

To: Dr. Oman

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Subject: Implementation Memo II

Team 19F05 was tasked with designing and manufacturing a portable medical bench to be used by Dr. Becker and his team. The bench will be used in the Wettaw building on campus for experiments in conjunction with Dr. Becker's company, Aneuvias Tech. These experiments aim to improve human health care through aneurysm treatment. Dr. Becker wanted the bench to be compatible with the instruments used in the experiments and to simplify the set-up process. Since the last implementation memo, the team has made some changes and improvements to the design. The wheels, frame, and tabletop are now complete. The wheels were ordered and attached to the frame. The steel for the frame was received and welded together by the team. The tabletop was finished by the manufacturer and received by the team. Moving forward the team needs to assemble the bench.

1 Implementation – Weeks 7-11

In the recent weeks, the team has made an abundance of progress towards the completion of the bench. The components of the bench have been completed. Getting the wedges manufactured and then assembling the bench is all that is to be completed. For the wheels, the team ordered to the specifications that Dr. Becker desired. The steel for the frame was ordered and welded by the team. The manufacturing for the tabletop has been completed and picked up by the team. The only major design changes made by the team came in the frame. The frame material had to be changed due to high costs of stainless steel. Also, the team intended to send out the frame to be welded but ran into budget constraints, so the welding was done in house. Also, the supports for the filter were made smaller to decrease total bench weight.

1.1 Manufacturing

1.1.1 Tabletop

Dr. Becker required the tabletop to be x-ray compatible and spill-preventing. The team decided to use a manufacturer for its completion. The team got in contact with the company *Only Table Tops*. The team gave the dimensions of the table and selected the material. The team decided to have the tabletop be made of Wilsonart in order to be x-ray compatible. The team also had the sides of the table rounded as per client preference. The tabletop was recently completed and received by the team. Analysis was carried out in excel in order to verify that the tabletop could support the loads it would be carried.

1.1.2 Frame

The frame's design has been slightly altered from last semester. The supports made to hold the filter have been made smaller to decrease the weight. The team wanted to use stainless steel but due to high cost could not do so. The steel needed to make the frame was ordered and received by the team. The team welded the pieces together to make the frame. The wheels were attached to the frame. Analysis was performed in excel and solidworks to make sure that the frame could hold the loads it would be carrying, and for estimating the total weight of the frame, as the team wanted to keep the frame as light as possible without compromising strength.

1.1.3 Storage

The design of the storage has not been changed much since last semester. The storage was intended for equipment needed by Dr. Becker and his team during experiments. The team altered the dimensions slightly in order to fit the devices. The team purchased the wood needed at a hardware store and built the storage on their own using a table saw and nails. The storage has been assembled. Dr. Becker requested that the storage not be attached to the frame and that the storage be black to match the tabletop. Analysis was carried out in excel to make sure that the storage would be strong enough to hold the medical devices stored within it.

1.1.4 Wheels

The wheels were chosen by Dr. Beker. He wanted wheels that would reduce the shock of transport and have two of the wheels be locking. The wheels were ordered and have now been received by the team. The wheels have since been attached to the frame. Analysis was performed in excel to make sure that the correct grade of bolts were selected for the wheels to be attached to the frame.

1.1.5 Tabletop Wedges

The wedges have been designed and material was ordered in order to manufacture these wedges with a CNC plasma cutter. These have since been put on hold and at the moment, the team is unsure if they will be made. The team decided to go with steel material in order to make them durable.

1.2 Design Changes -Weeks 7-11

The following will show some of the design changes made by the team for the tabletop, frame, and storage.

1.2.1 Design Iteration 1: Change in Tabletop discussion

For the tabletop, the design changed from square edges to rounded edges at the request of the client. This is to eliminate sharp edges. The client also specified a color of black and that change was made.



Figure 1: Tabletop preliminary design.

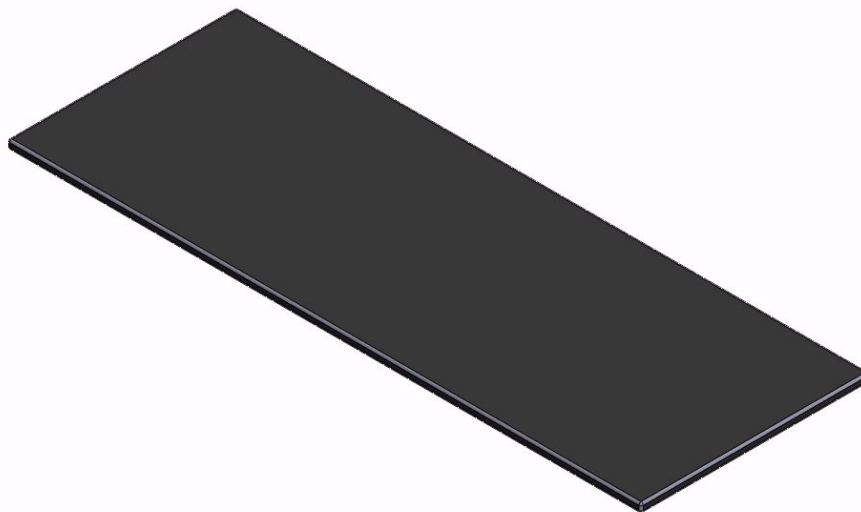


Figure 2: Tabletop final design.

1.2.2 Design Iteration 2: Change in Frame discussion

For the frame, the design changed from stainless steel to low carbon steel in order to save money. The team also added structural components to the frame after analysis in SolidWorks. Also, the shelves were reduced in size due to overdesign and weight concerns. Lastly, a frame component on the bottom was moved slightly in order to be able to weld a plate for bolting the wheels to the frame and fit the bolts. Those changes will be reflected below.

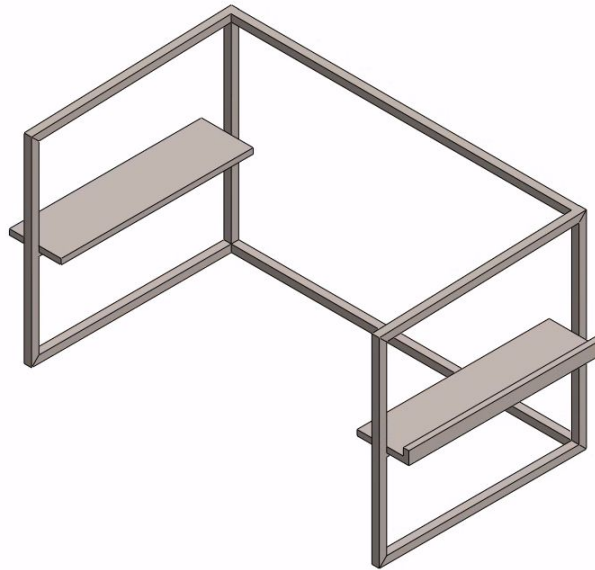


Figure 3: Frame Preliminary Design

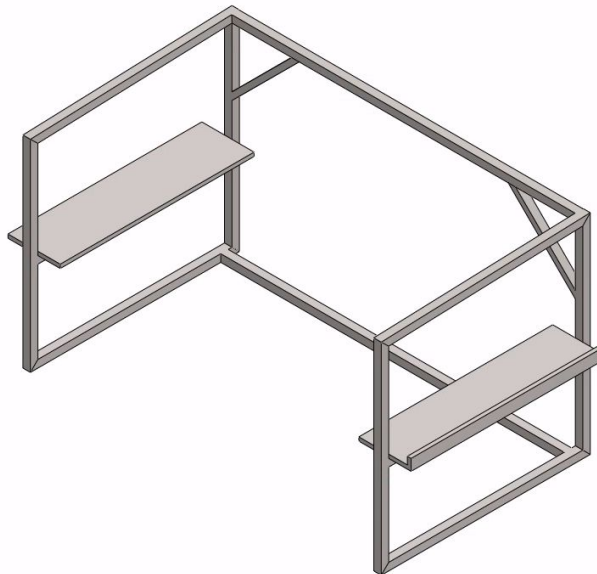


Figure 4: Frame Final Design

1.2.3 Design Iteration 1: Change in Storage discussion

The storage design originally had 1" thick wood but was changed to 0.5" wood for practical and cost reasons. This was analyzed with excel to ensure that 0.5" would be strong enough. The drawer slides were omitted because of the drawer being so small. Also, the hardware was changed from a handle to a simple knob. These changes were reflected below.

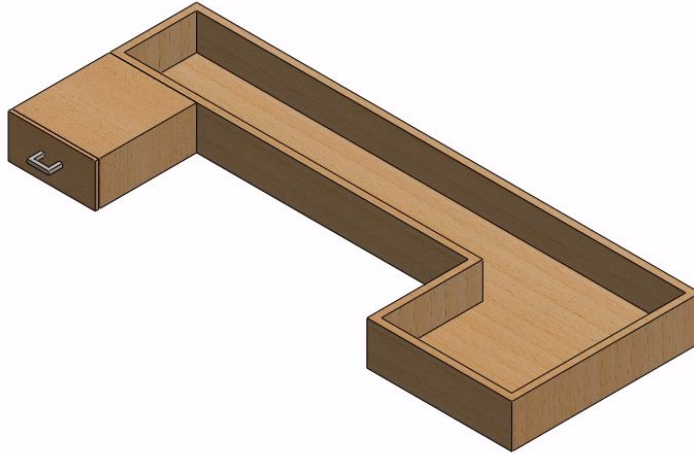


Figure 5: Storage Preliminary Design

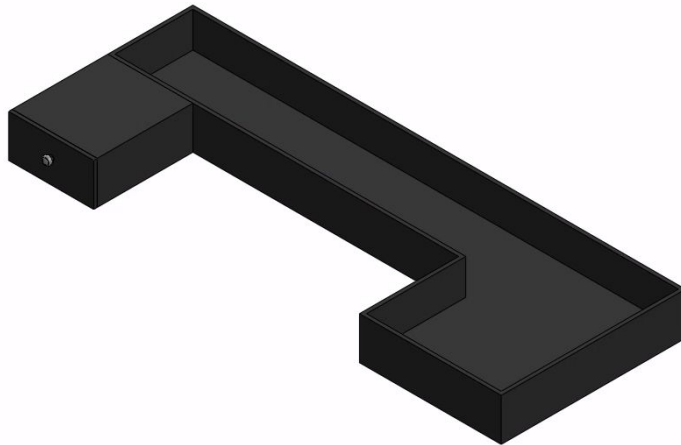


Figure 6: Storage Final Design

2 Standards, Codes, and Regulations

The following table represents standards of practice and codes that have applied to the design of the portable bench. These standards affect the project in general by guiding in the design of certain components. The tabletop had to be carefully designed in order to be sent out to a manufacturer so that the team received the product that we thought we were.

2.1 Standards applied to project

<u>Standard Number or Code</u>	<u>Title of Standard</u>	<u>How it applied to Project</u>
ASNI/AAMI HE 74:2001	Human Factors Design Process for Medical Devices	Helped in the design of how the device interfaces with the user in a safe manner.
ASME Y14.5-2009	Dimensioning and Tolerancing	Helps with making drawings of parts to be manufactured with GD&T specifications for manufacturing. Manufacturing of the tabletop required GD&T.
ASCE 37-02	Design Loads on Structures	Provides guidance on designing for loads on top of the tabletop, mainly the cleanroom hood and medical devices being stored on top.
ASCE 7-05	Minimum Design Loads on Structures	Shows minimum design loads for structures including floors, which will be modeled with the tabletop.

3 Risk Analysis and Mitigation

In Table 2, *S* is Severity, *O* is Occurrence, *D* is Detection, and *RPM* is Risk Priority Number. In Semester 1, three subsystems were analyzed for potential failure in the design. These subsystems are the tabletop, storage, and wheels design. Within the tabletop design, the raised platform, drainage, and zip tie concepts were considered. The storage design included the U-shape and drawer concepts. The wheels design considered the polyurethane concept. The ranking system was based on a 1-9 numerical scale. The scaling was evaluated by 1-2 being considered very low occurrence, 3-4 slightly likely, 4-5 likely, 6-7 above average, and 8-9 very concerning. The following sections discuss each potential critical failure.

3.1 Potential Failures Identified Fall Semester

Part	Failure	Effects	S	Cause	O	Test	D	RPN	Recommendation
Wheels	Corrosive Wear	No Transport	9	Over Stressing	5	Wear	5	225	Material
Spill Guard	Chemical Spill	Spills	7	Maintenance	7	Chemical	5	245	Material
Zip Ties	Deformation	Devices loose	8	Over Stressing	7	Stress	6	336	Thickness
Drainage	Chemical Spill	No waste disposal	7	Chemical Wear	6	Chemical	5	210	Material
U-shape	Impact wear	Broken Storage	6	Impact Loading	6	Impact	6	216	Cushion
Drawers	Impact wear	No Storage	6	Impact Loading	6	Impact	6	216	Cushion
Bolts	Breaking	No Transport	9	Strength	5	Strength	5	225	Choice
Wedges	Unbalance	Derailment	8	Unbalance	7	Stress	5	280	Clamps
Gutter Tray	Detachment	Spill/weakness	7	Loose Clamps	8	Strength	5	280	Clamps
Handle	Detachment	Table Falling	9	Shear	5	Strength	5	225	Strength

3.2 Potential Failures Identified Fall Semester

Potential Critical Failure 1: Polyurethane Wheel→Flat-Free Rubber Tire

The polyurethane wheel was introduced through client suggestions. It was introduced due to it having a non-flat design. The potential failure of the tire was determined to be corrosive wear. The potential effects of this failure include not being able to transport the bench. The severity of this potential failure was ranked a 9. This failure was mitigated by reconsidering the tire to instead be a flat-free rubber-treaded tire chosen by Dr. Becker. The new chosen tires are replaceable if they do fail. Additionally, they are rated to support 250lbs each. A new risk has been introduced, discussed as Potential Critical Failure 11.

Potential Critical Failure 2: Raised Platform→Spill Guards

The raised platform concept was designed to prevent spills. The potential failure occurs from direct chemical attack. The potential effect of failure would have spills occurring. The severity of this occurring was ranked as a 7. This failure was mitigated through proper material selection, steel, of the wedges that provide spill protection. It is compatible with the chemicals used in sanitation. Proper material of the tabletop was also chosen to be compatible with the chemicals. A new risk has been introduced, discussed as Potential Critical Failure 12.

Potential Critical Failure 3: Zip Ties

The zip tie concept was designed to secure the medical devices on the tabletop. The potential failure occurs from deformation wear of the zip ties rubbing against the tabletop material. The effects of this failure include the devices not held in place. The severity of this failure was ranked as an 8. These failure effects were mitigated by providing storage for most of the devices during transportation, including the air filter. The failure effects not mitigated are that the devices' wires may not be secure, but zip ties can be replaced. The current state of Zip Ties is that the tabletop will not have access to any of the devices before the semester's end, so the team cannot secure the devices' wires. The Zip Ties as provided by the team are cancelled, but can easily be added to the bench by a lab assistant. No new risk was introduced.

Potential Critical Failure 4: Drainage

The potential failure occurs from direct chemical attack. The effect of this failure is an improper disposal of waste. The severity of this failure was ranked as a 7. This failure was mitigated through proper material selection and through a gutter tray system. This system will not be completed by the team, but can be manufactured in the future by the client or a lab assistant. It could be easily attached through clamps to the tabletop. A new risk has been introduced, discussed as Potential Critical Failure 13.

Potential Critical Failure 5: U-Shape

The potential failure occurs from impact wear. The effect of failure is lack of use of storage. The severity was ranked a 6. This failure was mitigated by increasing the support of the storage by the frame to strengthen the storage base. The storage is also removable, in case it needs to be replaced due to damage. No new risk was introduced.

Potential Critical Failure 6: Drawers

The drawer concept was introduced to maximize space for storage without taking away space for the medical devices being stored under the tabletop. The potential failure occurs from impact wear. The effects of this failure are lack of use of storage. The severity of this failure was ranked a 6. The failure was mitigated by embedding the drawer into the storage area to reinforce its strength. The number of drawers was reduced to one and its size was greatly reduced. It is mainly to be used for office supplies, further reducing the risk. No new risk was introduced.

Potential Critical Failure 7: Single Handle

The single handle was introduced by the project's client as a preference. The potential failure occurs from corrosive wear. The potential effects of this failure are difficulty transporting the bench. The severity of this failure was ranked a 5. This failure was mitigated by planning to have the handle be constructed of chemically-resistant material such as steel. The handle will not be completed this semester. Not including a handle introduces a new risk, discussed as Potential Critical Failure 14.

Potential Critical Failure 8: Inclined Tabletop

The inclined tabletop concept was designed to assist in directing spills. The potential failure occurs from direct chemical attack. The potential effects of this failure could cause spills to seep into the devices on the tabletop. The severity of this failure was ranked a 9. This failure was mitigated through proper material selection that is compatible with the chemicals used in

sanitation. An additional risk was identified - an uneven tabletop workspace if it were to be utilized. This risk was mitigated by tilting the frame instead of angling the tabletop surface. This risk was mitigated so no new risks were introduced.

Potential Critical Failure 9: Polycarbonate Workspace

Polycarbonate was used for the material because it is x-ray compatible. The potential failure occurs from deformation wear. The potential effects of this failure could distort the x-ray imaging needed during treatment. The severity of this failure was ranked an 8. This failure was mitigated by removing the polycarbonate workspace from the design.

Potential Critical Failure 10: Polycarbonate Workspace

The grooves were designed to hold the hood in place. The potential failure occurs from deformation wear. The potential effects of this failure could result in the hood not being secure. The severity of this failure was ranked as a 7. This failure was mitigated by removing the polycarbonate workspace from the design.

New Potential Critical Failure 11: Wheel Bolts

The wheel bolts are required for attaching the wheels to the frame. The potential failure occurs from the wheel bolts breaking by not being strong enough. The potential effects of this failure could result in not being able to transport the bench or even collapsing the entire bench and breaking the devices. The severity of this failure was ranked a 9. This failure was mitigated by choosing the correct wheel bolts that have the necessary strength to not break.

New Potential Critical Failure 12: Wedges

The wedges are used to level the support of the clean room hood, since the tabletop is resting on a tilted bench frame. The potential failure occurs from the clean room hood not being properly attached to the wedges, from the wedges not being properly adhered to the tabletop, and from the adhesion not being strong enough. The potential effects of this failure could result in the clean room hood derailing from the wedges. The severity of this failure was ranked as a 8. This failure can be mitigated by attaching the clean room hood to the wedges with clamps, or a track. This failure is also mitigated by properly, permanently adhering the wedges to the tabletop.

New Potential Critical Failure 13: Gutter Tray

The gutter tray is to catch, contain, and direct any spills from the tabletop. The tabletop is tilted to direct the spills to the gutter tray, especially large spills that would otherwise puddle onto the floor. The potential failure occurs from the gutter tray not being strongly attached to the tabletop, and the spill consequently not being caught by the gutter tray. The severity of this failure was ranked as a 7, similar to other potential critical failures having to do with chemical spills. This failure can be mitigated by attaching the gutter tray to the tabletop with strong, locking clamps. The gutter tray will not be constructed by the team this semester.

New Potential Critical Failure 14: Handle

The handle was designed to move the bench. Until there is a handle, the bench will be maneuvered by pushing and pulling on the tabletop. This can lead to the attachments of the tabletop to the frame failing by shear. The severity of the tabletop falling is ranked 9. This failure can be mitigated by making sure the tabletop attachments are strong enough until the handle is installed. The handle will not be constructed by the team this semester.