Bed-mounted Modular Procedural Training Surface

Date: 9/24/2026
Client: Shannon DiMarco
Advisor: Darilis Suarez-Gonzalez

Team:
Nathan Knight – Team Leader and BSAC (nknight3@wisc.edu)
Evan Koelemay – Communicator (ekoelemay@wisc.edu)
Tess Fitzgerald – BWIG (tkfitzgerald@wisc.edu)
Andrew McLaughlin – BPAG and BSAC (asmclaughlin@wisc.edu)

Problem Statement:
A secure, lightweight, procedural workstation is crucial for clinical simulation centers to conduct procedural training. Current solutions leave much to be desired as they lack stability, take up excessive floor space, or exhibit tipping hazards. To resolve this, the team is being tasked with designing a modular workstation attachment to existing bed architecture. The workstation must be compact for storage, quickly attachable, and meet desired constraints for sanitation and safety.

Brief Status Update:

- This week the team met to discuss and brainstorm the three main design ideas for the bed-mounted procedural training surface. At the team meeting, we brainstormed the design criteria for both the model itself and for the material that the model will be made with. Two design matrices were created using the design criteria that the team came up with and the designs were ranked according to the matrix to come up with the final design idea. The design matrices are attached later in the progress report along with explanations for each design criteria and their rationale.

Project Difficulties/Advice Requests:

- None to report

Current Design

- This project is still in the research phase. There is no current prototype or design as of this week.

Materials and Expenses:

- None to report, see table below:

Item	Description	Manufac-turer	Mft Pt#	Vendor	Vendor Cat#	Date	#	Cost Each	Total	Link

Category 1										
									$0.00	
									$0.00	
								TOTAL:	**$0.00**	

Team Goals for Upcoming Week:

1. Begin working on and complete the preliminary presentation
2. Start drafting the preliminary report
3. Continue conducting any additional research that is needed

Individual Goals for Upcoming Week:

- Nathan Knight
  - Work on the preliminary report
  - Look into the winning material choice to ensure I am familiar with that material's specific properties
- Evan Koelemay
  - Begin work on the preliminary presentation
  - Meet with client and advisor to discuss current design ideas
  - Research material costs and amounts
- Tess Fitzgerald
  - Meet with advisor to discuss if the final design and material design choices are suitable for the project
  - Discuss the proposed final design ideas with the client to see if the client has any potential input that can impact the final design that is chosen
  - Create and complete the preliminary presentation
- Andrew McLaughlin
  - Meet with advisor and client to share and discuss design matrices
  - Begin working on preliminary presentation
  - Begin researching distributors of materials and costs

Timeline

Task	**September**				**October**					**November**				**December**		
	4	**11**	**18**	**25**	**2**	**9**	**16**	**23**	**30**	**6**	**13**	**20**	**27**	**4**	**9**	**11**
Deliverables																
Progress Reports		**X**	X													
PDS Draft			X													
Design Matrix																

Preliminary Presentations																
Preliminary Lab Notebook																
Preliminary Report																
Preliminary Evaluations																
Show and Tell																
Final Poster Presentation																
Final Lab Notebook																
Final Report																
Final Evaluations																
Meetings																
Team	**X**	**X**														
Client	**X**															
Advisor	**X**		X													
Website																
Update	**X**	**X**														

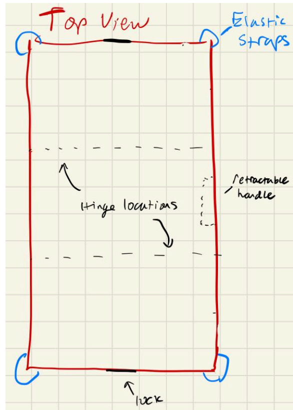
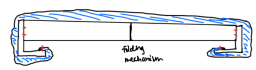
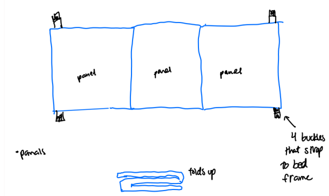
Previous week's goals and accomplishments:

- Nathan Knight
    - Brainstorm multiple designs for the Design Matrix, along with criteria they would apply to
    - Continue looking into material options that apply to the constraints given via the client
- Evan Koelemay
    - Begin ideas for design matrix that comply with all of the client's requirements
    - Develop a list of possible materials to use for fabrication
- Tess Fitzgerald
    - Continue researching plausible material to use for design (look into current materials used for operating table surface materials).
    - Draft various design ideas for the design matrix, including physical designs and material choices.
- Andrew McLaughlin
    - Start drafting different designs to meet the client's needs
    - Brainstorm and develop different ways that the design can be ranked
    - Continue to research procedural training models, and brainstorm ways to add complexity to the project

Activities

Name	**Date**	**Activity**	**Time (h)**	**Week Total (h)**	**Sem. Total (h)**
Nathan Knight	9/23/2026	Prepared material/design ideas for the design matrix and met with the group to work on it collectively	2	2	6
Evan Koelemay	9/17/2026	Brainstormed preliminary designs for design matrix Met and completed design matrix	3	3	7
Andrew McLaughlin	9/22/2026 9/23/2026 9/24/2026	Researched bed dimensions and materials for design matrix Worked on design matrix Finalize design matrix	1 2 1	4	8
Tess Fitzgerald	9/23/2026	Prepared material and design ideas for the design matrix Met with team to finalized three design ideas Worked on my portions of design matrix Created progress report	3	3	7
Team	9/17/2026	Team meeting where design matrix was created and work was divvied	1	1	2

Table 1: Design Matrix between Models

Criteria	Weight	Design 1 Trifold Corner Strap 		Design 2 Bifold Mattress Cover 		Design 3 Buckle Bedframe 	
		Score (5 max)	Weighted Score	Score (5 max)	Weighted Score	Score (5 max)	Weighted Score
Compactibility	30	5	30	3	18	5	30
Ease of Use	25	4	20	2	10	3	15
Secureness	20	3	12	5	20	3	12
Ease of Fabrication	15	3	9	3	9	4	12
Safety	10	5	10	5	10	5	10
Total	100	**81**		67		79	

Criteria for Model Design Matrix:

Compactability

Compactability is the ability for the simulation surface to go from an orientation that lays over the mattress to one that is easily able to take up much less space and be stored. The Clinical Simulation Program's main constraint to providing the most effective training is due to their limited space. Without room to host a table in their simulation spaces, the design must condense into a much smaller orientation in addition to providing a space to perform procedural training on models. This left compactibility high on the team's list of priorities, with a weight of 30/100.

Ease of fabrication

The ease of fabrication refers to how easy the material can be processed in order to fabricate the design. The team has access to University of Wisconsin-Madison fabrication spaces, which include machinery that will be employed for fabrication of prototypes and final designs. With this, the team has to be cognizant of the resources that are available, and the fabrication process will be a lower priority of the design, with a weight of 15/100.

Ease of Use

Weight refers to the overall maneuverability and application of the simulation surface. Since transferring between a compact and fully extended design will be conducted by either the trainers or the students, the design must easily be picked up and moved. The Clinical Simulation team has requested that the design be no more than 10 lbs, allowing anyone within their team to apply or compact it easily. This places ease of use relatively high on our priorities, with a weight of 25/100.

Secureness

Secureness pertains to the ability of the design to fit securely over the bed. When the simulation surface is being used, it will be supporting training models for pediatric airway openings, suturing, and many others that will require the surface to be stable and level. Due to this, the design must contain a novel attachment method that securely attaches to the Procuity Lex and ZX beds the Clinical Simulation Program uses. Considering this, security will be one of our top priorities, ranking 20/100.

Safety

Safety describes the ability to operate the simulation surface going from its compact to full length design. With this, the surface must be able to fold relatively easily without risk or hurting the person operating the device, in addition to having an ergonomic design in which edges or sides can not maim the users while it is being converted between designs. With the scope of our project, relatively to the other criteria the safety is of low priority at 10/100.

Conclusion:

The final design selected is the Trifold Corner Strap. This design was chosen because of its exceptional performance across the criteria outlined in the design matrix, giving it the highest score of all three designs. After reviewing the designs, it was evident that a trifold design would allow it to be most compactable. Implementation of the trifold design allows to maximize the amount of space within the procedural training rooms and as a result be able to run trainings more efficiently. By dividing the surface sheet into three even sections, and the utilization of piano joints, the trifold corner design was ranked highest, as it would be able to fold into a third of its original size in addition to providing a portable surface that can be attached to the beds. Since both design one and three utilized this design, they were ranked highest. Design two was compactable, but it only halved the surface height, leading to it being ranked a little lower. Each design either used a strap to secure the simulation surface or utilized the mattress itself and the geometry of the design to secure it. Design one and three were not rated very highly as it was assumed that the straps could lead to the simulation surface moving if too much pressure was put on it depending on the training being conducted. Design two is geometrically secured by designing the shape around the mattress itself. This provides a very rigid attachment method and would be most stabilized once inserted onto the bed.

Table 2: Design Matrix of Materials

Criteria	Weight	Material 1 HDPE		Material 2 Polypropylene		Material 3 Aluminum (6061-T6)	
		Score (5 max)	Weighted Score	Score (5 max)	Weighted Score	Score (5 max)	Weighted Score
Steralizability	35	5	35	5	35	5	35
Weight	25	5	25	5	25	2	10
Durability	20	3	12	4	16	5	20
Cost	10	5	10	5	10	2	4
Ease of Fabrication	10	5	10	5	10	3	6
Total	100	92		**96**		75	

<u>Sterilizability:</u>

Sterilizability refers to the cleaning of surfaces after training and procedural practices. The Clinical Simulation Program uses training models in which replicant bodily fluids are used. The simulation surface will never come in contact with bodily fluids, and because of this, FDA regulations for sanitization of medical devices do not have to be considered. Since the only sterilization will come from rudimentary cleaning, this is a relatively low priority,

<u>Weight:</u>

The weight refers to the weight of the material. The material being used in the design will go into the design. Regardless of the design, utilization of a material that is lightweight will assist in the goal of reducing the weight to be around 10 lbs. To make sure that the design is as universally usable as possible, this is a high priority, and given a weight of 25/100.

<u>Durability:</u>

Durability refers to the amount of weight the material can support. The operating service does not need to support much weight. Since the surface will be used to assist in training simulations, the client stated that the models and the pressure applied by training is negligible and do not have to be a concern. This makes this a low priority, ranking 20/100.

<u>Cost:</u>

The cost pertains to the cost of the material. Material cost will be used in the final design. With this, the Clinical Simulation Program provides $2000. Considering the cost of all of the considered materials and large funding given, cost is ranked at a low weight of 10/100.

Ease of Fabrication

The criteria for the ease of fabrication portion of the material refers to how easily the material will be to work with. The team's final design will require the material to be cut and formed into a foldable mattress cover which can accurately act as an operating table for pediatric airway procedural training. Given the complexity of the design is relatively low, the team does not expect the materials to undergo significant alterations. For this reason, the ease of fabrication was weighed with a score of 10/100.

Conclusion:

The three material options that the team considered were high density polyethylene (HDPE), polypropylene, and 6061-T6 aluminum. HDPE is a strong, chemically resistant thermoplastic made from polymerized ethylene. Polypropylene is a lightweight, semi-rigid thermoplastic, with high toughness, chemical resistance, and heat resistance. Aluminum is a lightweight metal used in construction, transportation, and everyday products due to its high strength, corrosion resistance, and ductile properties.

After evaluating material considerations alongside client specifications and requirements, the team has determined that polypropylene is the most suitable material for the base of the design. Polypropylene scored highly across all categories. This final design will act as an operating table for students in the clinical lab simulation. For that reason, durability in the form of stiffness and strength is important. Polypropylene has a tensile strength of 30-50MPa [1], while HDPE has a tensile strength of 31.7Mpa [2]. Lastly, aluminum has a tensile strength of 310MPa [3]. While all of the materials possess substantial tensile strength, aluminum has a density of 2.7g/cm^3, which would yield a final design weight of 70.2lbs. That is significantly outside of the specifications. Additionally, the cost of aluminum is far greater than the two thermoplastics, making it less accessible and compelling as a material selection. The density of HDPE and polypropylene are 0.95g/cm^3 and 0.9g/cm^3 respectively. While these densities will both yield a design within the weight range, polypropylene's stiffness and creep resistance properties are slightly more advantageous for the team's design. Sterilizability is another important factor in the team's design. All three materials are chemically resistant, and therefore scored similar in that section.

References:

[1] King, Purvis. “Polypropylene Properties & Polypropylene Characteristics Explained.” Palmetto Industries, 1 Apr. 2025, https://www.palmetto-industries.com/polypropylene-properties/.

[2] “HDPE Plastic Properties — Mechanical, Thermal and Chemical.” Ready Plastics, https://www.readyplastics.com/resources/materials/hdpe/properties. Accessed 24 Sept. 2026.