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Stump Grinder Project

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MECH 447H Postmortem Report

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Project 3 Stump Grinder Portable Device

Sponsored By: Gary and Carol Sherman

Made For:

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And For
The University Of Nebraska Lincoln Honors Department

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Project Description:

The project that the team and I sought out to complete this year was a Portable Stump Grinder device sponsored by private investors known as Gary and Carol Sherman, two farmers out of Lincoln, Nebraska. The ultimate goal of this project, in terms of the work we were assigned, was to provide the foundation work for future engineering teams to design and build the stump grinder for Gary and Carol Sherman. In addition to laying the foundational work for these future teams we needed to create solutions and potential iterations of the stump grinder device and do so in a way that was within a very inexpensive budget compared to most stump grinders on the market. We also needed to design around the parameter of a universal hookup and operation between the Owatonna 770 loader and the L325 skid steer as this is something that our sponsors wanted. The exact definition of our scope was to design and implement a program that facilitates the overall design of the stump grinder for future teams to develop. It was within the definition of this scope that we provide multiple iterations of the stump grinder and provide multiple component choices, material choices, and frame choices so that future teams have options when designing the stump grinder just in case our analysis was wrong. It was also within our scope to analyze these iterations to test the overall compatibility with the two machines which are an Owatonna 770 loader and a New Holland L325 skid steer, and both of these machines can be seen below. In the next paragraph I will describe the deliverables we had for this project as well as the budget and overall timeline of the project.

New Holland Skid Steer:

Owatonna 770 Loader:

The first of our deliverables was to identify the key subsystems with the stump grinder and the requirements that go with each subsystem. The next deliverable was to make specifications and calculations for each of the subsystems and utilize this data to decide which subsystem was most important. The next deliverable was to produce a CAD model of the most important subsystem for the purposes of a finalized design concept. Our final deliverable was to provide a 3D printed prototype of the most important subsystem to prove our concepts and understand how the subsystem will interact with the machine. The next thing to be discussed is the overall budget of the stump grinder.

The budget that was given to us by our sponsors totaled to $3,000.00 and the reasoning for this price was to make a stump grinder that was cheaper than what the market offered and could fit the machines that they owned. Down below is the Bill of Materials for this project.

Bill of Materials:

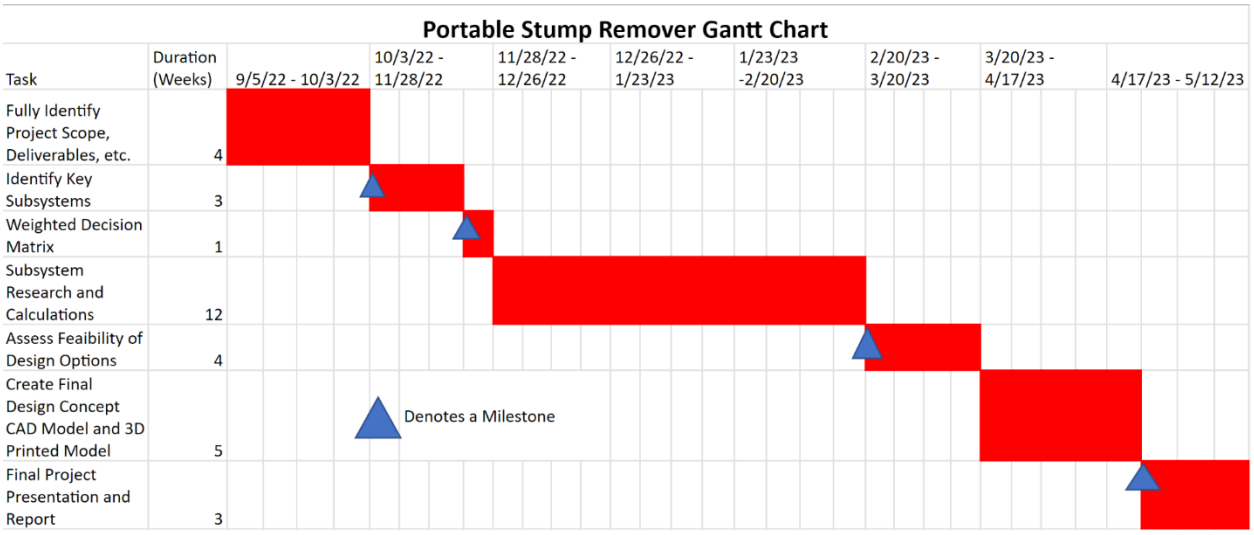
Bill of Materials				
Frame			**Grinder**	
12 GA Sheet Steel (12"x24")	$36.80		1. Disk Grinder	$121.14 - $920.62
Steel Tube 2x2x.25 (2X)	$41.00		2. Horizontal Cylinder Grinder	$484.56 - $920.62
Total	**$77.80**		3. Vertical Cylinder Auger	$169.20 - $1,495.00
			Grinder Teeth (1,2)	$227.67 - $455.34
Dampening			Wheel Hub (1,2,3)	$76.95 - $301.10
(Utilizes One Option)			Connecting Rod (1,2,3)	$46.20
Hydraulic shocks (2x)	$58.72-$109.37		**Total**	**$471.96-$1,796.10**
Vibration isolation pads (4x)	$18.99-$26.49			
Sping Isolation Mounts (2x)	$14.95		**Hydraulics**	
Total	**$29.90 - $218.74**		Hydraulic Hose (2x)	$70
			Hydraulic Motor	$215
Swivel			Hydraulic Solenoid Valve	$350
Hydraulic Cylinder	$160-$240		Male Hydraulic Coupler	$20
Hoses	$20-$30		Female Hydraulic Coupler	$20
Couplers	$25-$30		**Total**	**$675**
Locking Pin	$40-$50			
Total	**$245 - $350**			

Total Grinder	Cost ($)
Low	$1,499.66
High	$3,117.64

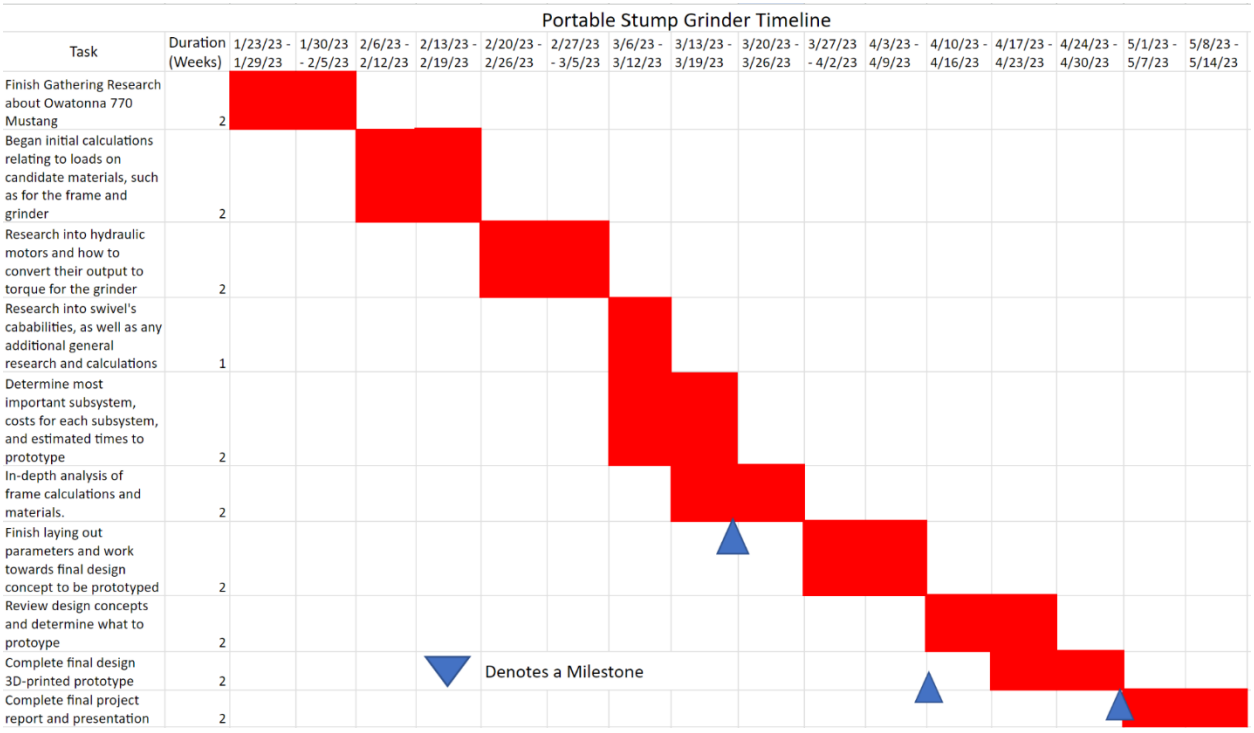
The Bill of Materials has changed in price between last semester and this semester, and we now have to new totals for our project. These totals are a max of $3,117.64 and a minimum of $1,499.66. This was gathered utilizing sources that generated prices for components currently on the market and was additionally done by taking the high and low costs of each component to give us a maximum and a minimum. It should be noted that this does not include the cost to manufacture and the reason for this is we believe it did not fit within our definitional scope to include this in the budget as prices could increase or decrease in terms of manufacturing costs between now and when future teams go to build the project. To avoid going over budget it is recommended that future teams utilize combinations of parts to get the correct price point, while also making sure that the components work well with each other. To keep the project under budget it is recommended that the future teams utilize the cheapest components found in the budget, whilst also making sure that the components work well with each other and making sure that manufacturing costs aren't too high for chosen components. Moving on from this we go to the updated timeline which can be seen below.

Timeline:

Fall:



Spring:



Comparing the two timelines above it should be noted that the newer timeline has only the spring semester as all milestones had been completed up to that point. It should also be noted that the time to finish the calculations was pushed back due to the calculations being more complex than anticipated and doing this also pushed back some of the other milestones, but still allowed us to finish on time. It should also be noted that the calculations sections for the timeline are more specified for each subsystem compared to last semester's timeline which grouped them all

together without any specifications. As far as challenges that needed to be overcome to keep the project on schedule were as follows. The first challenge was trying to understand the scope of the project and all in all what we needed to complete for this project. This challenge had set us back 5 weeks that we could've utilized for more specified calculations. The next challenge was understanding the calculations and verifying accurate results within our calculations, which had set us back 2 weeks in terms of our timeline. The final challenge was creating the design for the prototype and printing it which only set us back 3 days in terms of our timeline. To mitigate these issues and keep the team on track we devised several methods. To get us back on track with the first issue it was decided that each member would conduct their own research on their own subsystem which allowed our team to recover the initial 5-week delay as with each member conducting their own research over the span of 3 weeks we could reduce overall research time from 10 weeks to 3 weeks. To address the second issue, it was decided that the team be split in half to conduct individual calculations of the subsystems, and this allowed us to recover the time we had lost. To address the final issue, it was decided to have one person on standby to print the prototype, while the team discussed the most important subsystem this way the printer would be ready to print when we were ready, and it should be mentioned that this issue did not affect us greatly and still allowed us to finish on time. Next I will discuss how I rate the overall success of this project.

In terms of the success of the project in terms of the initial goals and deliverables I would say we were 100% successful. The reason I say this is because we managed to provide the foundational work and calculations for future teams to build the stump grinder. In addition to this we gave them the definitional parameters of the budget and of what the stump grinders requirements are. With this information hopefully Gary and Carol will be able to see their final product and use it to remove the stumps off their land and go back to their farming.

Discussion of 446 Post-Mortem and of Implementation of Action Items:

In the previous semester I discussed the issues the project had in terms of project improvement, design improvement, and project team interaction. After analyzing the issues in each of these sections it was found that the project as a whole had issues of specifying design, sharing information, not having enough iterations of the grinder mechanism as well as material choices, not meeting enough to get efficient work done, and finally the issue of member-member communication. To resolve these issues, I implemented an action plan to address the issues and hopefully solve them for the spring semester and in the next paragraph I will discuss how this plan had gone.

In terms of first steps of implementing the action plan I held a meeting to discuss the importance of communicating amongst members, doing combined research and analysis for subsystems, and the importance of analyzing iterations of the subsystems we analyze. This meeting went well and effectively put everyone back on track coming into the semester and allowed everyone to be focused on the project. The importance of communicating amongst members was understood, but not implemented to the degree I would've liked as some members were still communicating to me and the team leader for information instead of asking the member in charge of the information. The next step in my action plan was to collect the schedules of all members and develop a meeting schedule to increase productivity on the project and this plan worked with 100% success as I was able to set a meeting schedule that made all parties happy and allowed majority of the team to meet twice a week for an extended period of

time. The final step of the plan was to ask for various specified iterations in design for the stump grinder and this worked out great as by the time research and calculations were complete we had a massive list of different iterations of the stump grinder that could feasibly work. The success parameters for each of these action plans are as follows and are in respective order: did we accomplishing more work for the project, did we complete the project correctly, and did we communicate more and work together; and if there were multiple variations for each subsystem and if my team members were working together to make these variations and compare them to their own respective subsystems throughout the semester. I would say given the measures of success I would say that this plan was 100% successful as we managed to increase communication efforts, be more productive on the project, and complete several iterations of the stump grinder. Next I will discuss the action items related to the areas of improvement.

The implementation of the action plan that involved Project Improvement was sharing of data with other team members and this worked to improve the overall project as with the data being shared they were able to analyze each other's results and utilize the data to complete their own unique subsystems. The implementation of the action plan that involved Design Improvement was the final part of the plan which involved making multiple iterations and additionally analyzing material selections for the stump grinder which ended up being a massive success as my team was able to take the data they shared with each other and create multiple iterations of the stump grinder that worked perfectly and in addition to this we researched several different kinds of metals and compared them to see which were the cheapest and had the most harmonic properties we were looking for in the project. This material and iteration analysis can be seen in both the report and in the presentation. The implementation of the action plan that involved Project Team Interaction was utilizing the members' schedules to coordinate meeting times and in addition implementing a source of communication that everyone can see and communicate with. This worked as I was able to set up an email communication page, a community research paper and presentation page, and a group chat over the phone to utilize collective communication and I additionally utilized my team's schedules and built a meeting schedule that allowed most of the team to meet twice a week and do so at a time that wasn't too inconvenient for everyone. The only part of the action plan that I did not implement with the improvement section was making the iterations more specific as I had come to find out that doing so would be outside of the scopes definition which does not work for larger projects like this one. Next I am going to reflect on the project as a whole.

Reflection:

I would say all in all the project went quite well with a few hiccups or challenges that we had to hurdle over. A few things that went well for us were doing the research and design work for the stump grinder and analyzing these designs to make sure that the components worked well together. Another area that went well was the overall prototyping process as we already had the model we wanted to prototype made and tested in solid works and the printer we utilized was ready to go for us. The things that could've been done differently for this project would be to figure out the definition of the scope more quickly that way we would have more time to actually work on the project and in addition to this I would say if we spent some of our own time over winter break performing some of the calculations or at least collecting values that would be utilized in the equations I think the whole process would've gone faster. However, I still say that this project was completed successfully and taught us a lot about how to complete a real engineering project.

Conclusion:

This is the project that me and my team have been working on all semester. Throughout the course of the two semesters, we have had some issues, but this did not stop the overall successful completion of the project. Hopefully, upon completion of the project Gary and Carol will continue to work with the University of Nebraska Lincoln and hand off our ideas to future engineers to design and build the stump grinder we spent a year analyzing and hopefully they will have a device that will last for years of use.