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The Take It All Tailgate Wagon: From Concept Through Prototype Development

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THE TAKE IT ALL TAILGATE WAGON:
FROM CONCEPT THROUGH PROTOTYPE DEVELOPMENT

By

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ABSTRACT

This text outlines the design process of the Take it All Tailgate from concept design through two prototyping stages. The Take it All Tailgate was designed for the every gameday tailgater who has a lot of tailgating equipment to haul from their vehicle to the tailgating area. With this in mind, a team of five members designed a wheeled storage space that also acts as a table in the tailgating area. Lean manufacturing was implemented to improve the build process and the overall design of the storage wagon.

TABLE OF CONTENTS

LIST OF FIGURES 6
LIST OF ABBREVIATIONS 8
Introduction 9
THE CENTER FOR MANUFACTURING EXCELLENCE 9
LEAN MANUFACTURING 9
PROJECT IDEA FORMATION 10
TEAM FORMATION 11
Chapter 1: Prototype 1 12
MATERIAL SELECTION 12
DESIGN CONSIDERATIONS 12
BUILD PROCESS 13
Chapter 2: Prototype 2 18
NEW DESIGN 18
PROCESS STEPS 21
Chapter 3: Small Scale Business Considerations 28
FINANCIALS 28
MARKET EVALUATION 29
BUILD TO ORDER PRODUCTION 30
FINANCIAL CONCLUSION 30
Chapter 4: Future Considerations 31
NEXT STEPS 31
SCALE-UP CONSIDERATIONS 31
CONCLUSION 32

LIST OF FIGURES

FIGURE 1	Drawn on and labeled plywood panel	13
FIGURE 2	Assembled wagon/drawer section	14
FIGURE 3	Finished prototype 1	16
FIGURE 4	Interlock between the wagon/drawer section and the chest section	18
FIGURE 5	Drawer face design change from prototype 1 to prototype 2	19
FIGURE 6	Poke Yokes used in the building process	20
FIGURE 7	Visual aids on panel saw used in the cutting process	21
FIGURE 8	Panel saw and sanding station layout and flowchart	22
FIGURE 9	Labeled bottom assembly	23
FIGURE 10	Labeled drawer assembly	24
FIGURE 11	Labeled chest assembly	25

FIGURE 12 Finished prototype 2 26

FIGURE 13 Financial Data 27

LIST OF ABBREVIATIONS

CME	Center for Manufacturing Excellence
CAD	Computer Aided Design
TPS	Toyota Production System

Introduction

THE CENTER FOR MANUFACTURING EXCELLENCE

The Center for Manufacturing Excellence, CME, is a unique program at the University of Mississippi that teaches students teamwork, manufacturing terminology and practices, and safety. All students in the CME are taught business, engineering, and accounting courses to train them to become cross functional employees. These three disciplines are the primary groups that are involved in the manufacturing process and CME students enter the workforce with an understanding of the language and goals of each discipline.

During the senior year of the CME program, students complete a capstone project where an idea is prototyped, cost analyzed, manufactured, and formed into a final product. Students are broken into teams of three to five based on student project preference and major.

LEAN MANUFACTURING

The key manufacturing style taught in the CME is lean manufacturing. Lean manufacturing began in Japan in the 1940s at Toyota through the development of the Toyota Production System, TPS (Womack). Toyota's goal was to produce a continuous flow process and to reduce as much waste as possible from the process. Some of the key tools of lean manufacturing are the 5s's, the poke yoke, and eliminating the seven deadly wastes (Melton 662).

The 5s's are sort, set in order, shine, standardize, and sustain. In a manufacturing setting, it is imperative to have a clean organized space. The 5s's help produce a workspace that is well organized and a workspace that has a set place for each tool and part so that even a changeover of operator will not cause confusion. Poke yoke is a Japanese term for mistake proofing. Poke yoke is considered during the design process of a new product as well as to develop manufacturing aids that make installation or processing mistakes nearly impossible. The last of the lean manufacturing tools discussed is the elimination of the seven deadly wastes. These wastes are over production, waiting, transport, inventory, over processing, motion, and defects (Melton). The goal of a lean process is to eliminate as much of these wastes as possible. By reducing waste, the cost of manufacturing will be reduced.

PROJECT IDEA FORMATION

Tailgating is an integral part of the Ole Miss student and fan culture. In brainstorming ideas of CME capstone projects, team member Eric Reed realized fans, especially Ole Miss fans, have numerous tailgating necessities and end up making multiple trips to their car to get their tents completely set up. A product that could help fans carry all their tailgating necessities in one trip would be a must have. Erica developed the Take it All Tailgate to help save fans trips to the car and time while also giving them an all-in-one tailgating setup package. The Take it All Tailgate would be a wooden table showpiece on wheels that doubles as storage for food, drinks, paper products, and any other tailgating needs. It would include an insulated drawer for warm casserole dishes or platters, a shelf, a deep chest that housed a built-in cooler, and a flip up table to provide more serving or eating space. The wheels would make it easy for one or two people to move it from a car to the tailgating area. The storage areas would break into two pieces, the deep

chest and swing up table piece and the wagon, drawer, and shelf piece. This would allow for the Take it All Tailgate to be transported in a SUV or a truck.

TEAM FORMATION

Students were asked to submit project ideas in a video format. Instructor Mike Gill reviewed the videos and narrowed the submissions to projects able to be done on the factory floor of the CME. The videos were then shared with students to view and vote for the projects on which they would like to work. Students were then placed into teams based on student voting and ensuring a diversity of majors for each team.

The Take it All Tailgate team members are:

- Erica Reed (Mechanical Engineering)- team leader and point of contact for course instructor
- Carly Huguley (Chemical Engineering)- team recorder and CAD designer
- Jonathan Watts (Finance)- budget manager
- Trevor Allen (Mechanical Engineering)- co-designer
- Hannah Kent (Accountancy)- team accountant

Chapter 1: Prototype 1

MATERIAL SELECTION

The Take it All Tailgate prototype is made of a heavy-duty wagon, ½ inch Sande plywood (a marine grade plywood that has consistent coloring making it easy to paint or stain), 2x2 pine wood, 2x4 whitewood studs, a Coleman cooler, screws, and various hardware materials, and finishing materials. The Sande plywood is chosen as the primary visible material of the piece due to the smooth finish, the sturdiness of the material, the durability in all weather conditions, and being more cost effective than a plastic option. The plywood is used as the outside panels and to build the drawer. The 2x2 pine wood is used to create the frame to attach the plywood. The 2x4 studs are used to interlock the top and bottoms pieces of the Take it All Tailgate.

DESIGN CONSIDERATIONS

During the initial design process, the team's first decision was to buy a heavy duty, outdoor wagon to use as a platform on which to build the rest of the Take it All Tailgate. It would be much easier and more cost effective to start with a standard wagon versus building one. Due to purchasing the cart, the length and width of the Take it All Tailgate were set by the walls of the wagon (2' by 4'). When considering the height, the team wanted it to be a bar height for ease of serving or eating on the tabletop. The chest portion of the product was designed to fit the Coleman cooler purchased (approximately 14" high). After considering the height of the wagon and the chest, the team concluded that due to height limitations, the shelf should be removed

from the design in order to create a taller drawer that could fit casserole dishes, standard size catering platters, and sandwich trays. Although this change reduced the amount of storage space, the team realized the cooler would not take up the full interior space of the chest, so storage space would be available in that remaining space. Due to this design change, the two pieces of the cart were now the wagon with the attached drawer and the chest with the attached tabletop.

Another consideration during the design process was ensuring all plywood parts could be cut from 2 sheets of plywood. This plywood constraint along with the typical catering platter height of (about 4-5”) determined the height of the drawer as 6”.

BUILD PROCESS

The first step in building the Take it All Tailgate was putting together the wagon that is used as the platform to further build. The wagon was purchased from Harbor Freight and came with step-by-step instructions to assemble the steering system and install the wheels onto the cart.

Next, the plywood sheets were cut into the seventeen pieces needed to build the bottom (which houses the drawer), the drawer, and the chest. To optimize the amount of plywood used, the team decided to draw the various parts onto the plywood sheets. This solution posed many problems such as keeping lines square and once considering blade width the team realized the parts would not fit on the sheets as envisioned and a new diagram was needed for cutting the large wooden panels. In Figure 1 below, the parts are drawn on the plywood and labeled with their part names and dimensions.

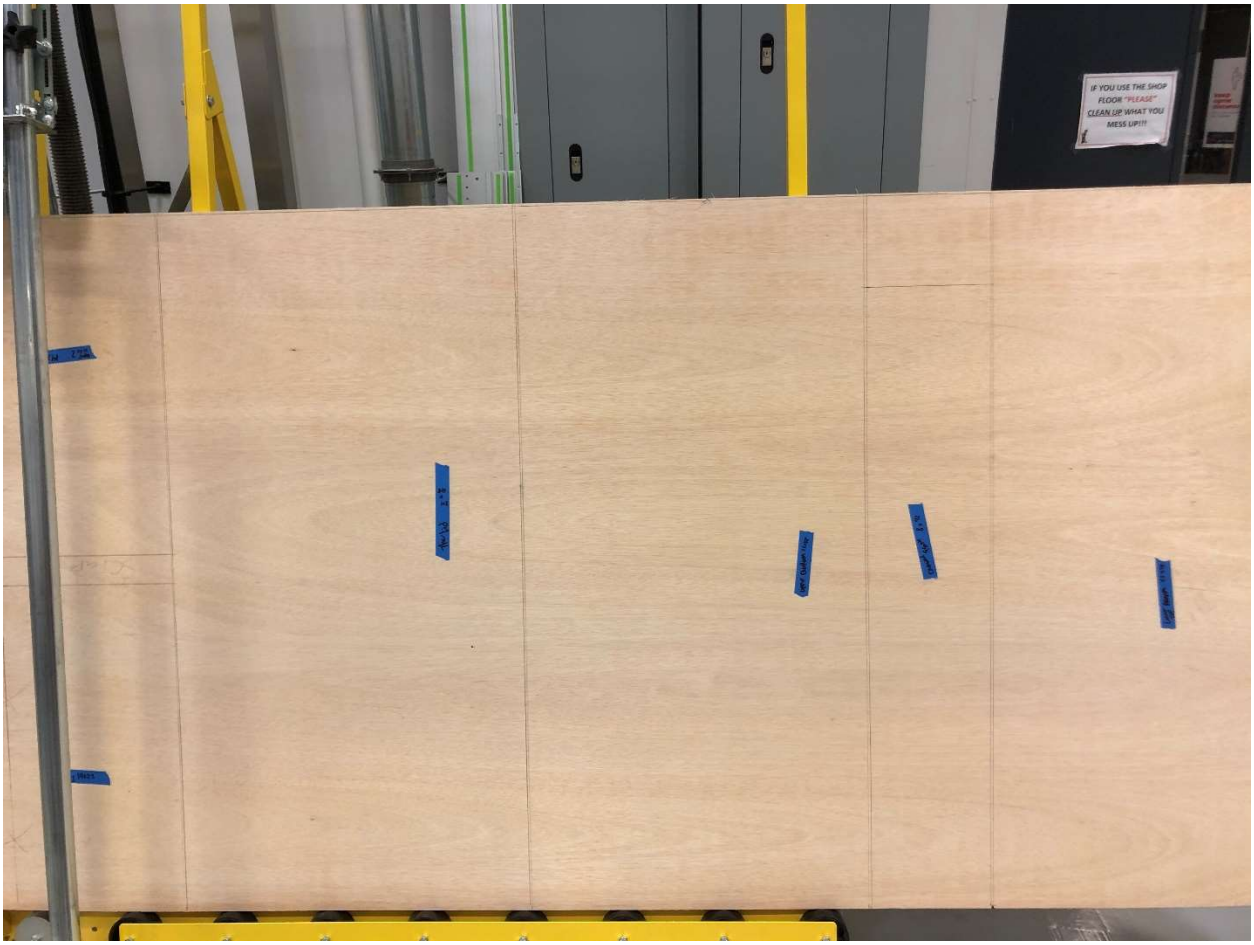

Figure 1: Drawn on and labeled plywood panel

The cutting process required use of the panel saw, the table saw, and the rotary saw to cut all the parts out of the large 8’x4’ plywood. The bottom face was then laser cut to provide a hole for the drawer to slide through.

The frame was then cut from 2”x2” to help support the plywood sheets on the bottom and provide a structure to build the chest. The plywood bottom walls were attached to the wagon by using a self-tapping screw to drill through the wagon into the plywood pulling it into place. The 2”x2” support was then added in the corners and between the sides to support the walls from

collapsing in due to the weight of the drawer that would be added. 2”x2” support was also used between the bottom walls and the drawer slides to provide correct dimensioning of the slide.

The bottom, sides, and back of the drawer were then assembled and the support for the drawer sides attached to the sides of the drawer. The drawer slides were then attached to the side of the drawer using a level to ensure the slide was straight. The mating side of the drawer slides was then attached to the slide support attached to the bottom wall by holding the drawer in place and marking where it should be installed. Once both sides of the slides were installed the drawer was installed and the team realized the slides were not properly aligned. The team continued to check and adjust the slides until they were satisfied with the way the drawer was installed and sliding. The top of the bottom section was then installed. The assembled wagon/drawer portion is shown in Figure 2 below.

Figure 2: Assembled wagon/drawer section

Next, the chest was built by screwing all the plywood pieces together. The sides were screwed together first, then the bottom of the chest was screwed to the sides. The supporting 2”x2” frame was then screwed to the plywood chest.

2”x4” planks were used to create the interlock between the chest and the bottom cart section. On the bottom of the chest, a rectangle of 2”x4” outlined the edges and a similar but

smaller rectangle was attached to the top of the bottom section. These two rectangles fit together to ensure that the chest did not slide when transporting the Take it All Tailgate from one's car to the tailgating area. Latches were then installed on the side of the cart to further ensure the chest would not slide.

Supports were added under the table top plywood piece and inside the chest, but upon instillation of the tabletop brackets, the team realized that support wood was needed. The table top support wood was removed and the brackets were installed on the table top. The brackets were then used to attach the table top to the chest.

Finally, the lid for the chest was added using door hinges. The chest lid was made of two plywood pieces that would open upwards and toward the sides of the chest. The handles were then installed on the front of the drawer and the sides the chest. Handles were installed on the side of the chest for easy lifting in and out of vehicles. The completed prototype 1 can be seen in Figure 3 below.

Figure 3: Finished prototype 1

Chapter 2: Prototype 2

NEW DESIGN

After thorough consideration of the previous design, the goals of the new design were to make the building process easier, eliminate excess materials, and improve visual appearance.

To make the build more efficient and mistake proofed, a CAD model was used, and the structural supports were a forethought to the design and included in the CAD. The first design was not drawn in CAD which resulted in dimensioning and tolerancing issues as well as disconnects in the conceptual design such as the need for structural wood and the orientation of the pieces of wood when assembled. The CAD model allowed for the team to have a visual of the finished product and verify fit and dimensions. Having this visual also helped the team view different design options before making a final decision, especially appearance-based decisions.

The second goal of the new design was to eliminate excess wood to reduce material cost and reduce the weight of the product. In the initial design, 2x4 was used to create a rectangular interlock between the upper chest and the wagon and drawer section. The interlock is depicted in Figure 4 below where the blue rectangle is the 2x4s attached to the top of the drawer/wagon portion and the gray rectangle is the 2x4s attached to the bottom of the chest portion of the wagon.

Figure 4: Interlock between the wagon/drawer section and the chest section

The team was concerned latches would not be sufficient to hold the chest and wagon/drawer section together, however during a field test around campus it was determined that the interlock was unnecessary, and latches were a sufficient method to hold the two sections together. This change eliminated approximately 10 pounds from the product and eliminated the need for the purchasing 2x4s. The reduction of weight made it easier to unload from a vehicle and made handling of the wagon more user friendly. Another part that was removed from the design was the top to the wagon/drawer section. This part was not needed for structural purposes and helped remove weight from the lower section of the product. The removal also allowed for a gain of 8 square feet in plywood that can be allocated to other plywood parts.

The third and final goal of the new design was to improve the visual appearance of the product. The team wanted the design to hide more edges of plywood because of the visual difference between the painted face of the plywood and the rougher painted edge. This also minimized the amount of hole filling required on the plywood due to the face not having the defects the edges of the plywood had. In the new design, all of the plywood sides seen face the sides of the cart. The drawer face became the whole bottom front panel (instead of having a bottom front panel and a drawer face separately) as seen in Figure 5 below.

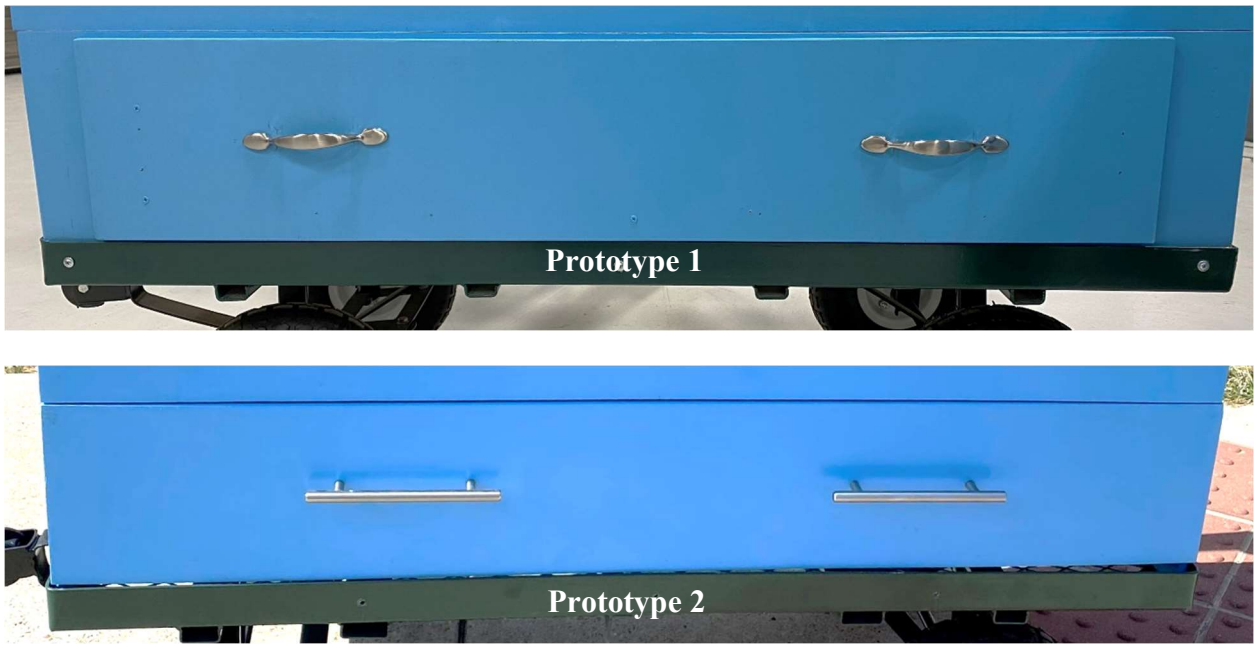

Figure 5: Drawer face design change from prototype 1 to prototype 2

All wood was painted with two coats of paint and two coats of polyurethane prior to assembly. Although painting prior to assembly requires touching up the original paint at the end, this step enhanced the durability and performance of the cart. Also, the overall time to paint was shortened due to painting flat pieces of wood rather than an already assembled cart with attached metal fixtures that were not painted. Lastly, the base of the chest and table top section of the cart was designed to fit inside the bottom drawer, acting as an interlock similar to that of the first design and to avoid such a stark break between the bottom drawer encasing and the chest walls. A second visual improvement was adding vinyl stickers to break up the solid color and add a customization option for customers. Since the product was designed with tailgating in mind, the team thought it was important to provide the customer with the ability to represent their team on the product.

PROCESS STEPS

Before building prototype 2, the team spent time thinking through, mapping out, and building production aids to improve the ease of building the Take it All Tailgate. These improvements ultimately significantly reduced the build process time, increased the quality of prototype 2, and reduced the need for making and mapping measurements during building.

As mentioned earlier, poke yokes were implemented for the drawer slide support placement, the drawer slide placement, the drawer handle and chest handle placement, the building of the drawer, and the installation of the drawer front. These pokes yokes are shown in Figure 6 below.

Figure 6: Poke Yokes used in the building process.

Drawer assembly poke yokes- left, Drawer support and slide poke yokes- top right, Handle placement poke yokes- bottom right.

Visual aids were added to the panel saw, shown in Figure 7 below, along with work instructions created for the panel saw operator.

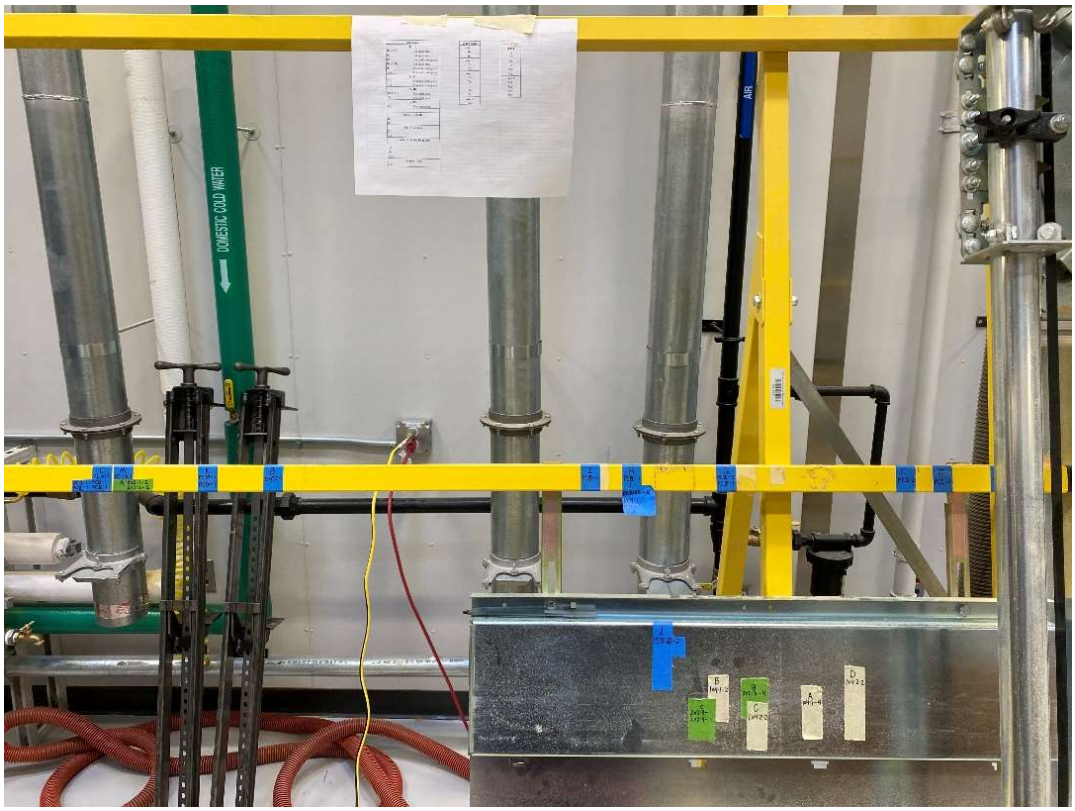

Figure 7: Visual aids on panel saw used in the cutting process

The visual aids told the operator in which order to set the stop and make cuts, how many cuts to make at each stop location, the part numbers to label the panels, and whether to place the panel in the “finished pieces (cutting)” area, in the “cut again” area, or “scrap” area. Figure 8 shows the layout of the cutting and sanding area.

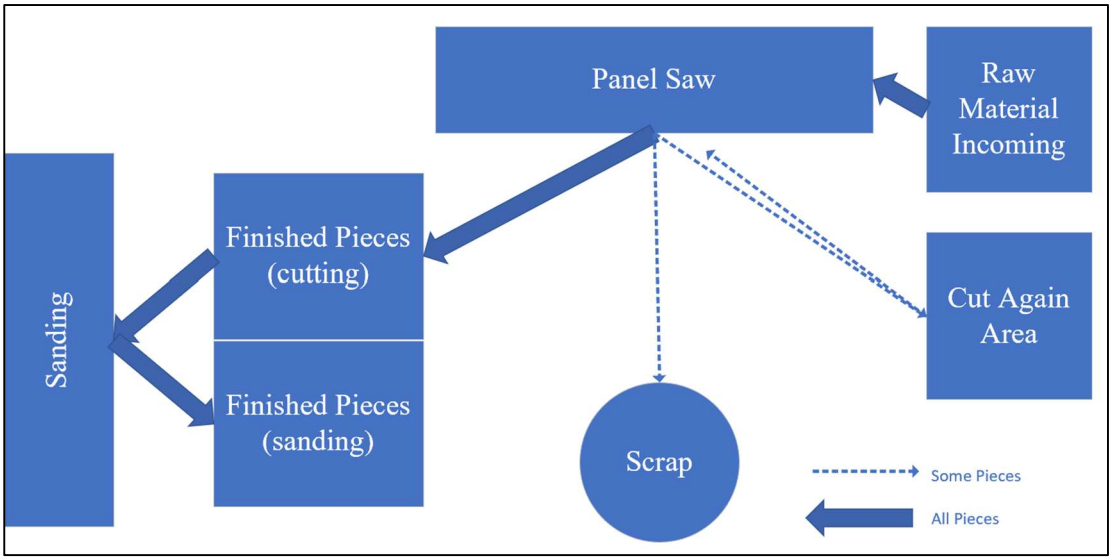

Figure 8: Panel saw and sanding station layout and flowchart

This visual aid system eliminated the need for measuring each panel to be cut and ensured that all parts cut at the same dimension were exactly the same due to the use of a stop and the stop being placed at any given dimension once.

After the wooden parts were cut to size and placed in the “Finished Pieces (cutting)” area, the parts were then taken by a second operator to the sanding area. The parts were sanded on all sides and placed in the “Finished Pieces (sanding)” area. Once the sanding and cutting process was complete, the team wiped the wood parts down to ensure good adherence of paint and then painted the wood with 2 coats of paint and 2 coats of polyurethane. The vinyl lettering was installed onto the parts after the first coat of polyurethane and a second coat was painted over the vinyl. The painting process spanned over the course of a couple of days due to drying time and team members schedules. The first day of painting, the team used a spray painter to paint the wood. However, after the first day of painting the spray painter no longer worked so the remaining coats of paint and polyurethane were rolled. The team chose to spray the paint initially

due to a rough finish on the 1st prototype however after having to roll the final coats, it was realized that the sanding process after cutting removed the rough finish. Painting with rollers was deemed the preferred method due to the cost, ability for numerous people to be painting at the same time, and efficiency of rolling as compared to spraying.

Next, structural wood, drawer slides, handles, and eye hooks were all installed on their respective wood parts. This was done prior to assembly in order to make the assembly process more efficient and ensure there was enough space to install these parts easily. Holes were then drilled into the cart and the sides of the bottom were screwed into the walls of the cart. Drawer slides were installed onto structural wood which was then added to the bottom sides for the instillation of the drawer slides. Support was then nailed into the top front and the top back of these sides to ensure the weight of the drawer would not cause the sides to cave in. A labeled diagram of the bottom assembly can be seen in Figure 9 below.

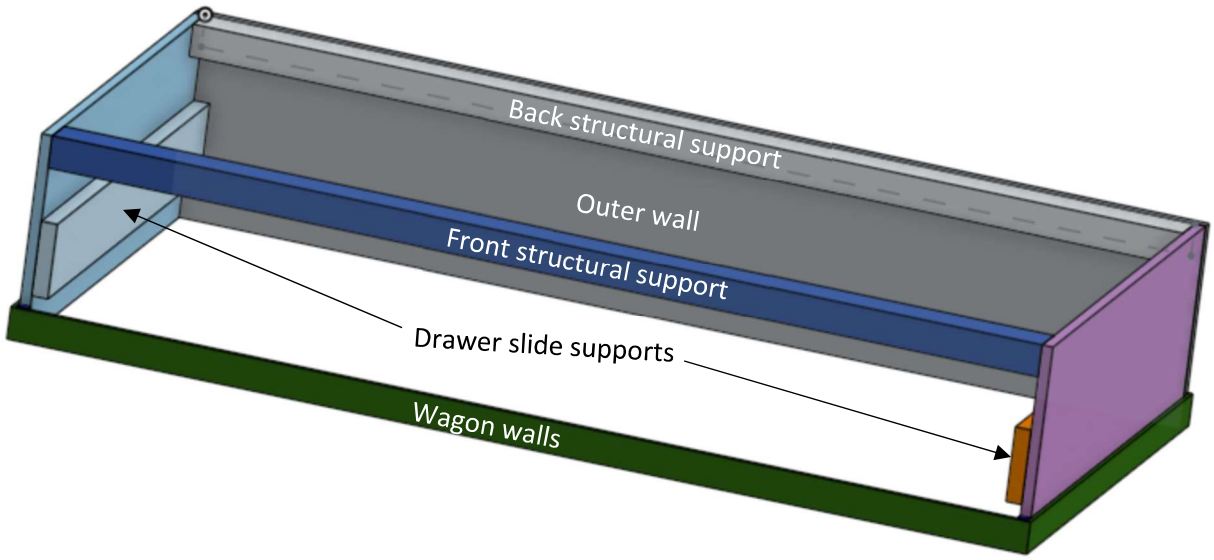

Figure 9: Labeled bottom assembly

Next structural supports were added to the drawer sides for installation of the adjoining drawer slide piece. The drawer sides were then assembled using a square poke yoke. The face of the drawer was installed using a second poke yoke to center the face on the drawer as well as provide a half inch tolerance from the bottom of the face to the bottom of the drawer. The drawer slides were then installed on the drawer sides using a poke yoke to ensure the drawer slides on the bottom sides and on the drawer sides aligned with one another properly. A labeled diagram of the built drawer is shown in Figure 10 below.

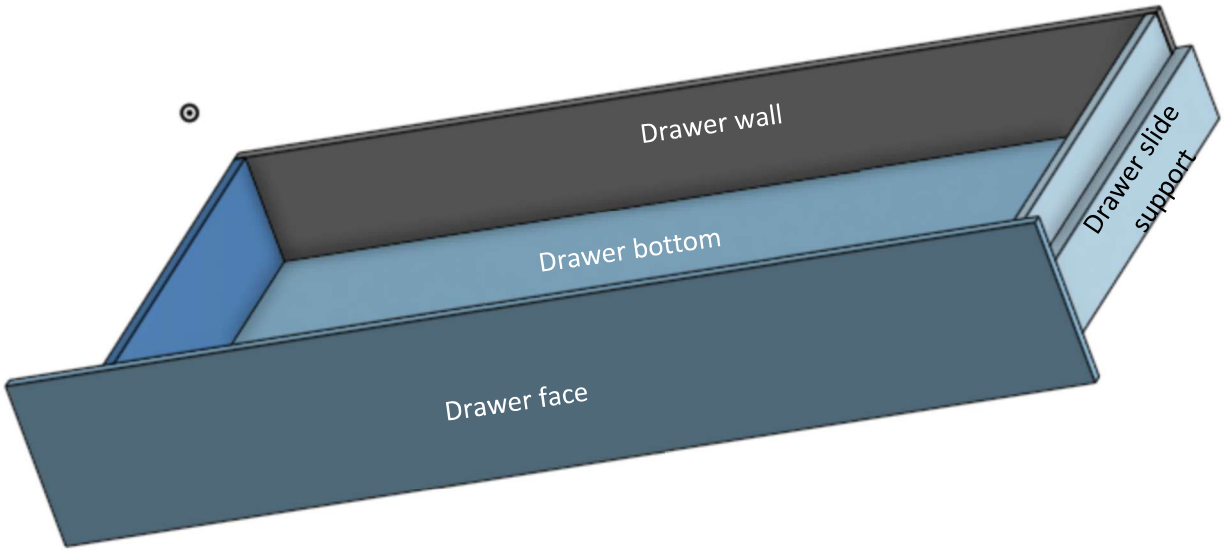

Figure 10: Labeled drawer assembly

The frame of the chest was assembled next. The sides of the chest were nailed to the frame and then the bottom of the chest was nailed to the frame. The chest assembly can be seen in Figure 11 below.

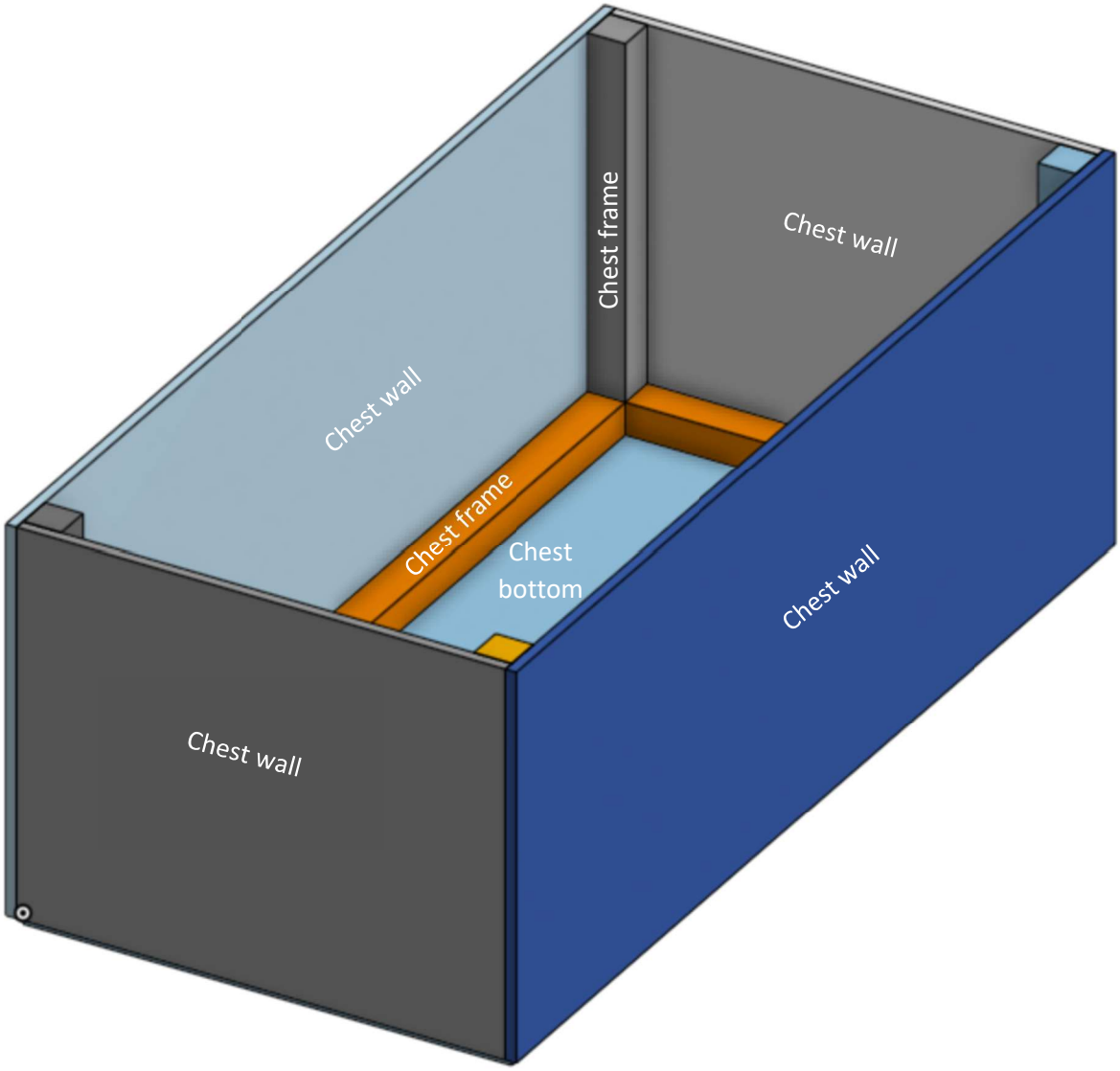

Figure 11: Labeled chest assembly

The supports for the table top and for the chest lid were attached. The table supports were installed on the tabletop. The table hinges were screwed to the chest and then screwed to the tabletop. When installing the lid, the team realized the supports were not necessary or feasible for the type of cabinet hinges being used, so the lid supports were removed. The hinges were then installed onto the lid and then the lid installed onto the chest.

After completing the assembly process, all nail holes were filled, sanded, painted, Ole Miss stickers were added, and the entire cart was coated with polyurethane to ensure a good aesthetic of the cart. The final prototype 2 assembly is shown in Figure 12 below.

Figure 12: Finished prototype 2

Chapter 3: Small Scale Business Considerations

FINANCIALS

The finances for this process were only considered for prototype 2 due to the second prototype being built with a procedure and the first being built by feel of the team. The "feel of the team" approach made machine time estimates difficult and required rework of the assembly numerous times. The financial data to produce 167 units a year of prototype 2 is presented in Figure 13 below.

Take It All Tailgate Financial Data

Selling price	$	1,000.00
Unit price	$	926.37
Profit margin	$	73.63

Particulars:

Labor (contract)		
Hourly wages	$	17.00
DL hours/employee		12
Estimated employees		2
Total DL costs	**$**	**408.00**

Materials		
Materials for prototype 2:	**$**	**471.00**

Overhead		
Rent:		
Cost per sq. ft.	$	5.80
Sq. ft.		500
Yearly rent	$	2,900.00
Estimated units per year		167
Overhead per unit	**$**	**17.37**

Machinery Usage: (Approx. 1 hour each)		
Panel saw/unit	$	10.00
Table saw/unit	$	10.00
Bandsaw/unit	$	10.00
Machinery costs	**$**	**30.00**

Figure 13: Financial Data

The 167 units per year was calculated considering that each unit requires 12 hours to build and a 50 week per year work schedule. This is the maximum number of units that could be built if only one unit was produced at a time. The Financial data considers labor cost for two employees at $408 per unit, the rental of a facility and the machinery required to produce the product at $47.37 per unit, and the cost of the materials at $471 per unit. With a unit price of $1,000, the profit margin per unit is $73.63. The unit price of $1,000 was determined primarily through the unit cost analysis with some influence from polling of fellow students and faculty. This unit price limits the market willing and able to buy the Take it All Tailgate.

MARKET EVALUATION

The Take it All Tailgate is a customizable, niche product designed for the every gameday tailgater. This is due to the price and size of the product. The Take it All Tailgate has an eight square foot footprint and is not ideal for people from out of town to travel with, therefore the market is limited to fans who live nearby to the stadium and have plenty of storage. The price will also deter fans who do not tailgate every gameday due to having a lower return on the investment.

Currently, many fans use folding wagons to haul their supplies from the car to the tailgate. For these wagons the average price is around $100 (DICKS's Sporting Goods). The Take It All Tailgate provides more storage space (and hauling space) than the average folding wagon and does not waste space under the tent because it serves as a table. Even with a folding wagon, numerous trips to the car could be necessary.

BUILD TO ORDER PRODUCTION

Due to a limited market, the business model for this product would be best as an addition to an existing portfolio of wood products sold in an Etsy online store. If added to an existing portfolio of wood products, the machinery and tools necessary to build the Take it All Tailgate would already be rented or purchased allowing for the overhead costs to be shared among the products. Also, the Take it All Tailgate process has some waiting time due to paint and polyurethane drying, which could be time spent building a separate product. Lastly, with a niche market, a seasonal product, the size of the product, and the ability to customize, it is best to build to order to reduce inventory that could sit on hand for potentially months and would require further processing once an order is placed.

FINANCIAL CONCLUSION

Overall, the Take it All Tailgate would be an ideal addition to an existing portfolio of wood products. Year-round production is not feasible due to the slim profit margin, the product being seasonal, and the product supporting a niche market. Adding the product to an existing portfolio would allow for the overhead costs to be shared between products, the wait time due to drying paint and polyurethane to be spent working on other products, and allow for year-round production of the wood products versus producing excess Take it All Tailgates to store.

Chapter 4: Future Considerations

NEXT STEPS

Before adding the Take it All Tailgate to a wood working portfolio, market analysis should be completed to ensure there is enough interest in the product. A survey should be sent detailing the product, customization options, and price. The survey should ask for feedback on the product, if people would be willing to buy it for the set price, and if not, what price point they would purchase one for. The survey should be sent primarily to college football and NFL fan groups.

SCALE-UP CONSIDERATIONS

If the demand of The Take It All Tailgate increased and production needed to be scaled-up, there are some opportunities to eliminate waste and optimize the process. The first consideration would be to use an industrial spray painter along with painting fixtures to ensure the plywood parts get even coats and can be coated at one time rather than having to let one side dry before flipping it over and painting the other side. This would eliminate wasted time by doing the painting at once and would make the time to paint faster due to spraying rather than brushing or rolling. A second consideration would be to add fans to decrease the drying time of the paint and polyurethane.

If demand increased by a significant margin that warranted moving The Take It All Tailgate to an assembly process, a drying tunnel should be considered for drying the paint and polyurethane in-line. At that rate of scale-up, robot spray painters may be economically feasible

as well. If moving to an assembly line process, the poke yokes and production aids used in the batch production should be installed in-line. Lastly, the sequence of cutting the plywood would need to be reanalyzed to consider cutting parts for numerous wagons at one time rather than cutting all the parts for one wagon at a time. This could provide time savings due to moving the stop on the panel saw less frequently allowing for more time cutting the parts.

CONCLUSION

The Take it All Tailgate was taken from a concept to a full-sized prototype. During the build of the first prototype the team recognized improvement opportunities in the design as well as the building process. The lean manufacturing principles taught by the Center of Manufacturing Excellence were used to implement poke yokes in the build process of the second prototype, to create a more robust build procedure, and to eliminate wasted time and material. Time was saved by implementing of a build procedure, by installing parts and accessories before assembling, and by using poke yokes to ensure correct part placement. Material was saved by removing the interlock between the drawer/wagon section and the chest section and by recognizing that the addition of a cooler would be unnecessary because most people already have a cooler. Due to the improvements made after the first prototype, the second prototype build was more efficient and the ascetics of the product were greatly improved.

Financial analysis was conducted on the second prototype and the price of the Take it All Tailgate was determined to be $1,000. It was decided that instead of producing the Take it All Tailgate through year-round production, it should be added to an existing wood working portfolio in an Etsy type of online store. This is primarily due to the niche market and the ability to customize the product.

Finally, a survey should be sent to potential customers before adding the Take it all Tailgate to a portfolio to ensure there is a large enough market for the product and to ensure the price point is acceptable.

BIBLIOGRAPHY

DICKS's Sporting Goods. n.d. Article. 19 April 2022. <https://www.dickssportinggoods.com/p/quest-outdoor-wagon-with-ez-tread-21queuqsttdrwgnxxreca/21queuqsttdrwgnxxreca?sku=22571343&camp=CSE:DSG_927000060786378008_lia_pla-860331224524&segment=&gclid=CjwKCAjwu_mSBhAYEiwA5BBmfyHx6AJ09XvsLsEe2ZP5fEngIcSNldB9EBKR>.

Melton, T. "The Benefits of Lean Manufacturing: What Lean Thinking has to Offer the Process Industries." *Chemical Egnineering Research and Design*. Vol. 83. 6. 2005. 662-673. Print. <https://doi.org/10.1205/cherd.04351>.

Womack, James P., Daniel T. Jones, and Daniel Roos. *The Machine That Changed the World*. London, England: Simon & Schuster., 2007. Print.