is writing on the board, they can move the lectern to the board and keep notes and textbooks on it.

Two different forms of this concept are shown in Figures 12 and 13 respectively.

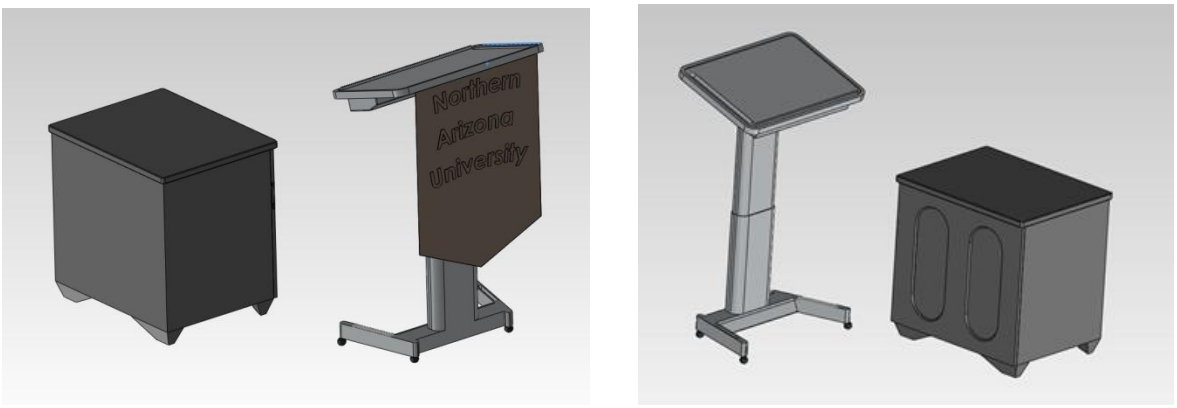


Figure 12 - Possible form for a two-part lectern

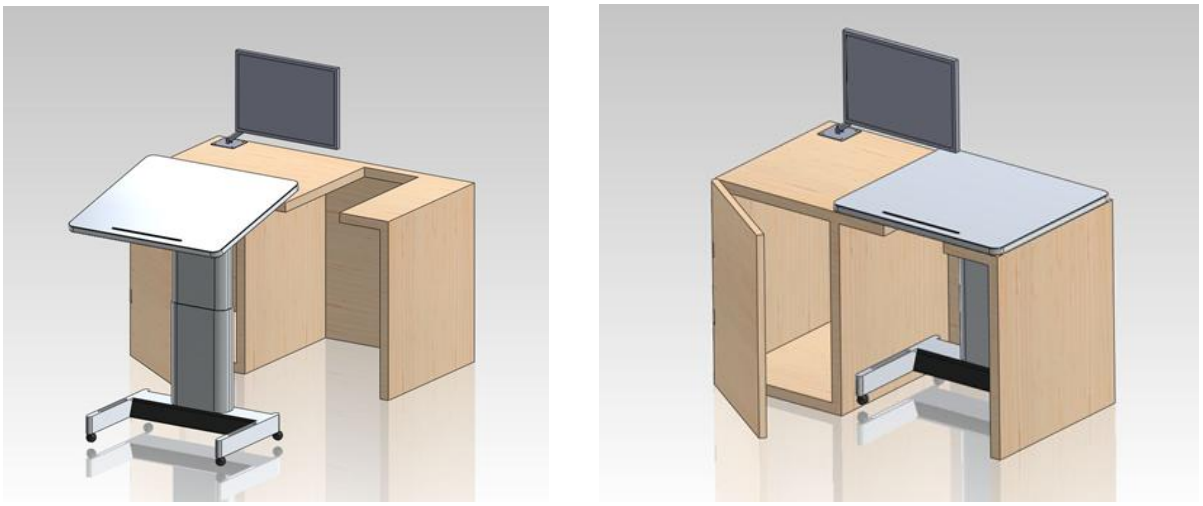


Figure 13 - Additional form for a two-part lectern

3.2. CONCEPT SELECTION

After the team designed the initial three concepts, we consulted Alejandro Rengifo and Matt Beals, our two contacts at Steelcase Inc., to receive feedback and their decision on which design they felt had the most potential and that they wanted us to move forward with in creating our final design. The team sent Alejandro and Matt a proposal with our three concepts. The design that they chose was the two-part lectern in Figure 13.

This design was chosen for its versatility. Because the two-part lectern consists of two parts, it is able to adapt to a wide variety of teaching styles and instructors much more effectively than the other two concepts. While the other two concepts had unique and simple solutions to some problems, they also had many limitations.

The rotary lectern, as talked about previously, is able to solve problems by motorized height and tilt adjustability as well as 360 degree rotation. As stated before, though, there are limitations to the design. Unless the center stand is built much larger, interfering with the access of rotation, there is not enough room to house the electronics. In order to keep the size down, the electronics may be placed in the ceiling, floor or walls of the classroom, but this means the room must be designed with the lectern. This means the rotary lectern cannot be integrated into any existing classroom. The other major limitation is the lectern must be stationary and located near power and data connections.

The modular lectern is height adjustable and may be easily moved around the room. The limitations surrounding the design come to its lack of technology integration. As it is designed to be very simple, it supplies no access technology. There is no room to house a computer or AV equipment. It does not have the ability to integrate room controls or a computer monitor. The podium look gives it the feel of the old styles of teaching, where the instructor just talks and there is no student-teacher interaction. There is minimal surface area and may be hard to sit behind.

The two part lectern is able to virtually eliminate the limitations of those two concepts by combining many of the themes into one by the use of two parts. The home base provides the housing for any necessary electronics, such as a computer, AV equipment and document camera. The mobile surface is height and tilt adjustable, allowing any instructor to use it how they want, whether sitting or standing. It provides easy access for a wheelchair user. The mobile lectern is also easily moveable around the room so it can be used anywhere. Alone, the mobile surface has more area than the other two concepts, and far more than available on current lecterns on the market. When combined with the home base, surface area is almost doubled.

In short, the two-part lectern is able to adapt to a wide variety of teaching styles as well as disabled and wheelchair users with very minimal limitations.

3.3. USER TESTING

During the project, the team solicited user feedback through three progressive interview efforts in the course of the design process:

1) Fall 2011 pre-concept (*Figs. 10-13*): brainstorming and interviews
   - Refer to section 1.2.5 for details on the results of part 1
2) Spring 2012 user testing (*Fig. 14*): foam prototype
3) Physical prototype (*Fig. 15*): final demonstration

In total, 73 professors of various specialties at Northern Arizona University critiqued the concept during the design process. Questions posed through these interviews addressed open-ended design problems and helped characterize profiles of current teaching styles. Part 2 (Spring 2012) of this progressive effort is detailed in the next three subsequent sections, 3.3.1 - 3.3.3.

Also, a visual timeline of the project progression is provided in Appendix B.

3.3.1. INITIAL PROTOTYPE

To begin improving the two-part concept selected by Steelcase Inc., the team constructed a to-scale, representative prototype for prospective end-user interaction. Foam was used to mock up the cabinet base, and a functional Airtouch™ table represented the final mobile portion. Figure 14 shows the prototype.

Figure 14 – Foam Prototype

After construction of the prototype we began interviewing. We considered a variety of different buildings across the campus of Northern Arizona University. Dividing the interviews amongst the team we spent a week traveling to different buildings to get professors and teaching staffs input. Within this interview process the team visited the engineering, forestry, business, and the social and behavioral science buildings. For each visit we brought the prototype to give the faculty member a visual aid for making decisions. Also we brought with us a questioner of questions that were designed for someone in a teaching position. Generally faculty and teachers were more than happy to provide us with their input for this project. The outcome of this process is detailed next.

3.3.2. SPRING 2012 USER TESTING

Interviewing university professors resulted in a cumbersome amount of raw textual data, the entirety of which can be viewed in Appendix 0. In this section, the entirety of this is summarized into a brief overview.

Each numbered question that follows is accompanied by an answer paraphrased from the raw data. These answers represent the majority opinion to the best of the team's abilities.

1) *Describe your teaching style. How would you envision yourself interacting with this product?*
   The overall consensus was that professors will be repositioning the lectern one or more times after they walk in the room. The lectern must allow for tablet and laptop connectivity as well.

2) *A flatscreen monitor may be inlayed into the lectern under a clear material. Where would you prefer the monitor be located?*
   Split decision between the left or right, although it should NOT be in the center

3) *The lectern is already height adjustable. How important is it for the lectern work surface to also be tilt adjustable? [not at all] 0 - 5 [very]*
The surface must be tilt adjustable (5)

4) *Does the small sidewall on the left of the base portion detract or add to the usability of the docking feature?*
Even split preferences. Steelcase will make the final decision.

5) *Do the dimensions of the mobile surface (40x22¼ in.) provide enough work space?*
The worksurface is more than necessary and should be sized down

6) *Laptop/tablet connectivity will be included. Where should the plug-in be? (cabinet or mobile lectern)*
There was no specific preference on placement, but the majority was adamant that laptop connectivity be simple and dependable

7) *The mobile lectern could be powered (1) by a retractable cord, or (2) for 2-3 hours by a rechargeable battery. Which would you prefer and how strong is your preference?*
There was again an even split in preferences. Including a small amount of battery power with a cord could meet both groups' needs

In addition to the majority answers summarized from the data, a number of unique general comments were extracted and considered during the design process:

- create a "garage door" type opening for cabinet access
- make the plastic housing for the monitor tilt above the surface
- have the monitor pull out of the inlaid position so it sits up in a normal position
- reliability is more important than a wealth of features
- some rooms already have AV equipment built into walls/ceiling
- would like to be able to control the computer from back of classroom
- Research "Docri", a program to connect wirelessly an iPad and a computer
- security of the mobile portion itself may be an issue
- keep the overall base height down below typical whiteboards so it doesn't block student view
- Consider ways to accommodate the hearing impaired

3.3.3. HIGH SCHOOL TEACHERS

The team was invited to a workshop for highschool teachers. Following the workshop, the team conducted an interview with a classroom full of teachers, asking a variety of different questions relating to how they teach and interact with the classroom. The teachers had many useful responses which were recorded verbatim and taken into consideration when designing the final prototype. The questions asked can be seen below.

Each question that follows is paraphrased from the raw data from the team's point of view, and is believed to be a representation of the majority opinion. This user input was used to refine the design. The raw data can be found in part 5 of Appendix D.

1) *Describe your teaching style. How would you envision yourself interacting with this product?*
   The overall consensus was that teachers like to move around the room while teaching. Technology applications are very helpful to their teaching style. Use of power point, video's, and doc cam's seems critical.

2) *If there were additional cubbies for food/drink, papers, and appliances would you use them?*
   The overall consensus was that teachers really find space important for teaching. Many teachers commented during the discussion about their need for space. A place for their food, drink, phone, bag, and etc. is essential.

3) *Would the inlaid monitor be accessible? Would it be necessary for it to be able to sit vertically?*
   The overall consensus was that the monitor did seem accessible and that the monitor should be tilt adjustable. Many teachers like the idea of also having a portable monitor or something similar to an Ipad that they could interact with students on.

4) *Do the dimensions of the mobile surface (40x22.25 in.) provide enough work space?*
   The overall consensus was that the surface does provide enough work space. Some people preferred a larger desk surface.

5) *Laptop/tablet connectivity will be included. Where should the plug in be? (cabinet or mobile lectern)*
   The overall consensus was that teachers would like the connection to be on the cabinet. Although many liked the idea of a wireless system that someone could potentially plug into.

6) *The mobile lectern could be powered (1) by a retractable cord, or (2) by a rechargeable battery (that charges when docked). Which would you prefer and how strong is your preference?*
   For this question the group seemed divided about 50/50. Some wanted retractable while others preferred battery power.

3.4. FINAL DESIGN

As previously emphasized, the goal of the project was to design a universally accessible product by applying user inputs to the design process. Following is a presentation of images showing the structure and features of the final product completed on April 26th, 2012. After the images, each piece of the product is explained in detail.

Figure 15 – Finished prototype, docked

Figure 16 – Finished prototype, pullout AV rack

Figure 17 – Finished prototype, raised and tilted

The physical prototype was also replicated in Solidworks as a complete 3D CAD assembly. This is shown next with annotations in Figure 18.

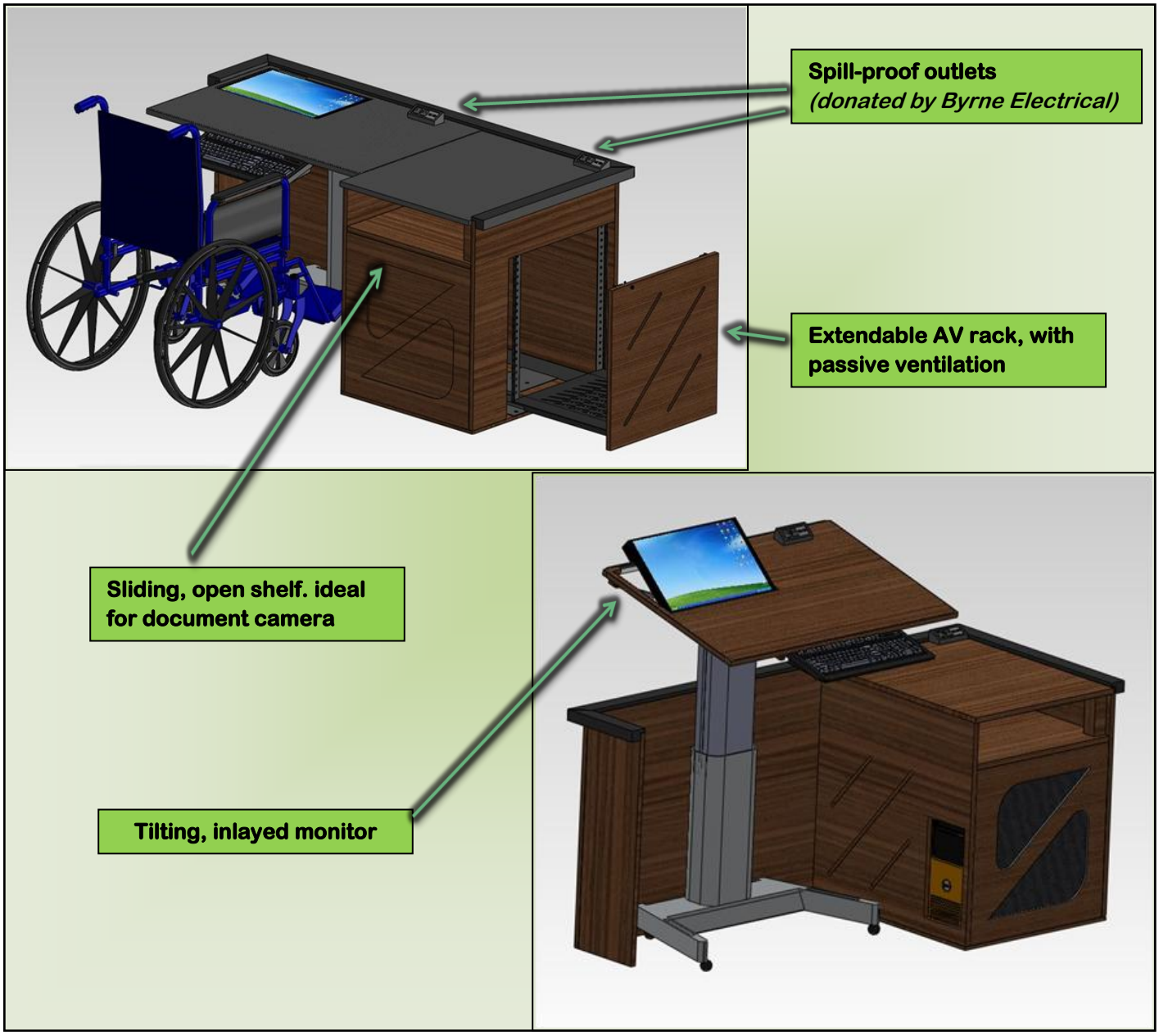


Figure 18 – CAD assembly of final prototype

The final prototype in Figures 15-18 has the following unique features which set it apart from its market competition:

Features:

- Height and tilt adjustable (*spring assisted*)
- Compliant with 2010 ADA standards [7]
- Spill-proof standard 3-prong and USB power outlets
- Wireless to room PC and AV equipment
- Capable of 12 hours battery power
- Sliding AV rack in ventilated cabinet
- Accessible and lockable by IT personnel

3.4.1. AFFECT OF USER TESTING ON THE DESIGN

The following table summarizes all changes and additions to the design that were a direct result of user feedback. Each significant feature is explained in more depth in a subsequent section.

Table 2- Major events in design lifecycle

Section #	Outcome	Design Addition
4.4.1	Professors would like more freedom to move around the room.	Casters on the base, and reductions in weight so the lectern can be moved with one hand.
3.5.2	The work surface of the initial demonstration prototype (*40x22¼ in.)* was excessively large.	Size down the final work surface dimensions (*30x24 in.)*, and base the area upon an open textbook and piece of 8.5x11" paper being next to each other.
3.5.2	When a teacher is seated, flat tables are uncomfortable to use.	A mechanism designed so that the entire lectern surface is tilt-adjustable. (Figure 4)
3.5.2	Common monitor placement (*i.e. upright and center on a table surface*) blocks the teacher's view of students, and vice-versa.	An inlayed computer monitor which is level with the lectern surface and can written upon, or tilted upwards for a better viewing angle. (Figure 5)
3.5.4	Professors had strong, conflicting preferences on the type of power source for the lectern (*battery vs. retractable power cord*)	Include an uninterrupted power supply, which can be plugged into a wall outlet, or run the electronic components off battery power for 12 hours

3.4.2. DESIGN LIFECYCLE

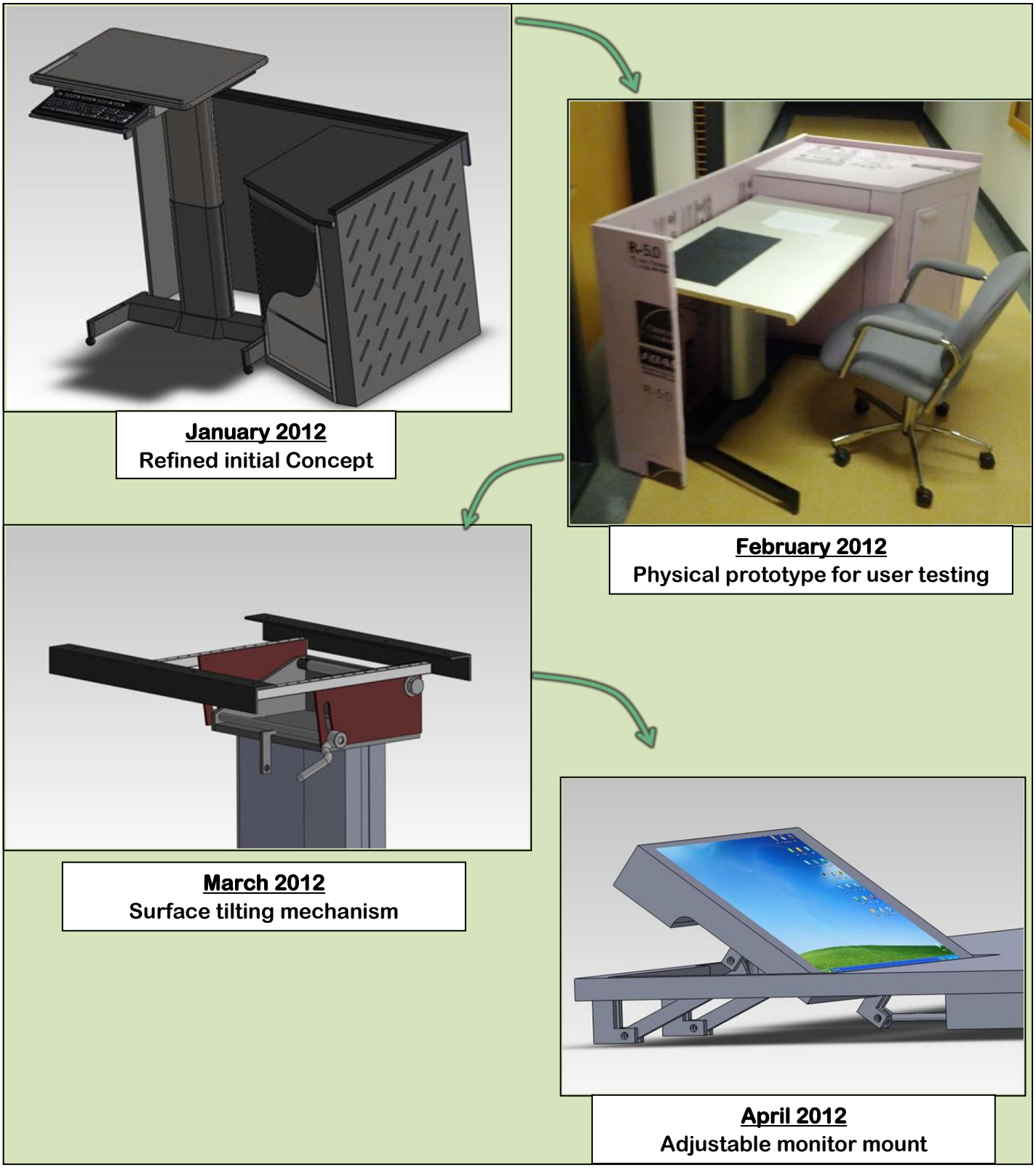


Figure 19 – Design Lifecycle

3.5. DESIGN ADDITIONS & FEATURES

3.5.1. BASE CABINET

Features

- ventilated AV housing
- doc cam storage
- slide-out AV rack, accessible through side (*IT use*)
- access to PC tower
- customizable Soto™ Rail

The base cabinet was an essential part of the lectern primarily because of its uses in a classroom setting. Housed within the base is an AV rack which holds equipment for classroom utilities. The AV rack slides out easily through a side access door. This door potentially could be locked and used for IT use only. The base cabinet also holds the computer tower which communicates wirelessly with the movable lectern portion. On the inside wall of the cabinet is a cut-out designed to provide access to the computer tower. This cut-out for the computer allows users to insert cd/dvd's and usb devices. The cabinet also features a shelf that may be used for any number of options including a document camera (doc cam). A doc cam is a widely used product which projects a visual image of the item placed underneath it. To further the use of the base cabinet a Soto™ Rail was also attached to the front of the base. A Soto™ Rail is a Steelcase product which allows the user to customize their experience. Multiple attachments can be purchased through Steelcase that provide a variety of utilize. Some of these features include a small light, cup holder, different sized cubbies, paper stands, and many other features that make teaching easier. All features can be easily mounted across the Soto™ Rail.

3.5.2. MOBILE LECTERN

Features

- spring-assisted, height and tilt adjustability
- completely wireless
- *12 hours battery power*
- inlayed, adjustable computer screen

The lectern has a variety of different features that make it easy to access and use. The actual dimensions of the surface are designed so that a piece of paper or a book can fit below the computer monitor. The width of the surface in relationship to actual class

materials can be seen in Figure 20. These dimensions were chosen due to the response from our user input.

The monitor is placed in the upper left hand corner of the mobile lectern so that the rest of the surface can be utilized and the screen can still be seen. The most interesting aspect of the monitor is that it can lay flat and also be brought up to an adjustable 90^{o} setting. While lying flat, a piece of plexi-glass allows the user to write on top of the screen if the space is needed.

The right half of the lectern surface is open for notes and any other personal items someone may bring to a lecture. However, there is a USB and power outlet on the top right hand corner which runs off of a battery unit underneath the surface. We calculated the battery unit to provide power to the monitor and wireless display adapter for up to 12 hours.
The wireless device which allows the monitor, mouse, and keyboard to communicate with the base is detailed in section 3.5.4. After getting feedback from teaching faculty it became clear many teachers use projectors and also prefer to the freedom to move around the room while teaching. The wireless monitor allows the lecturer to read from the screen and use computer applications while also moving around the class.

The final feature that makes our product easy to use is the amount of adjustability added to the surface. Using an Airtouch™ base from Steelcase, the surface can be raised up and down with little effort. One step further, a tilt adjustment mechanism designed by the team to provide the top surface with 18° of tilt adjustment. The tilt adjustment mechanism allows the user to adjust the angle to a more comfortable position. A gas spring support was also included to make it easier for a user to move the surface to the desired angle and to ensure that this feature was universally designed. All of these additions and features to the mobile lectern were designed and implemented directly from user input.

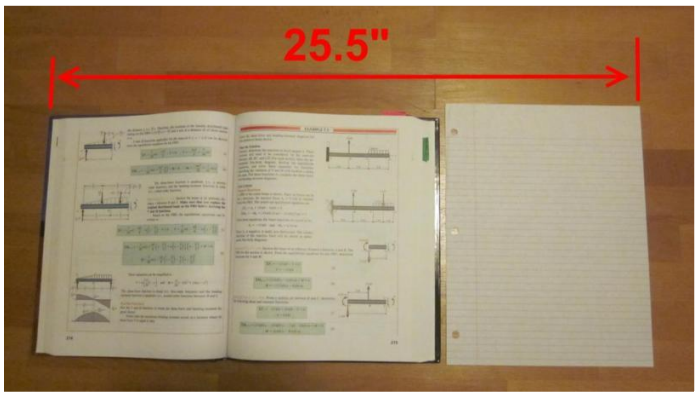


Figure 20 – Downsizing of the mobile lectern surface

3.5.3. DESK FEATURE

Features:

- compliant with **2010 ADA standards**
- 60" work surface, with desk seating
- laptop/tablet connectivity
- Spill-proof outlets *(Byrne Electrical)*

The most unique innovation of the final product is the docking feature. When the movable lectern is positioned at the base cabinet, a single desk is formed. Lowering the lectern to the right height has the lectern surface lay flush with the rest of the base cabinet. When docked the lectern and base combine to make a large desk with a work surface of 60" and ample seating space. This seating space is directly based off 2010 ADA standards (see section 4.1). Wheelchairs may vary slightly in size depending on the manufacturer but in general, there are certain dimensions that do not change.

To increase the comfort for visually impaired users, spill-proof outlets were located on the market and after contacting the manufacturer, *Byrne Electrical,* were donated to the project. One was installed on the base cabinet, and one on the mobile surface. This could help a user feel more comfortable if they are worried about damaging electronics. Finally, many users stated that they need to use their personal computer while giving a presentation. For this scenario, a tablet or laptop can be plugged in via a VGA cable at the base, and transmitted to the wireless lectern. The user can either operate their personal computer directly, or use the mobile lectern as a controller.

3.5.4. ELECTRONIC COMPONENTS

In recent years, computers and other electronic components have been becoming more and more necessary in the teaching classroom. Because of this, the base cabinet was designed to fit a desktop computer as well as a sliding AV rack that can house all the necessary components to control the room. The rack is dimensioned to the standard 19" x 19" size, which is typical of most electronic components that would be necessary to include in the lectern. The team did not specify AV equipment for this project because most AV systems vary from one to another and are constantly becoming outdated. Therefore, adequate space has been included in the cabinet to accommodate various system configurations. Some common electronic components included in teaching lecterns include: computers, room audio, projector controls, room controls (lights, temperature, etc.), accessibility controls, media playing devices and power distribution units.

As previously state, a major feature of the mobile lectern is to give the user freedom to move around the room, the team did not want any wires connecting the lectern to the base. In order to keep a monitor, keyboard and mouse on the mobile lectern, while remaining completely wireless,

the team utilized a "Keyboard Video and Mouse" (KVM) switch and an uninterrupted power supply (UPS) in our final design.

The KVM switch wirelessly connects the peripherals of the computer to the desktop computer which is housed inside the base cabinet. It consists of a display adapter which is connected to the monitor on the lectern, which has USB inputs for the keyboard and mouse, and transmits the computer inputs wirelessly to the computer. It basically creates a wireless network for the computer to communicate with the lectern. The specific KVM purchased is the Display Dock KVM from Cables Unlimited. Our research found this to be the most reliable wireless switch available in our price range. It is rated to cover a 30 foot separation but our testing resulted in an uninterrupted connection at 110 ft of separation, which is more than enough to provide coverage to any lecture hall. Also the quality of image displayed on the monitor is very good, even making it hard to tell the difference from a regular cable display connection.

User interviews directed us to include a battery on the mobile portion, with power connection while the lectern is docked with the base. The UPS battery provides power for the monitor, display adapter and the accessory outlet mounted on the top surface. The specific UPS included in our prototype was the Powercom E-Book which provides 500VA of power. In order to ensure unimpeded use of our lectern, the team specified the need of a 10 hours of battery life. Power consumption calculations showed that a 500VA UPS could supply the components on the lectern with power for over 12 hours. So that gives time for multiple lectures on battery power before the mobile needs to be plugged in for charging at the base cabinet.

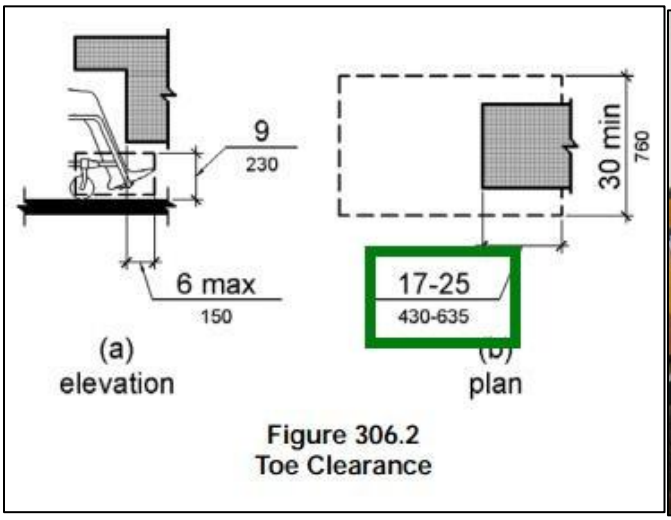
4. MODELING AND ANALYSIS

There are numerous aspects of the final product that benefit from further analysis. This section will analyze the ADA measurements, surface forces, and manufacturability of the lectern. Also included is a discussion of potential design improvements.

4.1. VERIFICATION OF ADA COMPLIANCE

A group of specifications of this project were to design the lectern to comply with the applicable 2010 ADA Design Standards. In this section, we will verify the dimensional compliance with the standards. On the left side of the page are the schematics with acceptable dimensions from the 2012 ADA Standards, and on the right is a visual display of the dimensions on our lectern.

[1] Toe Clearance Depth 17”- 25”



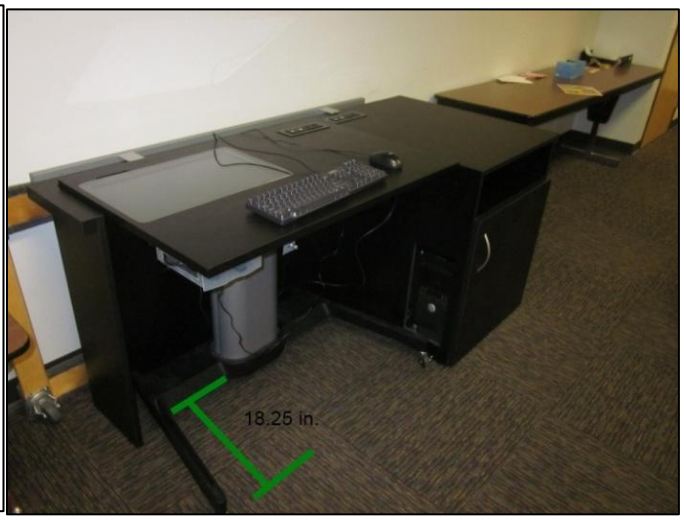
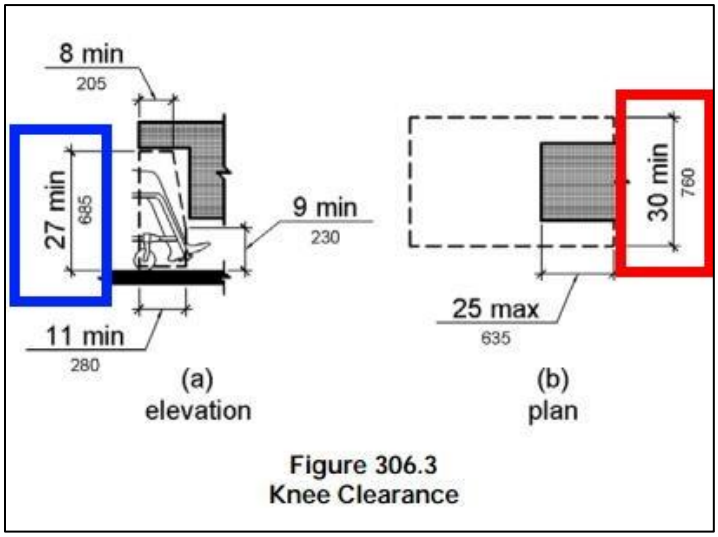


Figure 21 – Toe Clearance verification

[2] Knee and Toe Clearance Minimum Width 30”
Knee Clearance Minimum Height 27”



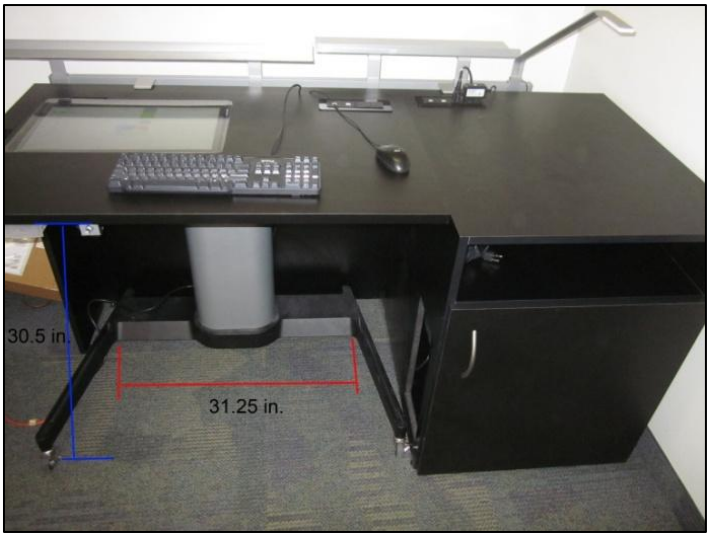


Figure 22 – Knee Clearance verification

[3] Work Surface Maximum Depth 25”

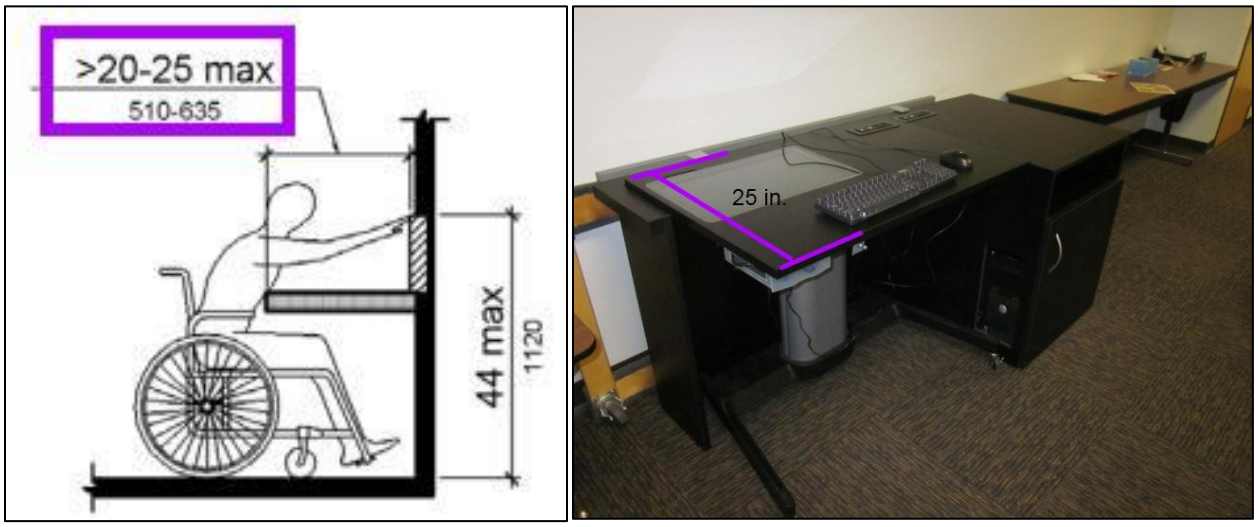


Figure 23 – Depth verification

[4] Work Surface Height 28”- 34”

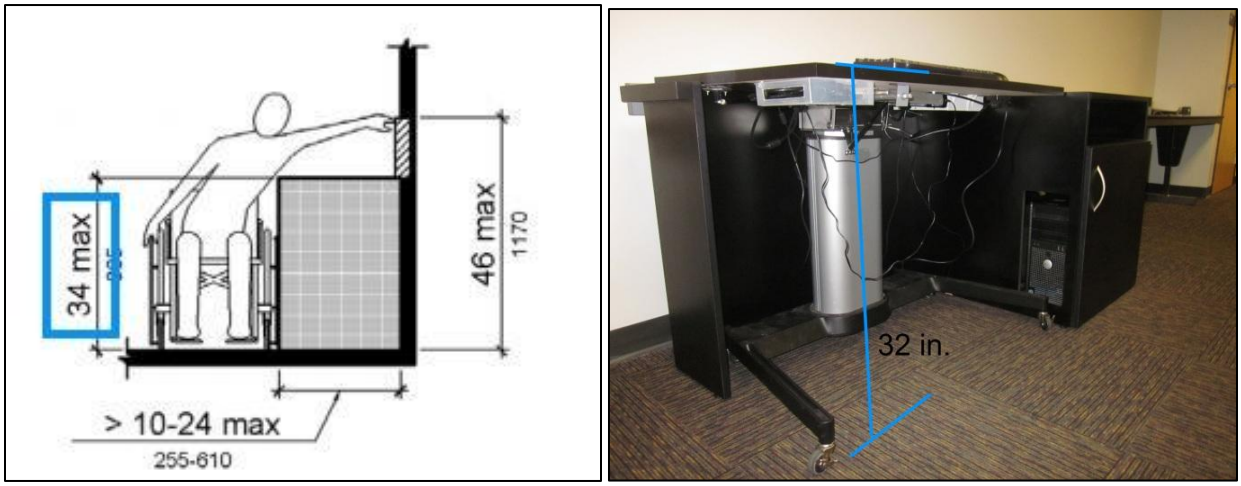


Figure 24 – Surface Height verification

As can been seen from the picture comparisons, all dimensions used in the design of our lectern comply with ADA Standards.

4.2. WORKSURFACE FORCE ANALYSIS

A gas piston was specified to assist in the adjustment of the tilt mechanism. Correct selection of such a piston requires a force analysis of the top worksurface. The relevant calculations are shown in Appendix C. The significant outcomes were that 60 pounds of force would be applied to a piston due to a weight of 71.5 pounds (monitor, UPS, cables,

laminate). This allowed the team to select a 60lb gas spring with ball joint fittings from McMastercarr.com (#4138T536).

4.3. MANUFACTURING DETAILS

Since a goal of this project was to build several prototypes as well as document it for the possibility of Steelcase taking it to production, we had to create the files needed to produce the parts. This started as designing the entire lectern in Solidworks. From Solidworks we created technical drawings that detail the dimensions of the parts and how they are assembled.

The technical drawings in this document are what were used to build the final prototype. The manufacturer of the cabinet base, *Associated Woodworks*, made a few changes to ease manufacturing for the representative prototype. However, the team recommends following the original designs as they take into account needed spacing to fit the AV rack and computer more effectively, as well as some minor styling differences. Also included is the technical drawing that was delivered to *AZ Top Shop* in Flagstaff, AZ who the team contracted to produce the custom surface attached to the mobile Airtouch™ (Figure A.13).

All the technical drawings created with Solidworks are located in Appendix 0. The lectern was designed to use 3/4 inch thick material. Any changes in the thickness of the material would have to be taken into account in the dimensions. It is not recommended to use thicker material as some dimensions are sensitive to this change. Changing to a thicker material may raise the top of the surface to above ADA standards resulting in inaccessibility for wheelchair users. Thicker material might also result in not enough interior volume to house the computer and standard 19"x19" AV rack and AV equipment. The 3/4 inch thick material provided adequate strength and 1/2 inch material may be usable. Half inch thick material would maximize interior volume for use with an ADA compliant surface height.

4.4. SUGGESTED DESIGN IMPROVEMENTS

In the design and fabrication processes involved in this project, the team has come up with various improvements to our final prototype. During the design process, the team had to make some compromises in order to be able to build a prototype within our time frame, budget and available resources. Through fabrication and testing, the team found other areas in which the design can be improved.

4.4.1. CASTERS

The team originally used a ball type caster on the Airtouch™. This caster was quickly scrapped for a conventional wheel caster. The reason we chose a ball caster was its lack of dependence on direction. A standard wheel caster must rotate when changing direction. Slow and sharp direction changes often make the wheel get stuck and not be able to turn without strong input. A ball caster can change direction at any point in time without having to swivel. This is much easier to a user with a physical limitation. The reason the team had to switch to a wheel caster is the lack of

developed ball casters. The only available ball casters are designed for heavy shop equipment. Because of this they operate poorly and often do not roll. A ball caster designed for lighter duty, indoor use would benefit the usability of the mobile lectern.

4.4.2. MONITOR MOUNT

A crank-slider mechanism was designed in order to allow the inset monitor to lift up and out of the surface to sit at a normal, upright monitor position. The team was able to manufacture the mechanism with available scrap materials. The team came up with two improvements. The first is the plate that the monitor bolts to. It is suggested that a wider plate be used to increase distribution of weight and not damage the monitor. The links used were aluminum plate that was 1/8 inch think. This did not provide enough stiffness. The team suggests thicker links made out of steel and cross members to provide the necessary stiffness so the mechanism operates smoothly and reliably. See Figure 25 below illustrating cross braces. Additionally the mechanism needs a locking feature to hold it in place. As of now it relies on friction in the joints to hold in place when lifted to the preferred location.

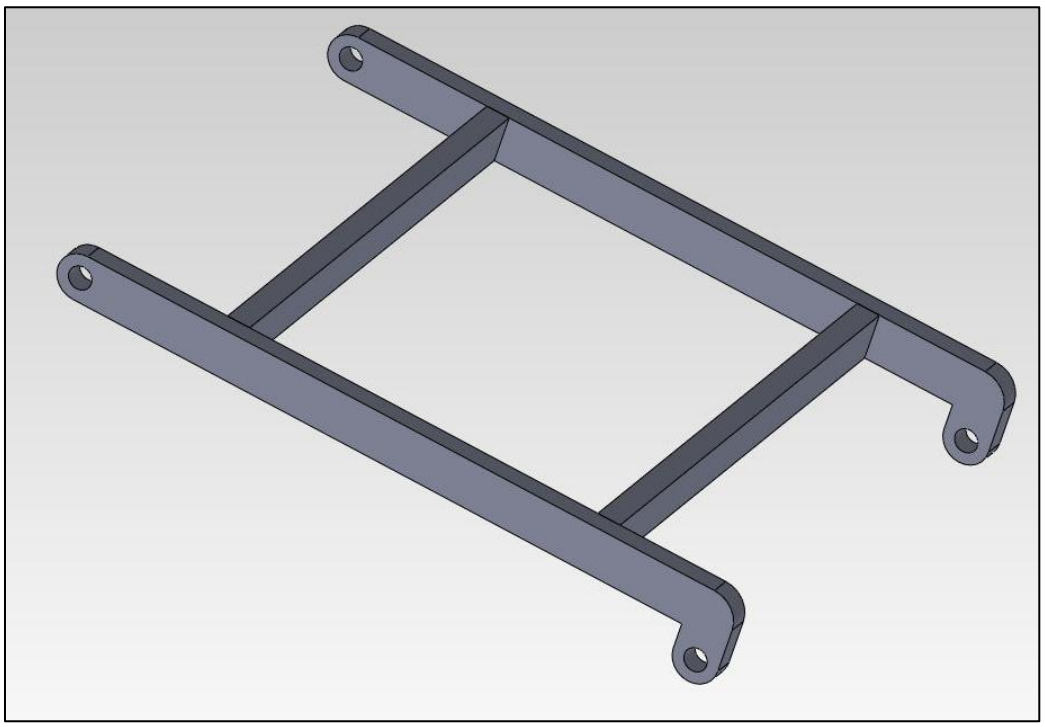


Figure 25 – Braced Links for Monitor Tilt Mechanism

4.4.3. TILT MECHANISM

The worksurface tilt mechanism was designed so that it could be easily fabricated by the team to provide a demonstration of the benefits of tilt adjust. It is recommended that certain design improvements be made before it were to be mass produced. Currently, the mechanism that holds the surface in place is a hand torqued lever on a carriage bolt. In order to tilt the surface, the user

must reach under the surface, find the lever, and twist it 180 degrees to lock it. Several design improvement suggestions include:

- A twist knob located near the front of the surface that, when twisted, forces hydraulic fluid through a line that in turn twists the locking mechanism.

- A cable operated spring clutch. It would be released by pulling a lever, exactly like the current lever for the Airtouch™ lift brake release. Once released, the surface would be adjustable to the desired location, and releasing the lever would lock it in place.

- The use of teeth would allow softer springs, but the tradeoff is that stiffer springs and flat clutch surfaces would allow for infinite adjust positions.

- The surface currently has a gas strut assisting the surface lift. When the angle of the surface is changed, the strut holds it in place. For more stability it may be locked in place. When the final surface weights and reduced friction from improved tolerances are in place, the proper strut force will need to be selected for correct operation if this design is to remain used.
- Finally, a servo or stepper motor is an option.

4.4.4. IT ACCESS DOOR

In the Solidworks assembly, the base cabinet has a side IT access door that varies from the one physically constructed. This door provides access to AV equipment, but may be locked so the internal equipment is not tampered with by other people. In order to improve ease of use, the door should be attached to the AV rack side. This way when the door is pulled open it slides out straight and pulls the AV rack out with it. In order for this to be possible, a design change must be implemented by Steelcase Inc. to its current HOST racks. The upright walls on the rack must both be rotated 90 degrees, as shown in Figure 26. The functionality of this setup is presented in Figures 27 & 28. Furthermore, this design change would improve the utility of the HOST AV rack, by allowing easier access to front and back of AV equipment.

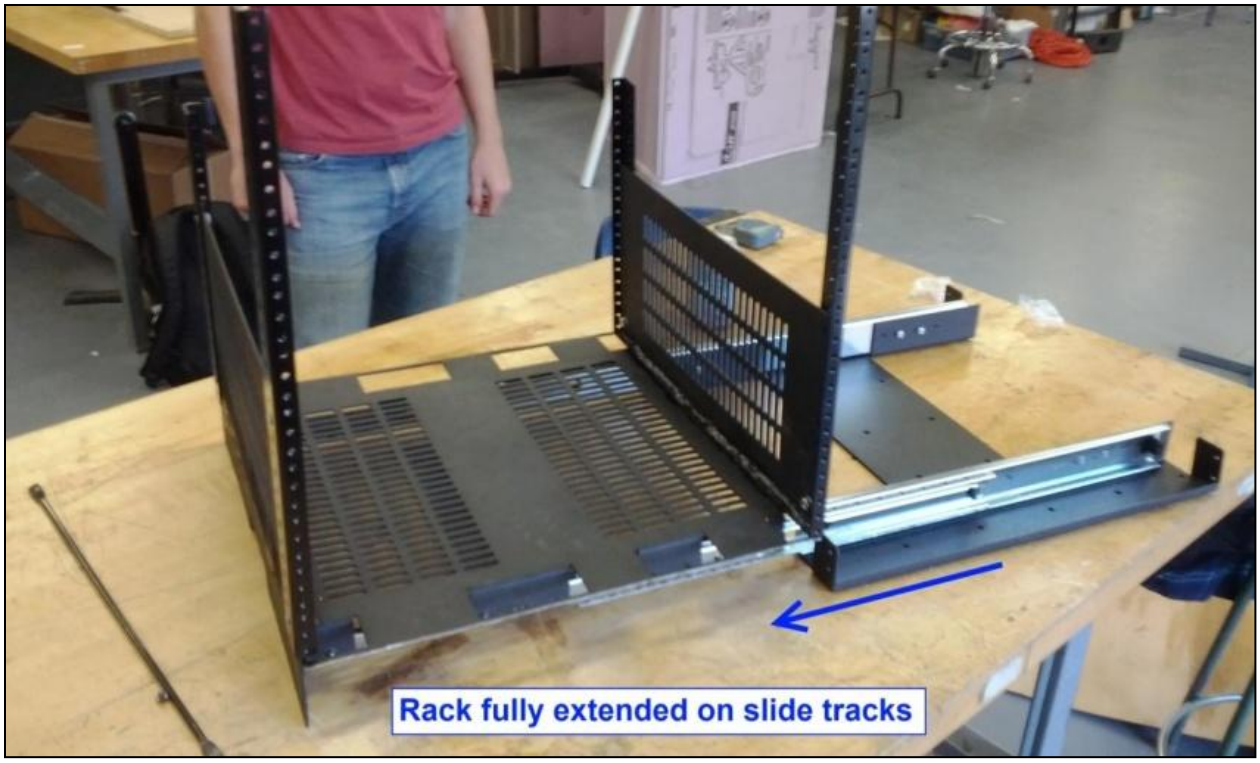


Figure 26 – Rotated rack extended

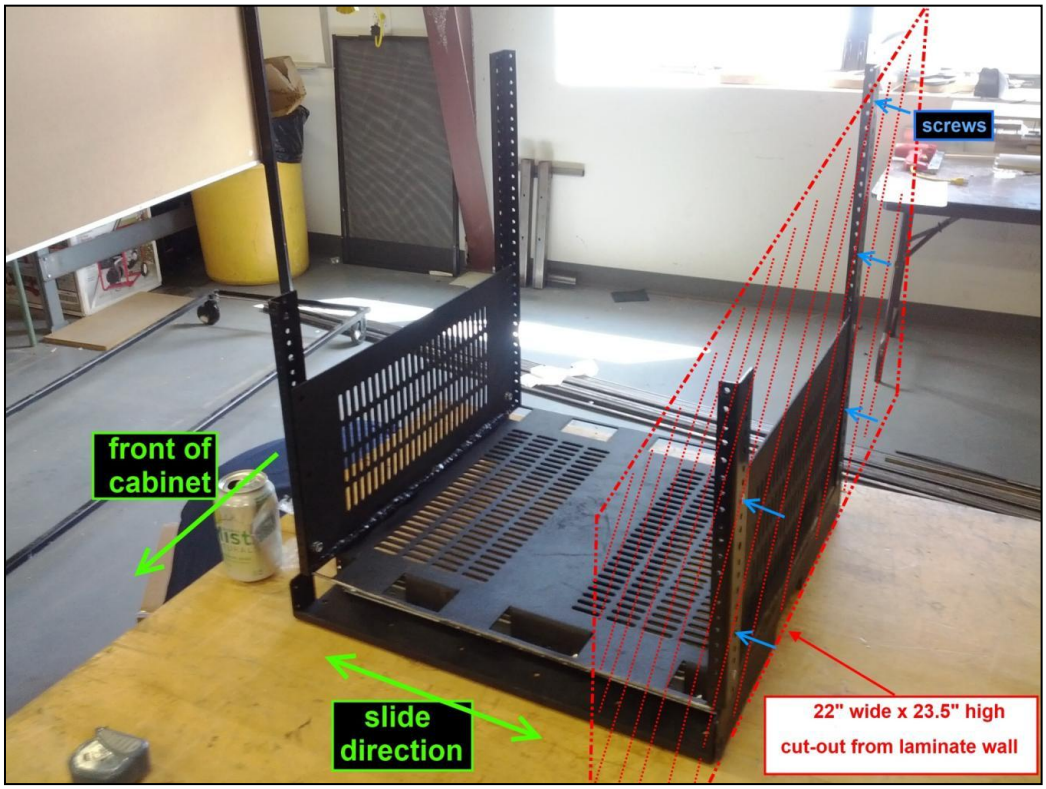


Figure 27 – Door attachment

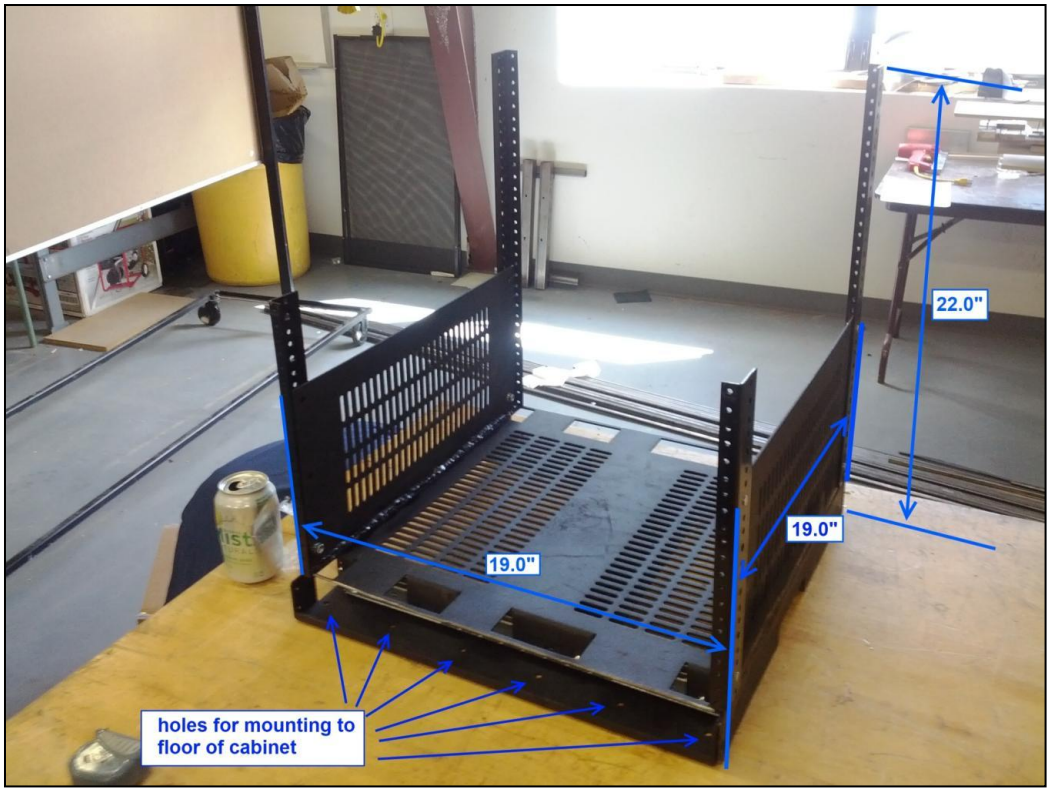


Figure 28 – Rack measurements

4.4.5. DOCKING FEATURE

A final item for consideration that did not receive the attention it deserved because of time constraints is a docking feature. The team believes a docking feature between the mobile Airtouch™ and home base would encourage use of the two together. Instead of the two parts feeling like two completely different parts, they would better integrate together and feel more natural when combined. A docking feature would serve two functions; provide a physical connection which joins the two pieces into a single desk, and provide structural stability for the large privacy wall of the cabinet.

To physically connect and add structural rigidity, the team imagines two slanted edges attached to the cabinet, which would guide the column of the Airtouch™ into its spot, as in Figure 29. To physically connect the two, a much stronger version of the magnetic cabinet door holders would work. They would grab onto the Airtouch™ and hold it in place. When being docked a "click" sound would be made to signal attachment, so the user knows it is in its designated location. Additionally, the magnetic docking lock could be used to automatically charge the battery located on the Airtouch™ when docked.

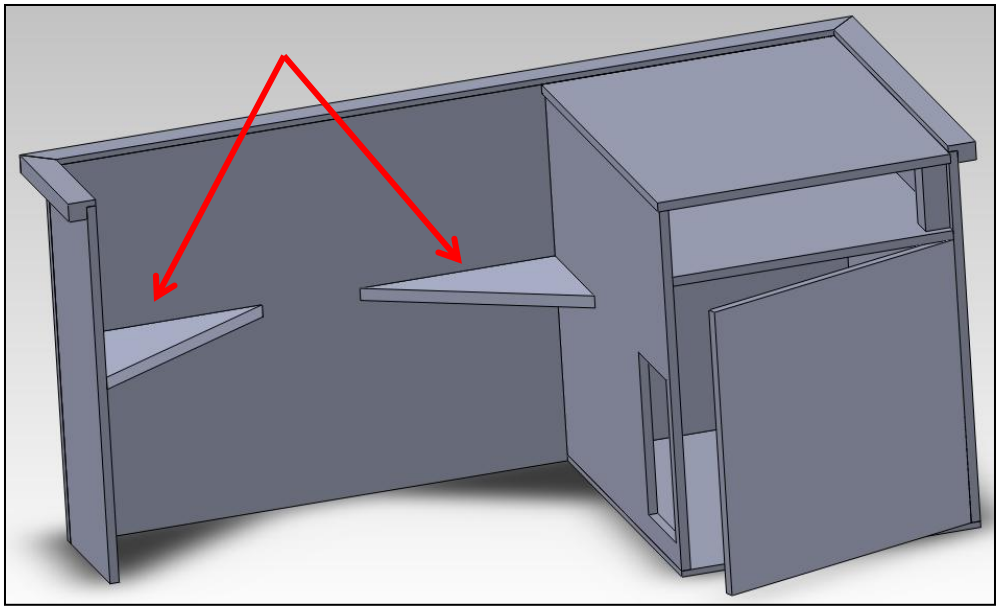


Figure 29 – Possible wedges for docking feature

5. BILL OF MATERIALS

The entirety of components and materials used to construct the final working prototype are presented below in Table 3. The first three items, provided by Steelcase Inc., are mechanisms or components in existing Steelcase furniture. The intent is that by including Steelcase products in the final design, it could be easier for Steelcase to transition the universal lectern into their product line if desired. The electronic components are explained in detail in section 3.5.4. Byrne Electrical in Grand Rapids, MI donated two of their spill-proof Axil-Z power faceplates for demonstration in the final prototype.

Table 3 – Bill of Materials

Item	Qty.	Vendor
Steelcase Airtouch® column	1	Steelcase Inc.
HOST AV rack	1	Steelcase Inc.
Soto™ rail	1	Steelcase Inc.
19” flatscreen monitor	1	Target
wireless KVM	1	Cables Unlimited
uninterrupted power supply *(500VA)*	1	Powercom
Axil-Z™ power faceplates	2	Byrne Electric

¾” laminate	64 sq. ft.	Associated Woodworks
Custom laminate worksurface	1	AZ Top Shop (Flagstaff)
1” bolts (1/4-20)	10	Ace Hardware
Stop nuts (1/4-20)	10	Ace Hardware
Polyurethane fender washers (1/4)	10	Ace Hardware
threaded casters	4	McMaster Carr
Internal-90 hinges	4	McMaster Carr
Gas spring piston (#4138T536)	1	McMaster Carr

6. FINAL BUDGET

A summary of costs expended during the Spring 2011 and Fall 2012 semester is presented below in Table 4. The total cost to construct the final prototype was approximately $2470. In a manufacturing environment, the cost of the custom cabinet base and laminate surface could be decreased dramatically as they were laminate products built by contractors per our designs. Also, the first three products from Steelcase Inc. would decrease in price from MSRP to the cost of manufacturing by Steelcase Inc. themselves. It should also be noted that the expenditure of $2525 exceeds the initial budget of $1000 dollars. Midway through the Spring 2012 semester, the budget cap was removed by the sponsor, Steelcase Inc.

T**able 4** – Budget summary

Item	Cost	Source
Initial Prototype		
Foam, threaded rod, glue	$57	Home Depot
Final Prototype		
Airtouch® column	$650	Steelcase Inc.
HOST AV Rack	$430	Steelcase Inc.
Soto™ Rail	$250	Steelcase Inc.
computer monitor	$125	Target
custom laminate surface	$75	AZ Top Shop
mechanical fasteners	$11	Ace Hardware
gas spring piston	$15	McMaster Carr
electronic components	$110	Newegg.com
Axil-Z™ faceplates	$0	Byrne Electrical, donation
custom cabinet base	$800	Associated Woodworks (*estimate*)
OVERALL TOTAL	**$2,525**	

7. CONCLUSIONS

Several meaningful conclusions can be made about the final product resulting from this capstone project. In summary:

- A majority of specifications were satisfied, and the project goal was met.
  - **Design a lectern that is easily accessible by anyone, with or without a disability**
- Design changes during the Spring 2012 semester were driven by actionable user requests
- The two-part, wireless lectern concept is unique in the current market due to:
  - Compliance with 2010 ADA standards
  - Height & tilt adjustability
- The final prototype is fully specified and documented for manufacturing

The final physical prototype funded by Steelcase Inc. was donated to Northern Arizona University. At the time of this writing, IT and facilities staff are planning to integrate it into a working classroom in the Engineering building.

8. REFERENCES

[1] "Exponent Furniture, Coalesse Collection," Steelcase.com , [Online]. Available: http://www.steelcase.com/en/products/category/tables/lecterns/exponents/pages/overview.aspx. [Accessed November 2011].

[2] "Lectern Model PL36," AvinED Technical Furnishings, [Online]. Available: http://www.avinedtechnicalfurnishings.com/default.as.

[3] "SwanSS Concept," Podiums and Lecterns, 2011. [Online]. Available: http://www.podiumsandlecterns.ie/index.php?main_page=product_info&cPath=1&products_id=1.

[4] "Center for Universal Design," North Carolina University, 7 September 2010. [Online]. Available: http://www.ncsu.edu/project/design-projects/udi/. [Accessed November 2011].

[5] R. A. Cooper, O. Hisaichi and D. A. Hobson, An Introduction to Rehabilitation Engineering, Boca Raton: Taylor & Francis, 2007.

[6] Steelcase Inc., "THINK Chair Environmental Product Declaration," 2004. [Online]. Available: http://www.steelcase.com/en/products/category/seating/task/think/documents/environmental_04-0011852_pdf.pdf.

[7] "ADA Home Page - Ada.gov - Information and Technical Assistance on the Americans with Disabilities Act," 2010 ADA Standards for Accessible Design, [Online]. Available: http://www.ada.gov/2010ADAstandards_index.htm. [Accessed 8 December 2011].

[8] "American National Standard for Office Furnishings: Desk/table products," BIFMA International, Grand Rapids, MI, 1998.

[9] "Youtube.com," YouTube, LLC, September 2011. [Online]. Available: http://www.youtube.com/.

9. APPENDIX

A. MANUFACTURING DRAWINGS

NOTE: All dimensions in inches

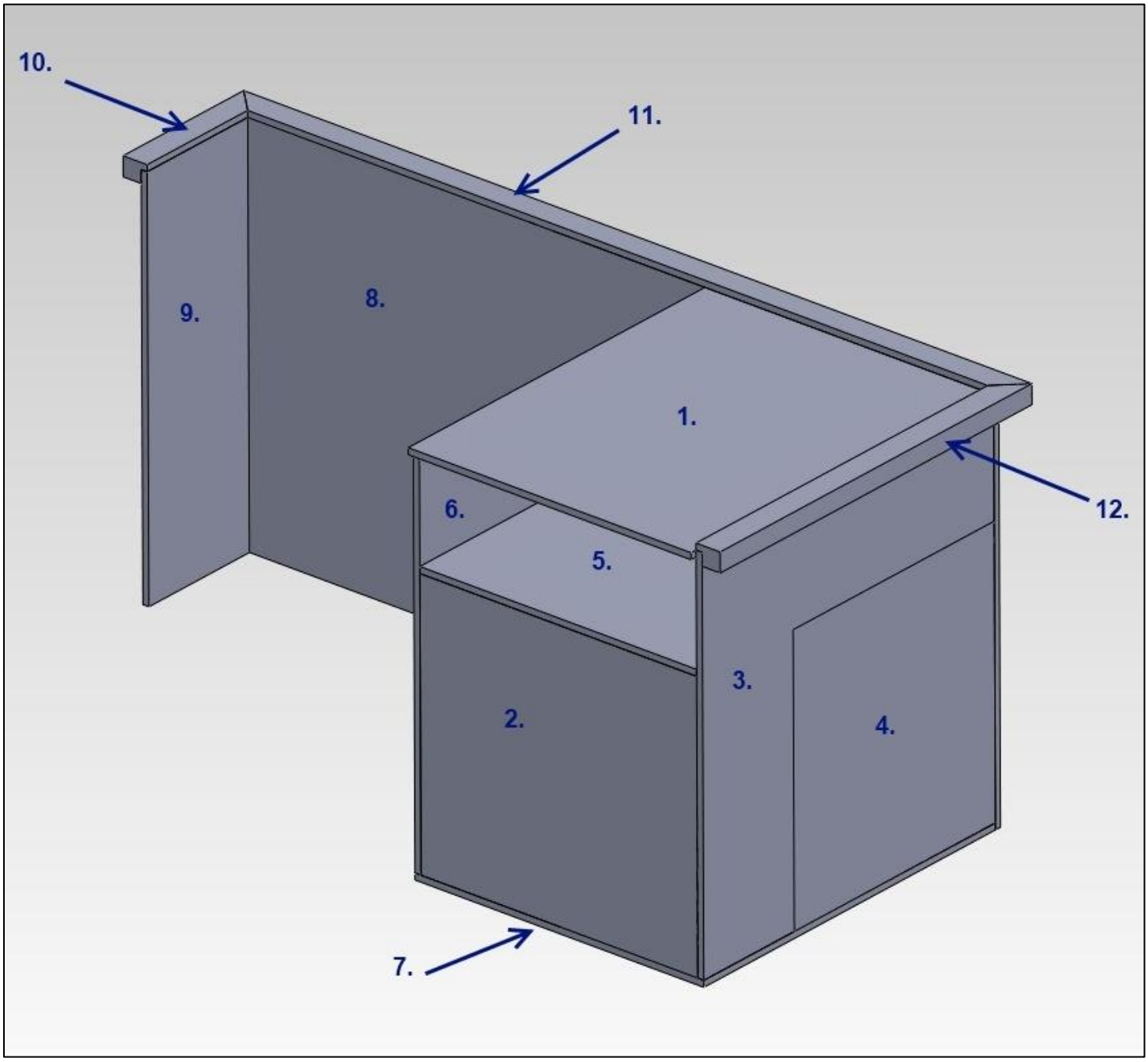


Figure A.1 – Reference drawing for manufacturing figures

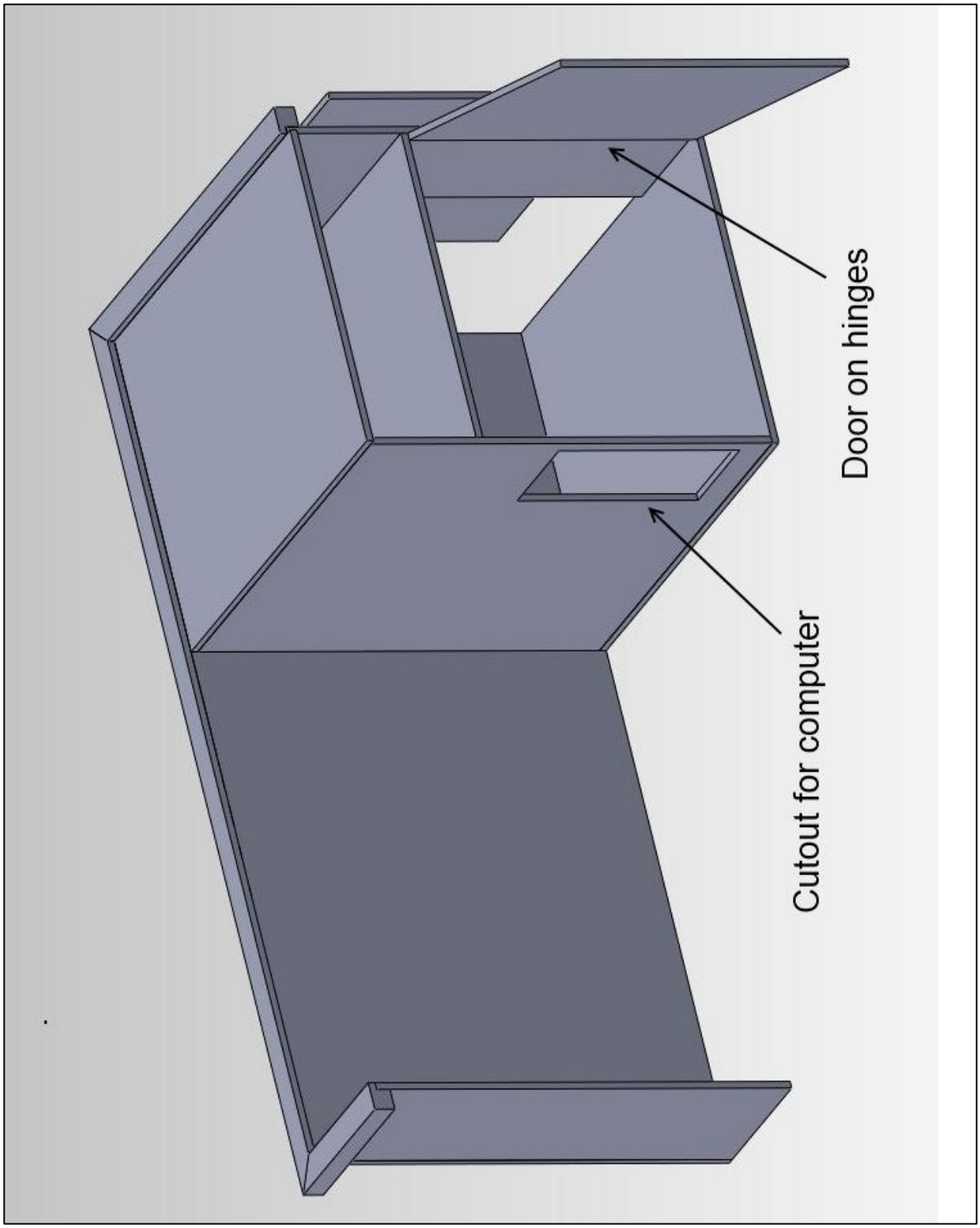


Figure A.2 – Details of cutouts and doors

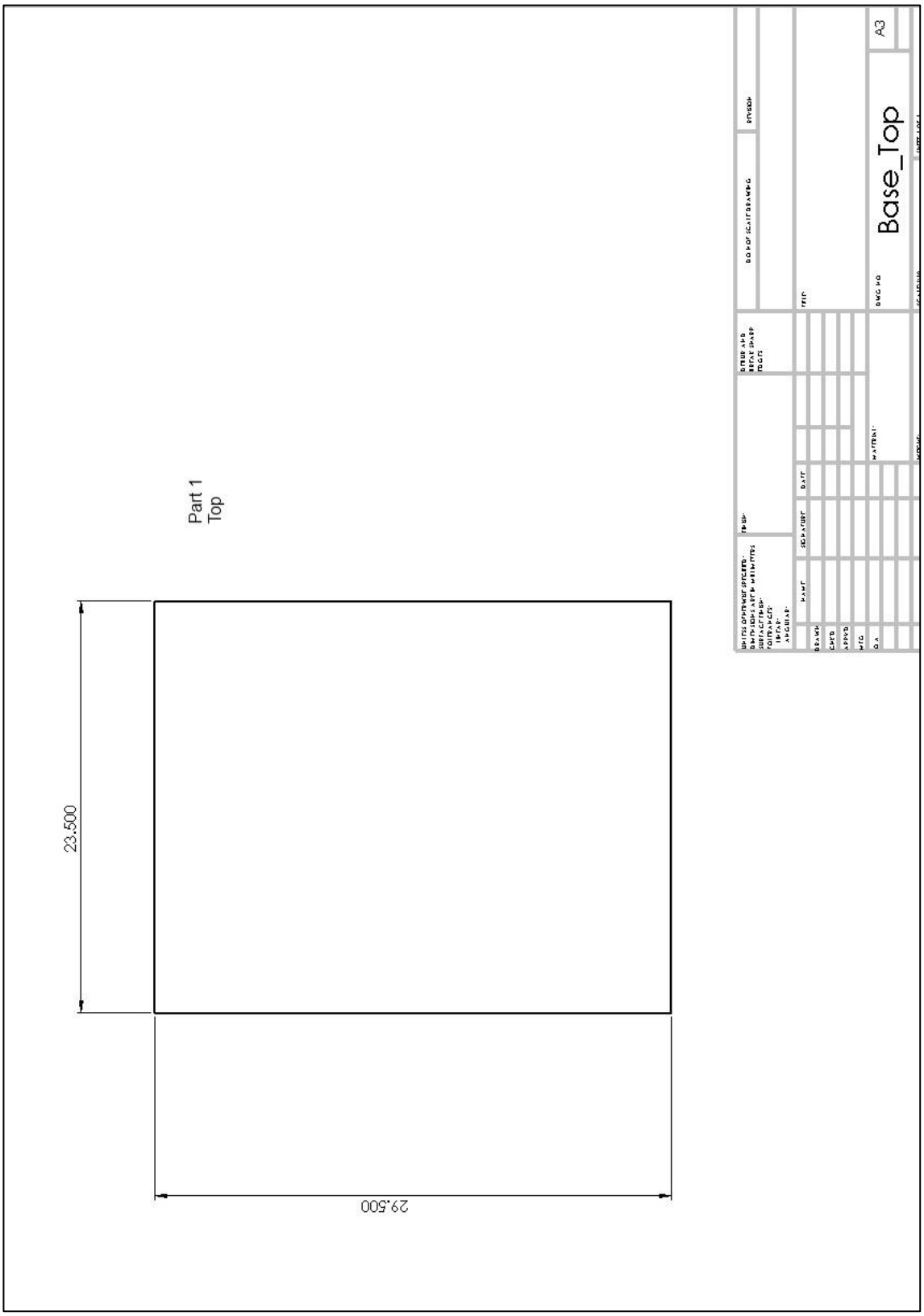


Figure A.3 – Part 1 (*ref Fig A.1*)

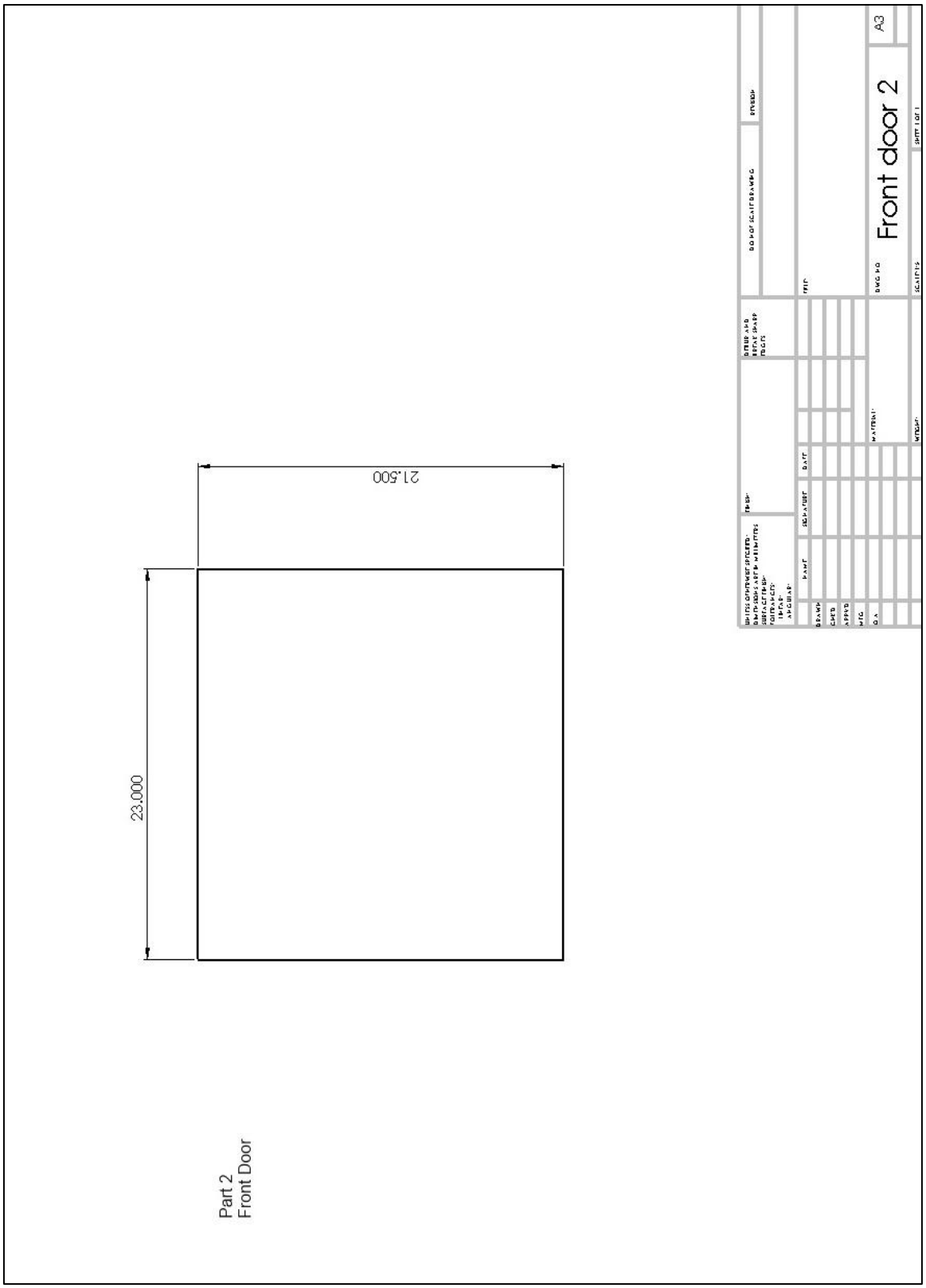


Figure A.4 – Part 2 (*ref Fig A.1*)

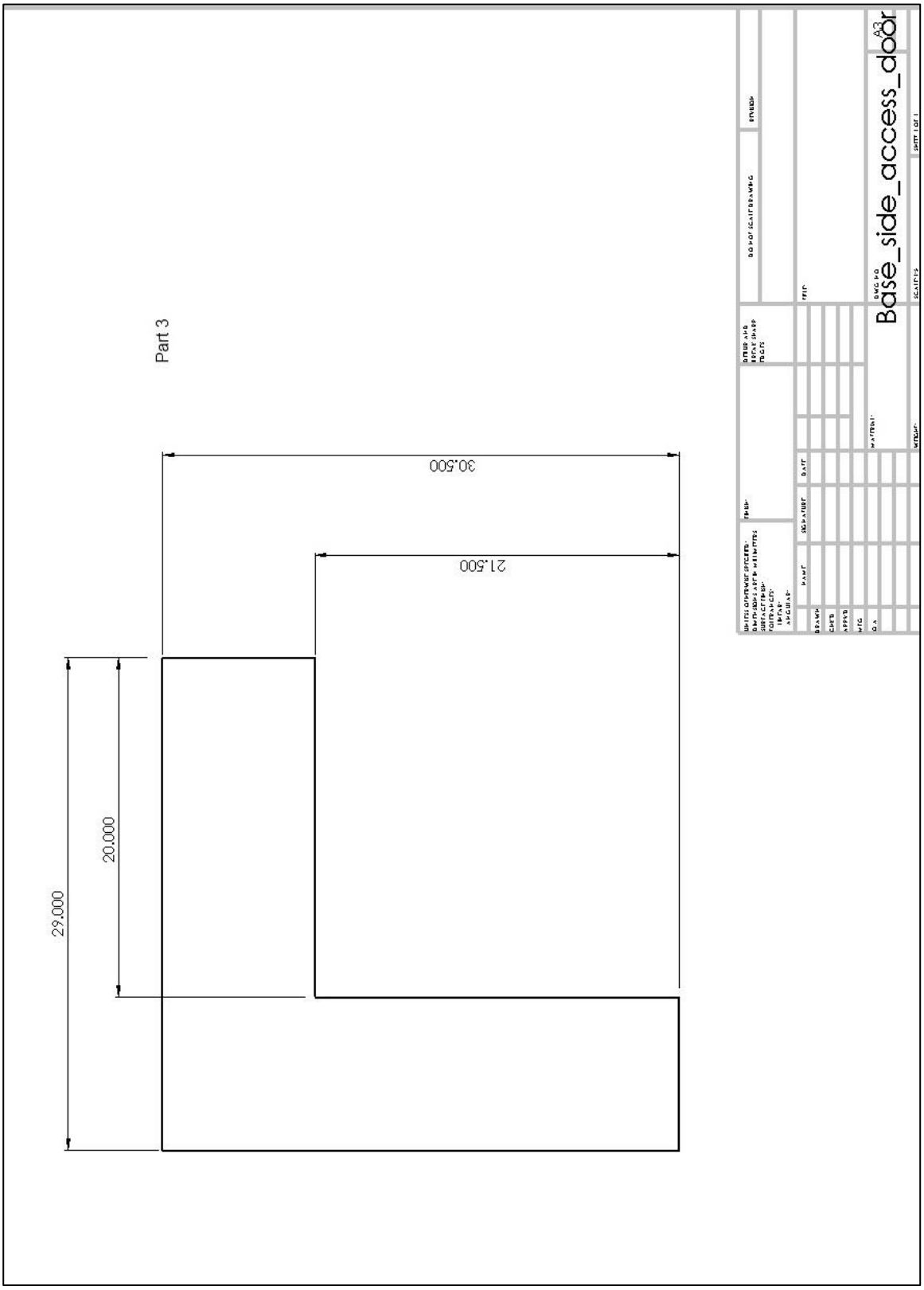


Figure A.5 – Part 3 (*ref Fig A.1*)

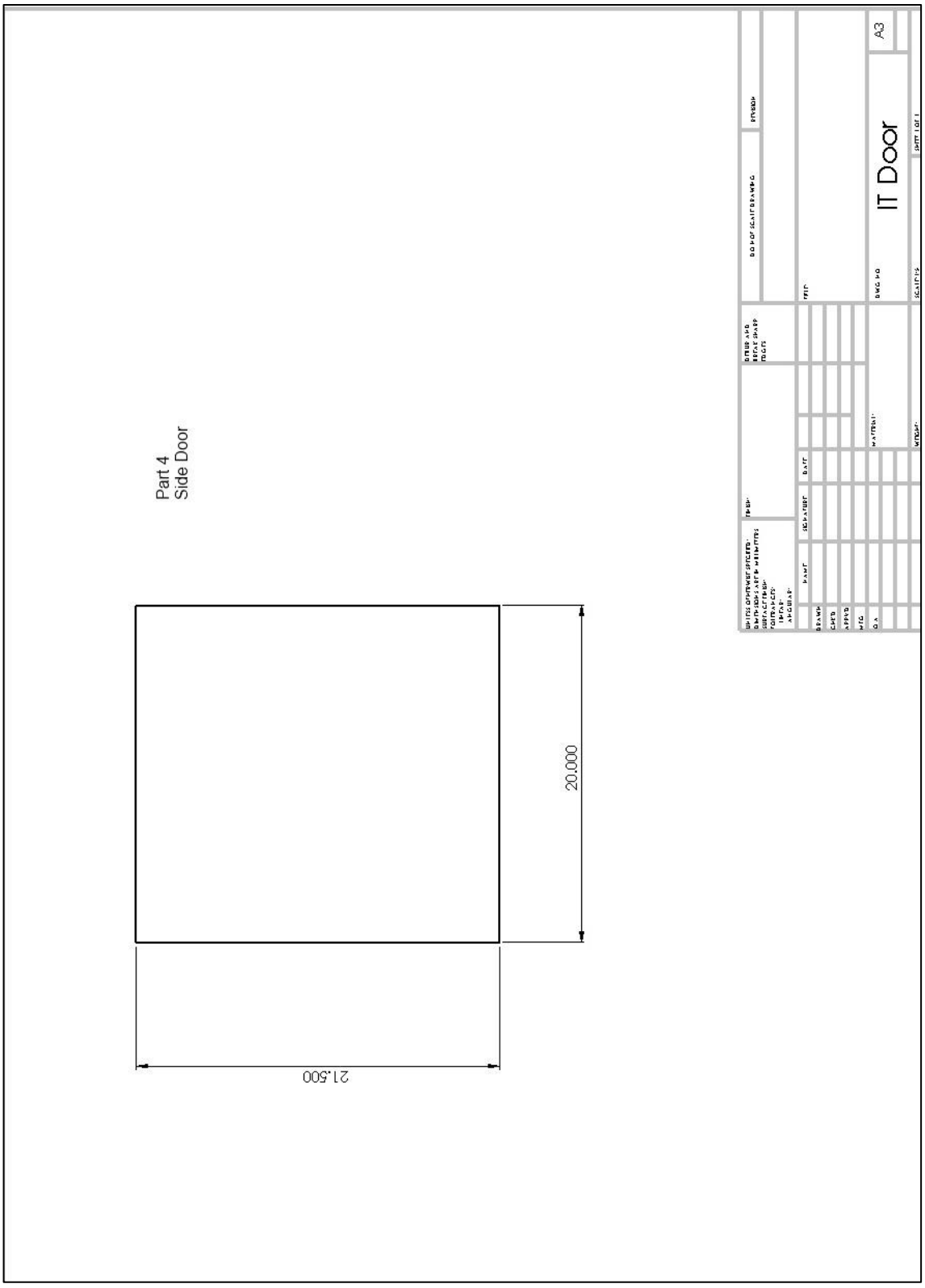


Figure A.6 – Part 4 (*ref Fig A.1*)

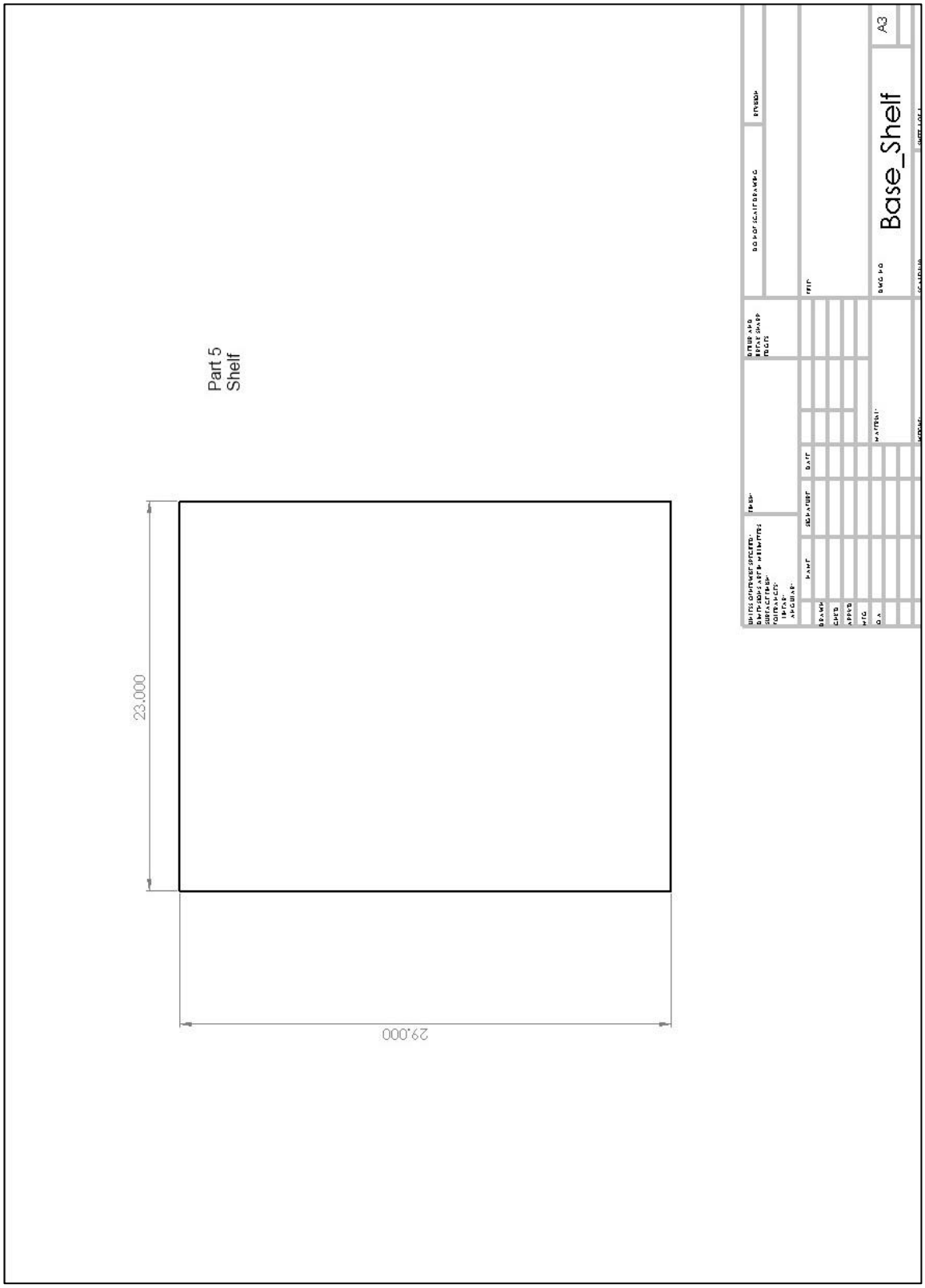


Figure A.7 – Part 5 (*ref Fig A.1*)

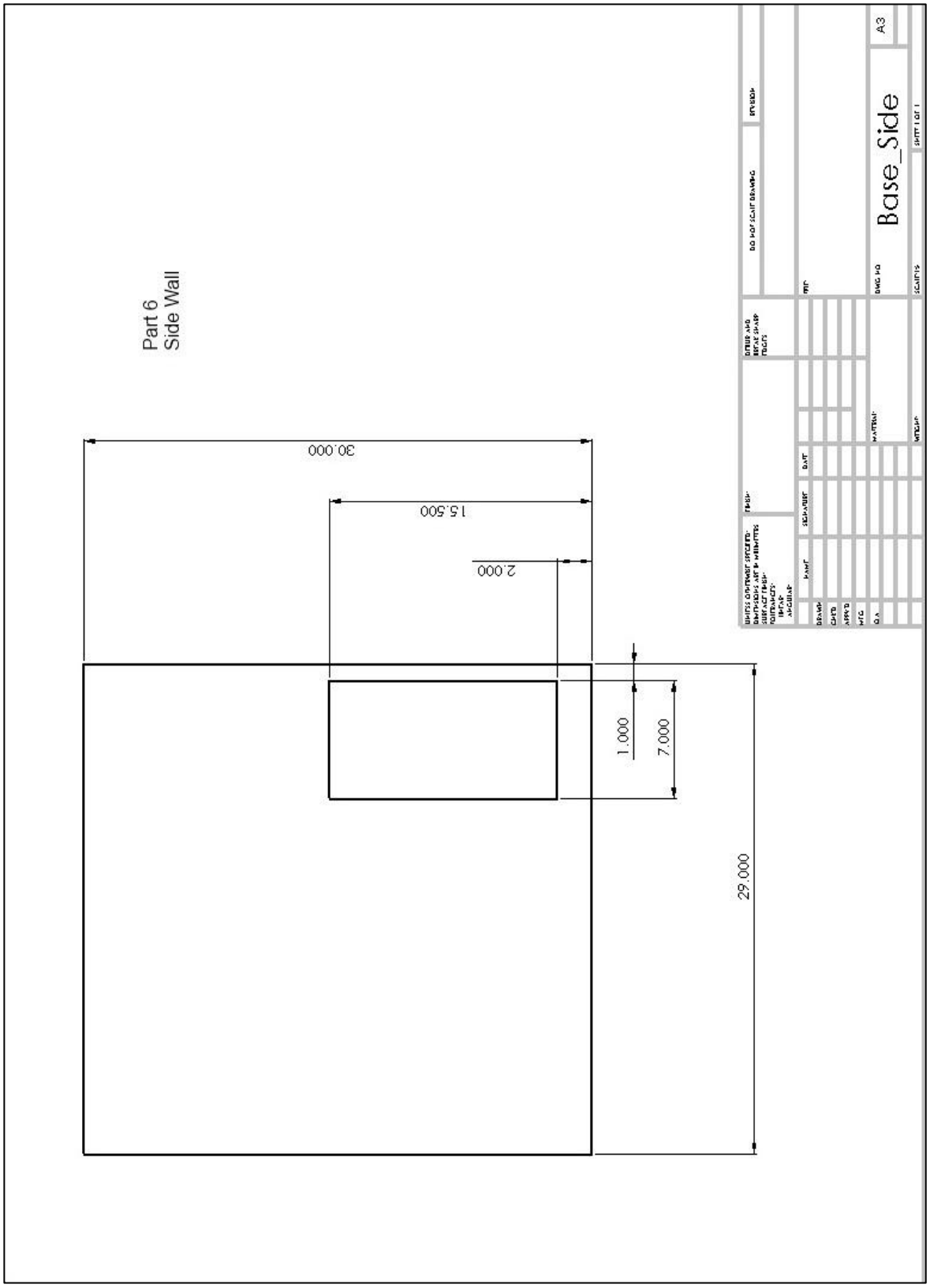


Figure A.8 – Part 6 (*ref Fig A.1*)

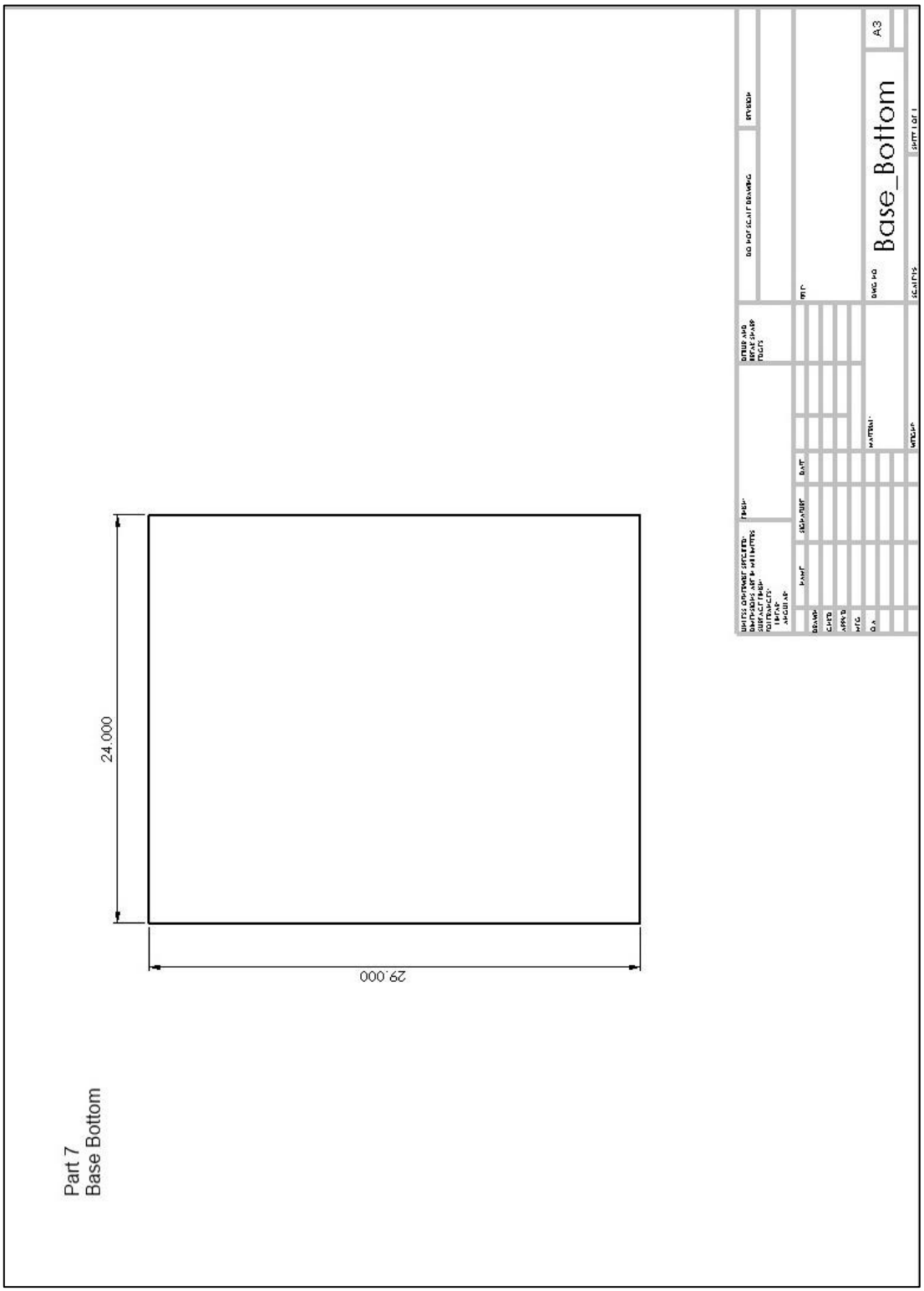


Figure A.9 – Part 7 (*ref Fig A.1*)

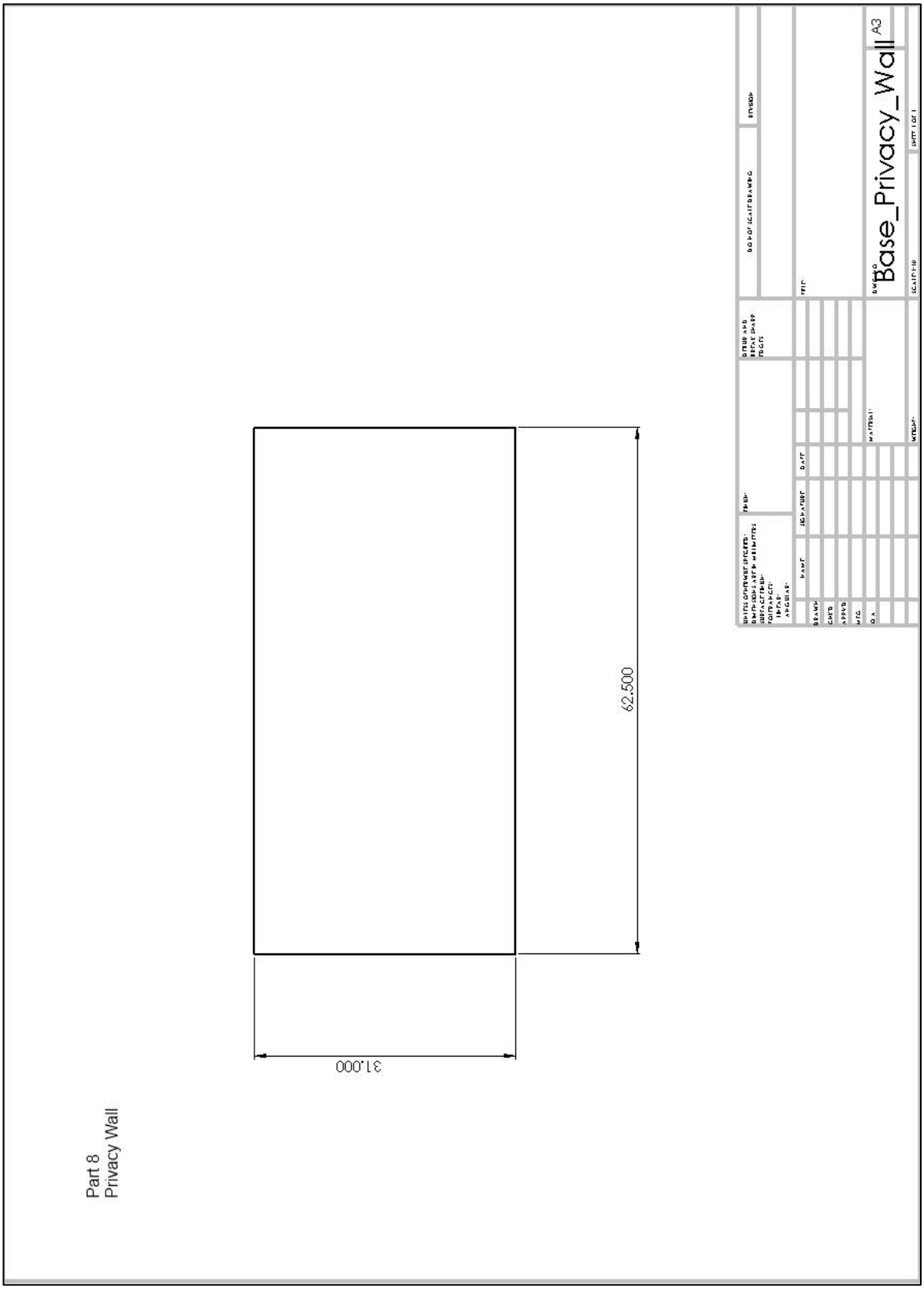


Figure A.10 – Part 8 (*ref Fig A.1*)

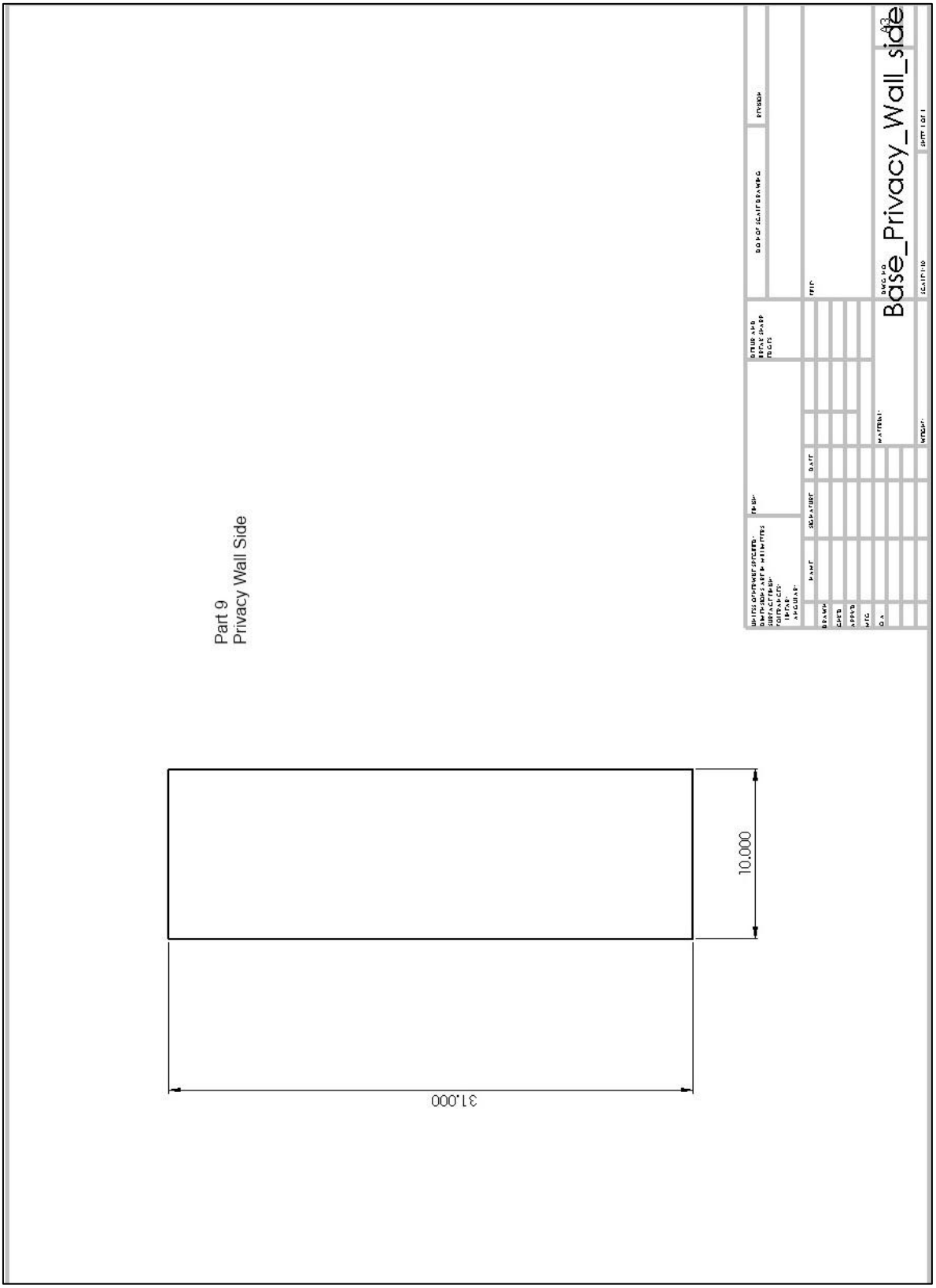


Figure A.11 – Part 9 (*ref Fig A.1*)

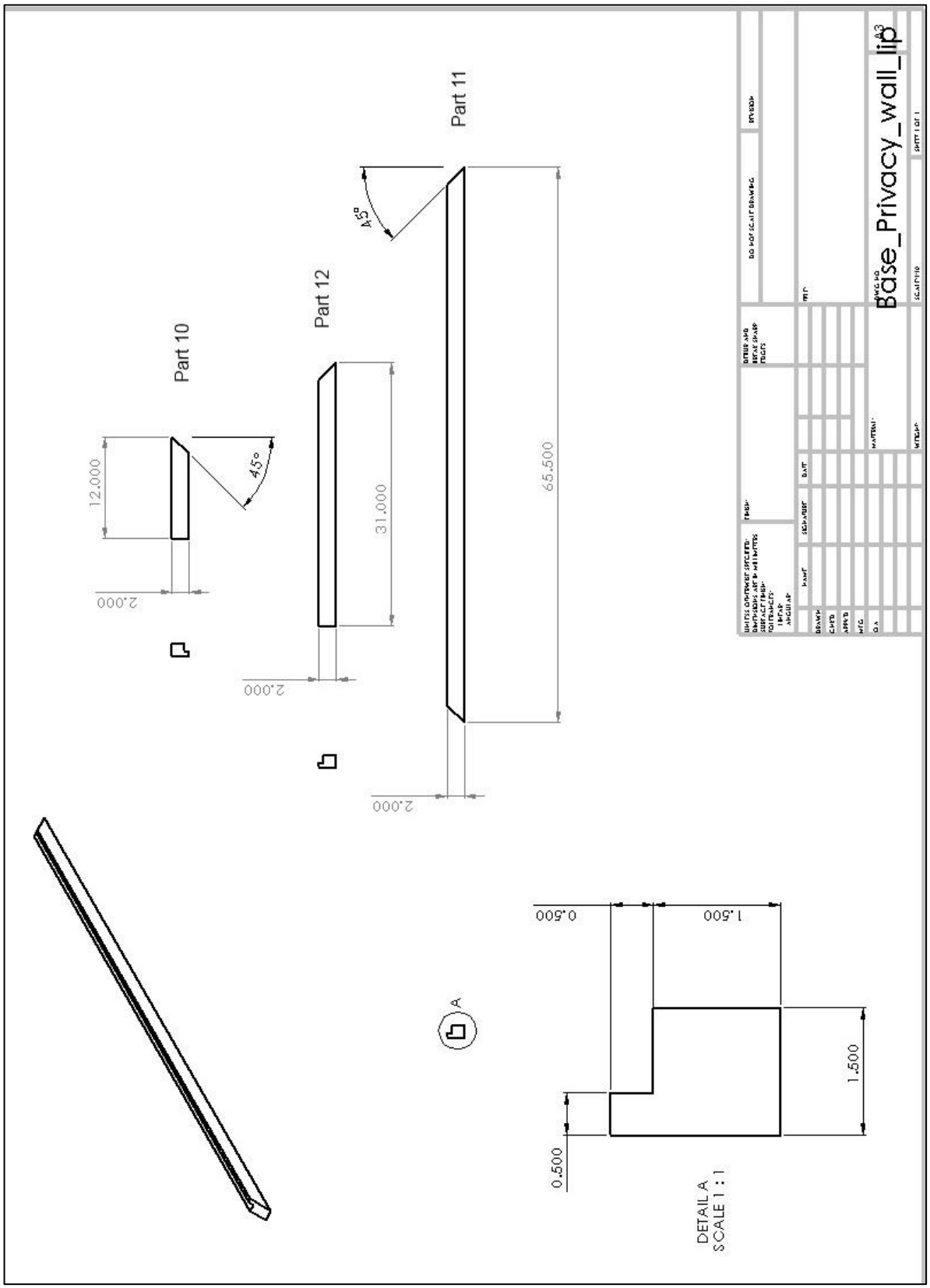


Figure A.12 – Parts 10-12 (*ref Fig A.1*)

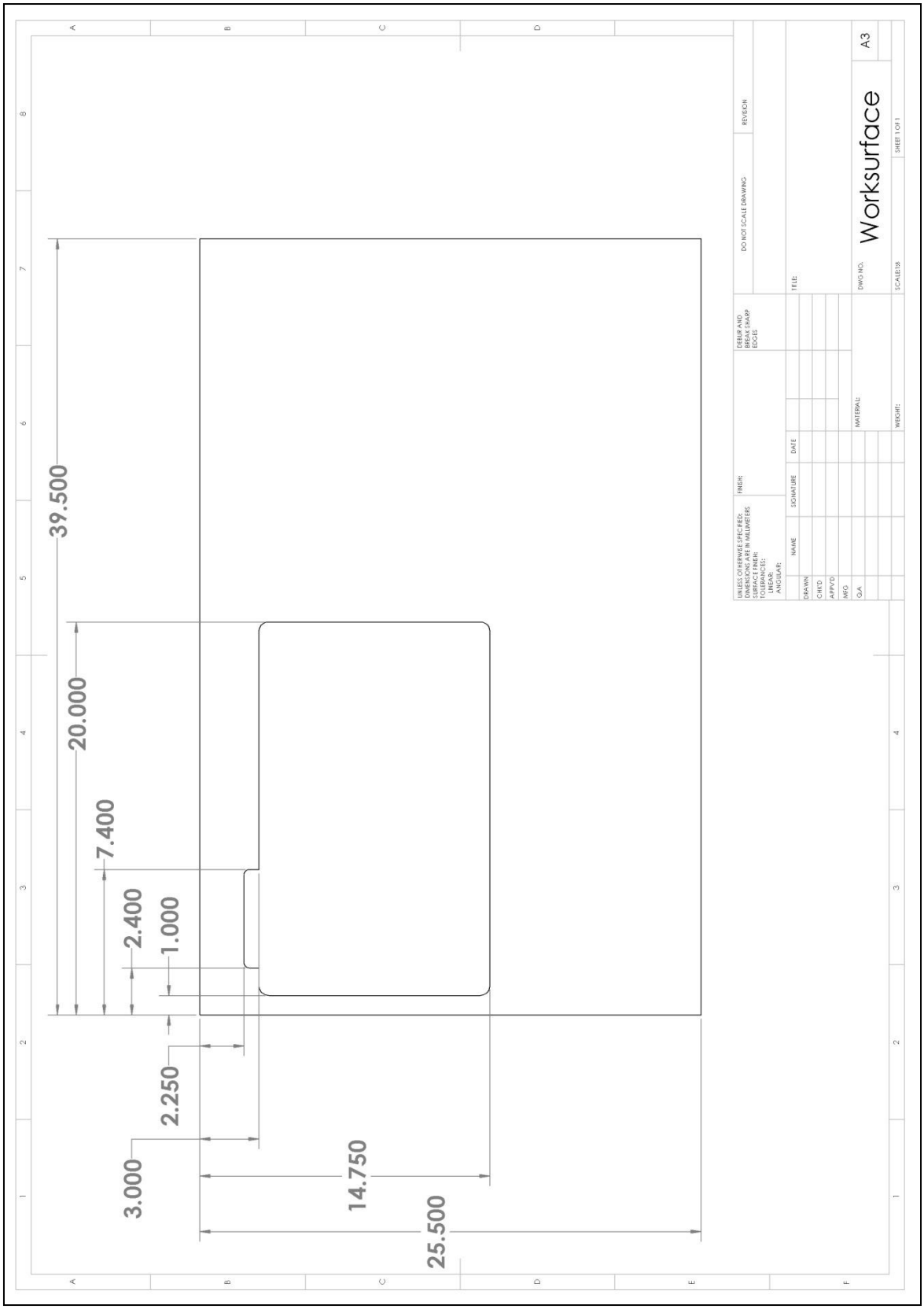
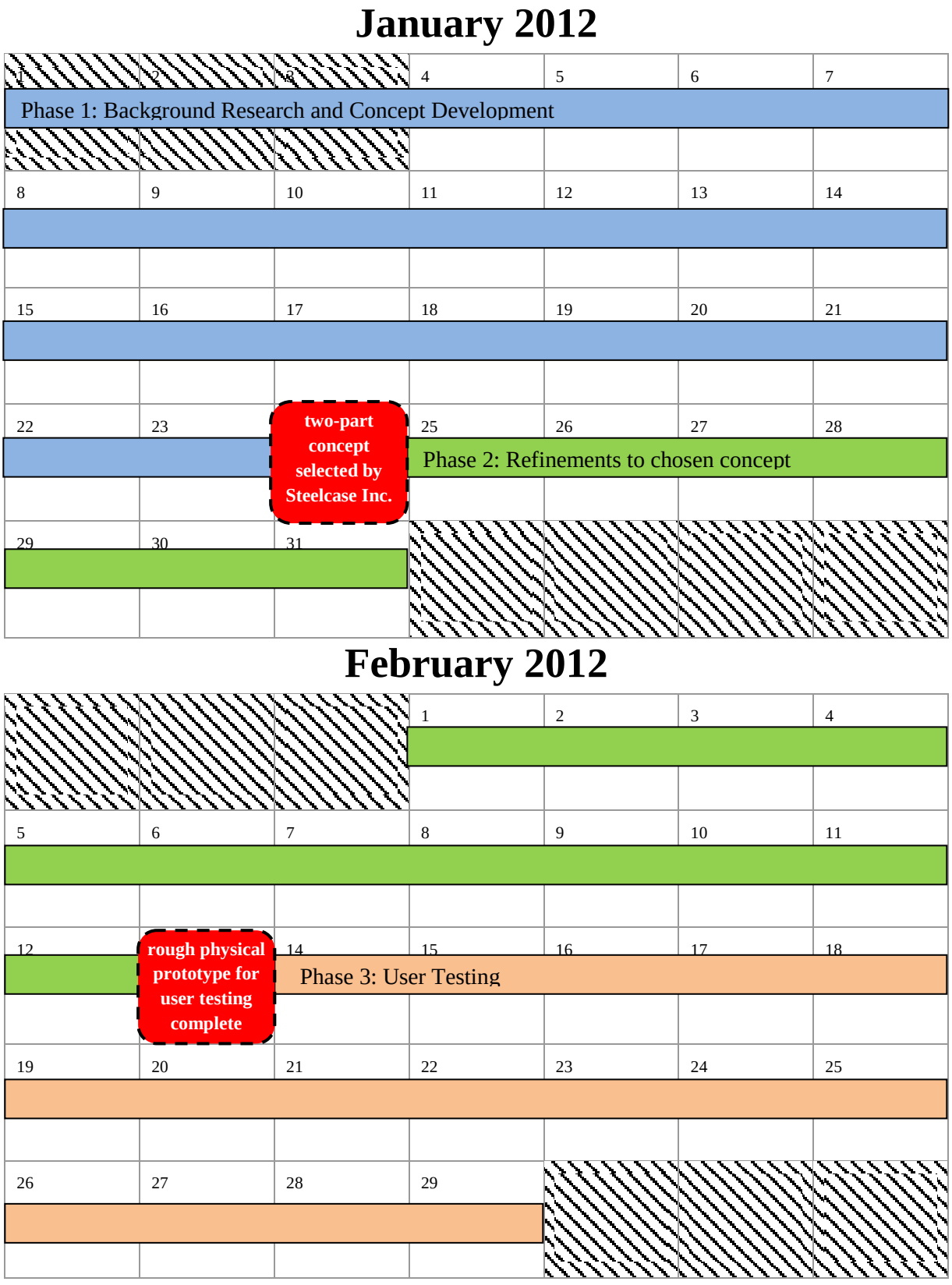


Figure A.13 – Custom worksurface for Airtouch

B. VISUAL TIMLELINE OF PROJECT



March 2012

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
SPRING BREAK						
18	19	20	21	22	23	24
Phase 4: Concept Additions						
25	26	27	28	29	30	31

April 2012

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
	Tilter mechanism complete		Monitor mount complete	Phase 5: Assembly of final prototype		
22	23	24	25	Final Prototype Complete	Capstone Conference	28
29	30					

C. FORCE ANALYSIS OF GAS PISTON

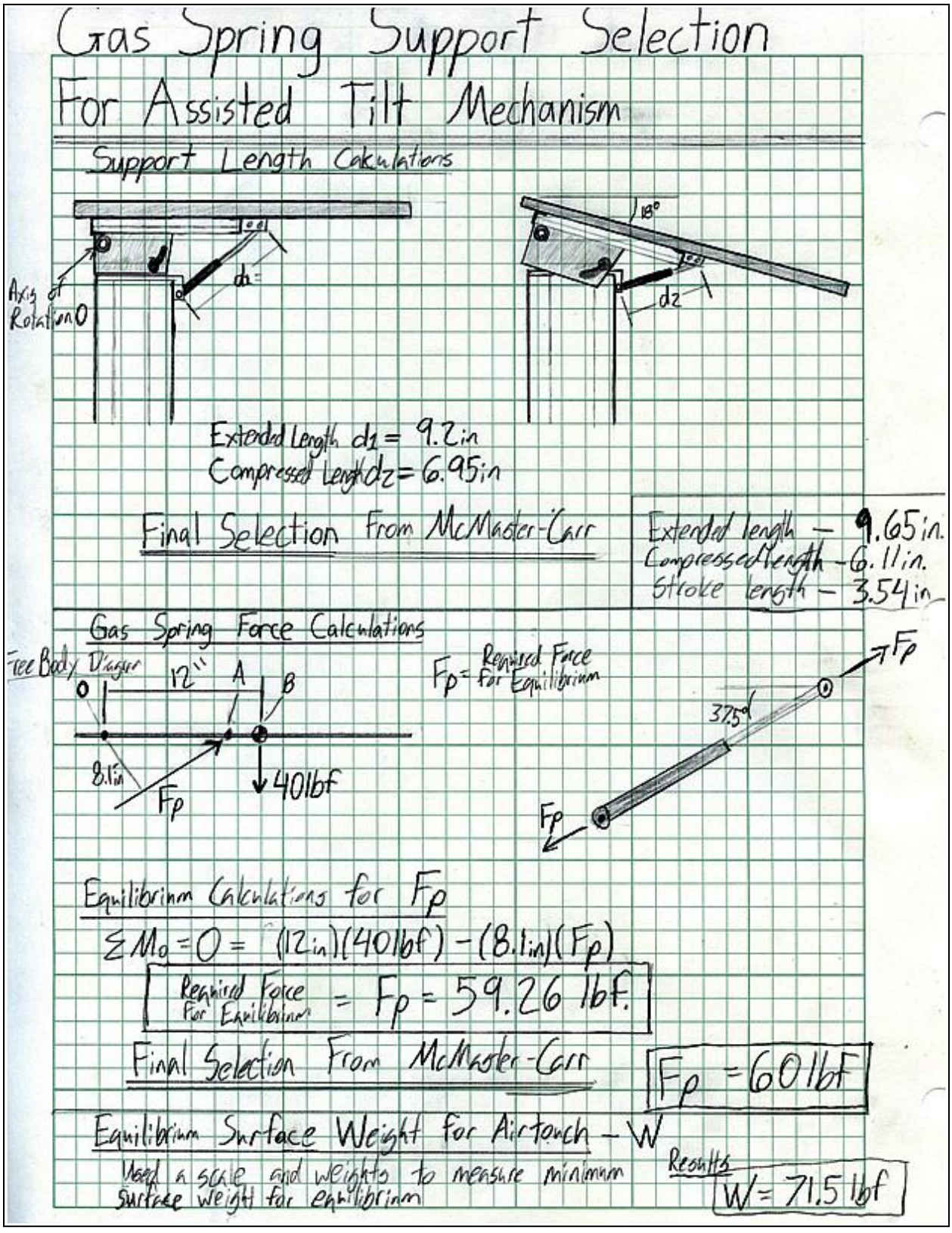


Figure A.14 – Hand calculations

D. RAW USER FEEDBACK

DISCLAIMER: The following constitutes the entirety of paraphrased responses collected during live user interviews with professors. The supplementary data is intended mainly to validate the summary of user feedback provided in the report. However, if one wishes to read the data and attempt to form their own opinion of what users were saying, they may do so, but should realize it is a subjective process.

[1]. ENGINEERING BUILDING, NAU

Interviewer: Adam Yoder

Professor John Tingerthal

Construction Management

1) I use lecterns in the middle-front of the classroom, so this thing would have to have that flexibility. I use a tablet pc to teach, so the lectern should have capability to provide power and AV connectivity
2) 5 = very important to tilt. Needs some sort of lip at the front to keep items from sliding off.
3) Detract – seems like it will get in the way.
4) Plenty, if not too much.
5) I would not use inlayed monitor unless it was a touch screen that used a stylus like a tablet pc. Note that in Rm 101, the original design was to have the monitors relatively flat, and this did not function for the users of the room. We ended up propping them up to make them useable. A flat screen like shown in your renderings is difficult to use unless you are sitting right over it – which doesn't occur much. Substantial tilt could remedy this problem. Monitor should be centered, and near the keyboard. Slide-out keyboards like you show usually end up too low to be used ergonomically when standing, and may get in the way if sitting. Recommend using one that can swing out and come up to the elevation of the table top.
6) 2 – would deter a little bit. Would need wheels.
7) Three smiles

Comments: to be universal, the sliding AV rack for IT access: is this intended just for service, or for use in the classroom (like document projector) if the latter, then needs to be more accessible.

Dr. John Tester

Mechanical Engineering

1) Would use the wireless screen almost the whole time and move to the center of the room
2) Tilting is extremely important
3) Keep the small sidewall for stability, possibly add a small ridge around the whole top
4) Yes
5) do NOT put the monitor dead center
6) Really wanted battery power for about 1 hour so that power wasn't lost in moving
7) No preference

Comments: create a "garage door" type opening on the base

Dr. Ernesto Penado

Mechanical Engineering

1) Would move the mobile portion to a preferred spot at the beginning of the lecture
2) N/A
3) N/A
4) Too large of a worksurface, size it down and the overall size is too big (base)
5) N/A
6) N/A
7) N/A

Dr. David Scott

Electrical Engineering

1) N/A
2) Watch that glare doesn't block the monitor
3) Keep the sidewall
4) The worksurface is a little too wide
5) The monitor must be easy to access for maintenance
6) Felt the retractable power cord would make it so nobody would move the lectern
7) N/A

Comments: Ensure the base is properly ventilated

Dr. Phil Mlsna

Electrical Engineering

1) Would leave the mobile portion docked
2) N/A
3) N/A
4) N/A
5) Lower corner preferred, if it was in the upper corner the monitor itself would have to tilt
6) Didn't like the UPS, wanted a retractable cord that was easily out of the way
7) N/A

Comments: make the plastic housing for the monitor tilt above the surface

Clint Baker

Engineering IT

(NOTE: general feedback, not answers to question set)

- UPS systems can be found for under $50
- the wireless components will be very lower power load
- Thin clients do not support multimedia well
- thinks passive ventilation of the base will be adequate
- There are digital switchers to detect and switch to a connected laptop, so dock the laptop on the base and use the wireless components to control the laptop

- route all USB and necessary computer connections to the surface and seal the base
- look into installing J.A.W.S on the PC so visually impaired users can use the wireless station
- wirelessly controlling the room could be done but isn't in the scope of our project

Professor Bryan Cooperrider

Mechanical Engineering

(NOTE: general feedback, not answers to question set)

- Ensure that the base could be flipped onto the other side of the lectern
- liked the idea of charging the base in a docked position (have it click in)

Professor Marti Blad

Environmental Engineering

1) May change the way she teaches given that the computer would be mobile
2) Five, very important to tilt
3) wanted the sidewall gone
4) fine
5) no preference
6) N/A
7) N/A

Comments: wanted a small clicker feature

Dr. Brent Nelson

Mechanical Engineering

(NOTE: general feedback, not answers to question set)

- would not use the lectern because he writes on the board and gestures
- maybe make a track on the floor for the power cord
- keep the VGA plug-in on the mobile lectern

Interviewer: Kevin Clark

Professor Alarik Reiboldt

Civil Engineering

1) Would like to move the lectern around with him
2) Would like to be able to pull the monitor out of the inlaid position so it sits up in a normal position. While up glass lays flat to write on. This opens more surface area and more natural viewing angle.
3) Would have to use it, but no initial objections
4) Work surface is a good size, 2 sheets of paper tall
5) See #2
6) Power cord could be an issue if you have to plug it in every time you move.
7) Would like integrated doc cam.

Unrecorded name

Speciality N/A

1) May use it to move short distances
2) Yes
3) Like it side wall, adds additional privacy and not in the way
4) Good size work surface
5) Not picky, enough room for paper
6) As long as plug ins are available, cord wouldn't be too much of an issue.
7) Not an issue as long as electronics work

Professor Kathleen Viskocil

Civil Engineering

1) Would move around, show parts/props to students
2) Would be nice to get a good angle while surface is flat for paper
3) Not an issue, like it for privacy
4) Good work surface size
5) Top Right
6) 2.5, don't like tripping over cords/unplugging them
7) Looks good

Interviewer: Robin Schwartz

Dr. Constantin Ciocanel

Mechanical Engineering

1) Monitor needs to be able to fold up. Preferable up to 90 degrees so monitor is easy to read
2) Value of 5. It is very important, must have.
3) Value of 1. No use for my teaching style.
4) Value of 2. For display.
5) Middle looks good and most universal.
6) Wouldn't affect but would still use.
7) Not many smiles.

Comment: Make the work surface/base much smaller.

Phillip Heasley

Technical Writing Consultant

1) Height adjustability is key. Would not pull it out very often.
2) Value of 5. Very important to him. Desk seems great for spreading out papers.
3) Value of 3.
4) Value of 5. Enough space.
5) Cut front of desk off. Make it a little smaller, maybe paper size width.
6) Value of 1. Not that big of a deal.
7) Value of 3. Depends on size of the room.

Comment: Have the mouse move on top surface not below.

Dr. Robin Tuchscherer

Civil Engineering

1) Don't use lectern now so wouldn't use it if I had one.
2) Value of .1. Not that important to me.
3) Seems good to have to define the docking space.
4) Yes, enough space.
5) Have the computer under a clear plastic surface. Needs multiple adapters for different utilities. Touch screen could also be something that could be used.
6) Value of 2. A cord could deter me from moving the lectern around the room. Battery option seems to be the way to go.
7) Value of 4. I like it and really like the wireless capabilities if they work.

Professor Eckehard Doerry

Computer Science

1) The lectern is nice, allows me to move freely...like that. Also like how I could potentially sit at the desk while an exam was going on.
2) Never tilt this...makes papers slide off.
3) Could get busted off completely. Do not use the privacy wall. Teachers need to be more involved with the classroom. A curtain on the lectern part might be a better alternative. Move desk surface another inch towards us.
4) Make the monitor have a slight tilt. Do not lay monitor flat. The placement of screen seems good now. It is out of the way of the writing surface.
5) Need a little more toe space...So move the base further back.
6) Give it 4 smiles...Nice idea.

Professor Perry Wood

Mechanical Engineering

Comments: Should work with Mac's. Doesn't like the desk portion. Nice dimensions for the moving lectern portion

Interviewer: Eric Neisen

Dr. Heidi Feigenbaum

M.E. Assistant Professor

1) Doesn't see herself moving mobile portion around the room. Typically just holds needed notes in her hand.
2) Only needs screen to slant. Tilt adjustment not important.
3) No not important, but likes docking feature.
4) Width for 1 open notebook and 1 open textbook
5) Upper left for right handed people. Feels monitor on mobile portion is somewhat unnecessary but wants monitor on the base that is always on.
6) Would not like to have to plug in mobile portion each time it is used.
7) Three smiles

Comments: Wants reliability not necessarily more features. Just what ever features there are they need to be reliable.

Professor Stephen Mead

Construction Management

1) Mainly as a place to set stuff down on. Possibly use the computer every once in a while. Also wants file folders for homework in and outboxes. Ability to show PowerPoint, but mainly lectures with problem based board problems.
2) Needs to tilt to see monitor.
3) No not important.
4) Yes just need monitor plus space for one open notebook or textbook.
5) Upper left
6) Would not like to have to plug in mobile portion each time it is used.
7) Three smiles

Comments: Tablet accessibility (on mobile or completely wireless). Would rather have tablet than computer. Research Carl Weiman who says professor must be higher than students.

[2]. FORESTRY BUILDING, NAU

After conduction interviews in the Engineering Building the question set was updated to address some new issues, or restate an issue in a different way.

Modified Question Set

1. *Describe your teaching style. How would you envision yourself interacting with this product?*
2. *A flatscreen monitor may be inlayed into the lectern under a clear material. Where would you prefer the monitor be located?*
3. *The lectern is already height adjustable. How important is it for the lectern work surface to also be tilt adjustable? [not at all] 0 - 5 [very]*
4. *Does the small sidewall on the left of the base portion detract or add to the usability of the docking feature?*
5. *Do the dimensions of the mobile surface (40x22¼ in.) provide enough work space?*
6. *Laptop/tablet connectivity will be included. Where should the plug-in be? (cabinet or mobile lectern)*
7. *The mobile lectern could be powered (1) by a retractable cord, or (2) for 2-3 hours by a rechargeable battery. Which would you prefer and how strong is your preference?*

Interviewer: Kevin Clark

Mark Sensibaugh

Forestry

1) Would bring it around if whiteboard/screen are in different locations
2) Room for paper is good
3) Nit an issue
4) Privacy wall is good and side wall is not an issue
5) Could even be a little smaller
6) Laptop connectivity on base

7) Battery is better, people could remember. Or have a second one charging to swap if it dies

Comment: Some rooms already have AV equipment built into walls/ceiling

Mike Stoddard

Forestry

1) Small classrooms may not support base for size
2) Prefer monitor vertical and centered
3) 5 – multipurpose desk/podium with tilt
4) Maybe too much cubicle feel
5) Good depth, and good width
6) On back side or underneath mobile lecturn
7) Retractable power cord, batteries die and stop holding charge

Amy Waltz

Forestry

1) Would bring notes with her. Want a mic in big rooms
2) Like the idea of monitor, no preference on location
3) Like surface tilt adjust, especially for formal presentations
4) Sidewall is fine, like privacy wall
5) Definitely big enough
6) Connectivity on base, no need to keep laptop on mobile desk
7) Batteries can die but it won't kill computer so only minor problem

Interviewer: Robin Schwartz

Wendy

Forestry

1) Looks good- I like standing- also like the computer inlay. It is important not to obstruct the view of the class.
2) Hard to say … Although it seems okay to me
3) Depends on the questions but value of 3.5.
4) Value of 1.
5) Depends on the department but it is good.
6) Down column and out the back. Keep it out of the way. Chargeable battery is good.
7) Both options would be nice to have.

Walker

Forestry

1) Flat screen is very nice. Good that is is inlayed. Cool it allows students to see you.
2) Corner/middle is enough space to place things on.
3) Value of zero.
4) Doesn't matter
5) Yes = plenty of space.
6) Go through base.

7) Battery would be preferred. 2-3 hours would be plenty. Make the plug easy to access/magnet would be nice.

Mike

Forestry

1) I like surface and it being mobile. Desk looks good although a little big. Nice that there is space underneath.
2) Prefer monitor upright at 90 degrees rather than being flush. Would probably place it center of the desk.
3) Value of 5. Multipurpose is good to have with different desk.
4) Would make teaching more difficult.
5) Good space.
6) Closer to the back. Don't take away from surface, short distance for cable, possibly a short wire dangling.
7) Batter would not be a good choice. Definitely prefer a retractable cord.

Erin Saunders

Forestry

1) Hands off. Power point so would not move around the room very much. Mainly use would be power point.
2) Make it central.
3) Slight downward slant so no glare. Value of 3.
4) No, doesn't bother me or detract from the use of the product.
5) Provides enough work space.
6) Top rite hand corner.
7) Battery is good for mobility.

[3]. SOCIAL AND BEHAVIORIAL SCIENCES, NAU

Interviewer: Robin Schwartz

Glen Phillips

Social and Behavioral Sciences

1) no wires connected.
2) Like mobility of the desk.
3) don't like tripping.
4) light weight have all media in one space.
5) Better clickers would make it easier for powerpoint.
6) have controls wireless. Switch to charge each operation of room controls.

Unknown

Social and Behavioral Sciences

1) Good for walking around.

2) Enough room for papers (good)
3) Value of 3. Semi important.
4) Just fine...Lectern fits the desk portion (good)
5) Yes - enough work space.
6) Have it on one side.
7) Battery would be better. The cord would be annoying.

Unknown

Social and Behavioral Sciences

1) Traditional/Talk from front of room. Use powerpoint, do group work, maybe go around the room.
2) Something to corner screen.
3) Tilt is value of 2.
4) Could pinch finger maybe.
5) Surface good.
6) Lower maintenance would be the best, something that won't die though.
7) open book/notebook. Could be good for big class with multiple teachers

Unknown

Social and Behavioral Sciences

1) Walk around to turn on controls so nice if it is in one spot.
2) Corner would work.
3) Tilt importance of value 1.
4) No opinion could be difficult from the side.
5) Enough.
6) On the desk part not the lectern.
7) Hate batteries, not good if no-one will plug it in . So don't do that.

[4]. BUISNESS, HISTORY, & PHYSICS, NAU

Interviewer: Eric Neisen

Dr. James N. Morgan

Computer Information Systems

1) Teaches with Powerpoint, doc camera, and student group work.
2) Likes monitor in the upper right hand corner of the surface.
3) 3 Tilt is a nice feature, but probably wouldn't use it.
4) No preference.
5) 3 feet wide same depth.
6) Laptop connectivity not so important to him but he acknowledges others would like it.
7) UPS. Power cord makes mobile pointless.

Comments: He would like to be able to roll the mobile to the back of the classroom for student presentations, and still be able to control the computer.

Dr. Ronald Gunderson

Economics

1) Traditional lecture(writing on the board), doc camera, PowerPoint, and class discussion.
2) Would prefer monitor on right, even though he is right handed.
3) 1, Tilt not very important, but he liked the airtouch.
4) Yes the back and side wall add a sense of a single piece of furniture.
5) Slightly smaller than current surface.
6) Laptop connectivity from base that you can access on the mobile would be enjoyable.
7) UPS battery preferred or both for ultimate usability.

Comments: Thinks he would use the mobility feature to change up his position around the room. Base too big.

Tracy Haney

Director of Career Development

(Note: Doesn't teach but she schedules and accommodates speakers and presenters at Franke that do use the lecterns there.)

1) No preference
2) 5 Tilt very important. Could NOT over emphasize the importance. Even hungry children in Africa would ask tilt.
3) Likes back and side wall. "Less messy"
4) 32 inches wide. Currently seems too big.
5) "Laptop and tablet connectivity becoming more and more important."
6) Preferred battery, but is worried people using the lectern would plug it back in.

Comments: Current overall size of base+mobile is too big, at least for some rooms.

Dr. Ding Du

Economics

1) Teaches with PowerPoint.
2) Likes the wireless monitor. Preferred placement on the left hand side.
3) Does not want tilt.
4) No side/back wall on base portion. Likes freedom to move around and not bump into things
5) Slightly smaller surface.
6) No need for laptop connection.
7) Wouldn't mind an extension cord to power the mobile portion, but a wireless battery would be nice.

Dr. Gavin Zhang

Assistant Professor, CIS

1) Mostly teaches with PowerPoint and class discussion.
2) Monitor placement in the top left.
3) Must tilt

4) Preference to keeping the sidewall.
5) Size perfect
6) Laptop/Ipad connectivity necessary.
7) "Wireless all the way"

Comments: Recommended "Docri", a program to connect wireless a Ipad and a computer.

Dr. Erik Nielsen

Physics

1) Mostly traditional lectures but needs a computer.
2) Would like a rather small monitor (>13in.) in the upper left. So close the monitor doesn't need to be big.
3) Yes tilt adjustment from 0 to 30 degrees.
4) Sidewall yes docking.
5) Work surface ~ a textbook and a piece of paper width.
6) Laptop connectivity not important.
7) 50/50 on battery. Would be nice but worried about issues with it. "Lecterns must be reliable when standing in front of 80 students."

Interviewer: Adam Yoder

Jenny Staskey

Accounting

1) uses a doc cam almost every class, needs it
2) one side, not in the center
3) Five, the surface must tilt
4) remove the sidewall
5) N/A
6) N/A
7) wanted the retractable cord over the battery feature

Comments: security of the mobile portion itself may be an issue and keep the overall base height down below typical whiteboards so it doesn't block student view

Dr. Leisl Carr-Childers

History

She would move it to the center of the room but not stand behind it, and would have to be able to use her IPAD. Might also use the desk feature during showing documentaries

Eric Meek

History

1) Teaches with both PPT and on board lectures, but noted that he DOES NOT like the brand new lecterns that are immobile in the history rooms. Wouldn't sit at the desk
2) Up in the corner for the monitor
3) N/A

4) N/A
5) N/A
6) N/A
7) Didn't want the battery function unless it was whole day

[5]. HIGH SCHOOL TEACHERS

To test the feasibility of the product in a high school teaching setting, the team conducted interviews among 14 high-school teachers. The responses are kept anonymous for this report. The question set was again modified to best apply to teaching issues in high school classrooms.

Modified Questions for High School

1) *Describe your teaching style. How would you envision yourself interacting with this product?*
2) *If there were additional cubbies for food/drink, papers, and appliances would you use them?*
3) *Would the inlaid monitor be accessible? Would it be necessary for it to be able to sit vertically?*
4) *Do the dimensions of the mobile surface (40x22.25 in.) provide enough work space?*
5) *Laptop/tablet connectivity will be included. Where should the plug in be? (cabinet or mobile lectern)*
6) *The mobile lectern could be powered (1) by a retractable cord, or (2) by a rechargeable battery (that charges when docked). Which would you prefer and how strong is your preference?*

Interviewers: Robin Schwartz & Kevin Clark

Respondent 1

1) Walk around the room
2) Yes
3) Sit vertically
4) Yes
5) Laptop yes – included on Mobile lectern
6) Retractable cord = rechargeable battery dock

Respondent 2

1) Using it to show students, how to use software programs and student presentations
2) Yes
3) Vertically and lay flat
4) Maybe a little bigger (45x30)
5) Make it wireless
6) Cost: Retractable cord, Best: battery powered – must think about cost to replace batteries

Respondent 3

1) Would love organized space to house everything
2) Cup holder + drawer for stuff would be good

3) Don't know how well I could see/use inlaid monitor, I'd have to try it
4) Work space looks food
5) Both
6) Rechargeable battery

Respondent 4

1) Consider recycled materials for final product
2) Consider ways to accommodate hearing impaired
3) Monitor closer to person – middle center
4) Chris Lanterman (College of Ed) may have feedback – he is blind and and has written/lectures about universal design

Respondent 5

1) I love using my projector & doc cam and have found it difficult to manipulate the doc cam while sitting next to it
2) Yes – area for small items
3) Monitor should be in middle of desk
4) Unsure
5) ?
6) Fewer cords please

Respondent 6

1) I would use this for power points and would need it to connect to the overhead as to watch videos at a class
2) Yes on cubbies, I use lots of notes, paper and places for food and drink wouldn't hurt
3) Inlaid monitor would be great as long as it can move up and down and tilt
4) Yes, it is enough space
5) ?
6) Retractable cord

Respondent 7

1) Seems complicated but useful
2) Yes
3) Yes, the monitor should tilt of move around
4) Yes
5) On the main desk I would think
6) No cords! They get in the way of everything

Respondent 8

1) Lecture w/ interactive class discussion. Use technology
2) Not really
3) It could be harder to use

Respondent 9

1) I like the idea of the lectern being mobile
2) I dislike the notion of using it for food storage, but a space for papers or folders is a great idea
3) I wonder if having a place to plug in a laptop on the podium might be more useful than having an in-laid monitor. With inlaid monitor though, tilt adjusting is highly important.
4) If there's enough space for an open textbook next to an 8.5x11 paper, it should be fine
5) Keep in mind ease of accessing electronics for addressing problems
6) Not considering cost, a rechargeable battery seems more practical. Could it use both?

Respondent 10

1) I move around all the time…so…this portable/movable station would be wonderful!
2) Yes.
3) Would help – place monitor directly in front if it will be protected.
4) Yes.
5) Cabinet-
6) Battery-for safety-cords are a definite safety issue.

Respondent 11

1) Using the tech aspects (doc cam, cpu etc…)
2) I would use cubbies.
3) The more space the better.
4) The plug in should be in a place where the computer can sit on the table top.
5) Chargeable battery for mobility issues.

Respondent 12

1) Active teaching style! Students must be able to us it as well.
2) Yes!
3) Yes it should be detachable.
4) No, I feel it should be bigger!
5) The plug in should be movable.
6) Once things are bought there are never funds to replace things like batteries, so , cords!

Respondent 13

1) My teaching style is visual and I roam around the classroom.
2) Yes. It would be helpful for supplies.
3) It should be accessible because in a typical classroom it can be shared by others.
4) The dimensions are fine.
5) All types of electronic devices need to be accessible but also should be used in caries places. I'm stuck with a document camera and projector in a specific place, while other devices can be moved around.
6) It should be powered by a retractable cord.

Respondent 14

1) I like the location of the monitor and the fact that it can be flat with the surfaces around it, but I would like to see it also be able to tilt at the teacher's discretion.

2) I really like the movable lectern on wheels and the wireless component.
3) I move around my classroom, rarely sit, and frequently rearrange student seating into different formations to facilitate our activities for the day. I love the wireless capability and being able to move the lectern to different locations in the room.
4) I would prefer to keep my "stuff" in my desk, not in the lectern set-up. However, if there was no desk, I would appreciate a drawer to throw my keys into. Food and drink don't belong in use at the same time as the lectern. Don't facilitate that.
5) The dimensions sound okay.