



University of Idaho




IDAHO CSC




## CSC REAR DRIVE COVID-19 ERA PROJECT UPDATE

TEAM SKIDADDLE :  
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# OVERVIEW

- Revisit value proposition
- Memory Refresh
- Budget Review
- Manufacturing update
- Validation plan overview
- Future recommendations



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# PURPOSE/VALUE PROPOSITION



Modern Snowmobiles have a track which is turned/driven with cog-drivers in the front. This pushes the track, which being a flexible element, bunches up. This leads to both drivetrain and handling inefficiency. A solution is to pull the track, by having the drivers in the rear. Currently, there are no rear driven snowmobiles on the market as an OEM or Aftermarket platform.

At the SAE Clean Snowmobile Challenge (CSC) which the U of I CSC Team competes in every year, technical innovation is highly valued.

To meet both these challenges, the goal is to develop a rear driven snowmobile system that will be able to directly generate data to compare rear-driven and traditional drive technologies. Our team is proposing a swappable front to rear drive system for this year's CSC team and snowmobile. Our design seeks to have similar suspension design and performance, while being easy to swap with the stock configuration.

In Short:

- The value to industry will be data showing the validity of rear drive vs. forward drive
- The value to the UICSC team will be an innovative project to bring to the 2020 CSC



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# MEMORY REFRESH



- 3 axle, 2 belt design
- Data between forward and rear track drive is the goal
- Two independent drivers on front and rear axles can be engaged
  - Makes 9 total possible configurations, plus stock configurations
  - Forward and rear configurations are priority



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# BUDGET REVIEW



Supplies/Parts	Supplier	Total Cost	Purchased/Needed
½" Sheet Aluminum	Facilities	\$ 696.99	Purchased
Angle Iron	Facilities	\$ 126.54	Purchased
Steel 4140	Facilities	\$ 23.98	Purchased
Belts (4)	Denniskirk	\$ 835.00	Purchased
Silent Drive Axles (2)	Valley Powersports	\$ 594.00	Purchased
Ski-doo Runners (2)	Valley Powersports	\$ 620.00	Purchased
Hardware Order	McMaster-Carr	\$ 281.39	Purchased
Hardware Order	Bolt Depot	\$ 192.53	Purchased
Brake Line Parts	Amazon	\$ 218.98	Needed
5" Round Stock W: 1ft	Metals Depot	\$ 171.56	Needed
Bronze Bushings	Moscow Building Supply	\$ 20.00	Needed
TOTAL COSTS (ESTIMATED AND FINALS)		<b>\$ 3,780.97</b>	Budget (\$ 3,750)



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# MANUFACTURING UPDATE



Parts Remaining:
Front Swingarm
Belt Sprockets
Tensioner Blocks
Front Belt Tensioner
Finish welds and paint
Brake Components
Front Axle
Shaft Inserts



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# VALIDATION PLAN PREFACE



- Design Intent:
  - Purpose is fuel economy first and foremost
  - Handling comes second
  - Durability is another consideration (testing apparatuses are not production designs)
- Testing:
  - Some tests show differences quickly
  - Other tests rely on quantity of data
  - Three-part plan allows for failure early: Beginning -> Middle -> End



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# VALIDATION PLAN BEGINNINGS



- Start with showing a difference
- Modified SAE J2263-coast down distance & time test
  - Very simple and fast
  - Shows that there is some differential in the drive train efficiency between configurations
  - Longer or shorter distances/times on a tracked vehicle do not directly correlate to a more efficient design
- Done first, so as not to waste time
- If there is no differences, then it must be decided to continue testing or not



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## VALIDATION PLAN MIDDLE

- Fuel Economy Testing
  - The most important metric
  - Requires an experienced rider
  - fuel economy rides are not the same as normal riding
  - The difference must be substantial – many miles must be recorded
- Durability Testing
  - A red-yellow-green test (broken - rideable damaged - fine)
  - Have fun riding, the intent is to stand up to “normal” riding
  - “Don’t do dumb things” – if a “normal” snowmobile shouldn’t do it, neither should this



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## VALIDATION PLAN END

- Assuming fuel economy is sufficient, proceed to the handling portion
- Braking test
  - A simple metric, but a difficult test to repeat
  - Many runs required
  - Judgement must be made to throw out “bad data” from final reporting
- Acceleration test
  - Difficult skill, repeatability and value drift must be considered while testing
  - Surface preparation and abandonment is a judgement call



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# VALIDATION FLOWCHART



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# VALIDATION/RISK MANAGEMENT



- Snowmobiling is dangerous, PPE must always be worn
- Experience is required to do testing effectively
- Details of each of these tests are in the Validation Plan Documentation
- All factors need to be considered when deciding to pass or fail



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# FUTURE RECOMMENDATIONS



## THOMAS

- If I could do it again, I would only worry about rear drive first, forward drive second
- Take accurate measurements and follow the design guides from the OEM. ie: don't make a 8mm bolt a 3/8" bolt for no reason
- Hold off ordering bolts/hardware until everything is made, so that you don't have to waste on parts you didn't actually need
- Try a 3-D scan of stock parts you are going to use



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# FUTURE RECOMMENDATIONS



## AREF

- Team members must know how to manufacture stuff, before taking on such a manufacturing intensive project
- Do not let teammates fall behind because they arrived later. Often designs are pitched, but there are not enough people. The people that "The Capstone™" assigns to the project must be brought up to speed too.



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# FUTURE RECOMMENDATIONS



## BRANNON

- Avoid welding things that are too much for the ME shop to handle ie: 3/8" aluminum+
- Be knowledgeable of the tools, machines, welding equipment, and tooling that is available before making design decisions
- A real understanding of the suspension, OEM design, and intent is required before even thinking about changing anything
- Use real metrology tools. Calipers, micrometers, laser, 3-D scans, CMM, ferule arms, etc. **DON'T USE TAPE MEASURES AS PRECISION INSTRUMENTS.** Anything that goes in CAD and is important needs precision dimensions down to at least 0.01", if not 0.001".



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# FUTURE RECOMMENDATIONS



## TEAM TO FUTURE TEAM

- The CAD models are never perfect. The poor metrology of the skid rails are still there from the previous team, and we still have them in our model.
- Future manufacturing: use all the shop and CSC material before buying.
- DON'T BUY FULL SHEETS FROM FACILITIES they will rip you off if it is not already stocked
- **IF IT IS NOT IN STOCK ALREADY ANY PRICE QUOTE IS MEANINGLESS.** Get price/part/dimensionally accurate specific quotes early!
- Work together. Manage week by week, Do not stretch out deadlines. CAD is best done with everyone present.
- **DON'T HAVE NON-SLED PEOPLE TACKED ON BECAUSE IT IS AN OPEN PROJECT**
- Have an open schedule, this is a lot more work than the average capstone. It requires far more attention to detail.
- **DO NOT USE PREMADE CAD FROM "PREVIOUS DEIGNS", OTHERS OR OTHER WEBSITES IF YOU DO NOT KNOW EXACTLY WHAT THEY ARE REFERENCING.**
- Without a 'real' sponsor, you must be self-driven and hold yourself accountable. You will need to secure sponsorship and other funding. Be bold and be ambitious. "Ask high and ye shall receive something reasonable"
- Two-part teams are dangerous. Stick to a single senior year team, if possible. Otherwise one team loses design control while the other dumps their work on to you. Especially if they do not meet the pre-assigned goals and deadlines.
- **STICK TO WHAT YOU KNOW!** Don't look to things you have no experience with as a possible "savior design". ALWAYS HAVE SOMEONE ON THE TEAM WHO KNOWS ABOUT WHAT YOU ARE DESIGNING: EX: If design a hydraulic drive, and all everyone knows is gears, it's a bad idea.
- Assign a team manager. If you have a 2-part team, have one manager who is there/present for all three semesters. Loss of consistency destroys productivity of large groups.
- Capstone hoops to jump through can helpful, or very hurtful. **BUT KNOW WHAT CAPSTONE DOCUMENTS/REQUIREMENTS/DEADLINES/"WHAT YOU ARE ALLOWED TO DO"**. Capstone is very different from CSC management, and you will feel like it is dumb and double dipping.
- Maybe a future CSC project could be a cruise control to help for testing the rear drive
- **FUTURE TESTING MUST BE ON THE 2017 SKIDOO TNT CHASSIS (SPECTRE)**



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# FUTURE RECOMMENDATIONS



## IF THERE WAS A RE-DESIGN

- Find a way to have the front belt center to center length be the same length as the swingarm pivot length, so as huge a dynamic tensioner is not needed.
- Find a way to machine the hubs as a solid piece, instead of welding
- Find a way to clock the key and bolt circle angles, so that they are consistently made
- Use commercial bearing retainer tech (like pillow blocks)
- Hardware should be a separate subassembly in cad, so that design changes are not a hassle
- Suspension is more relevant than the driveline, and that should be priority to investigate
  - Do not waste time investigating drive technologies that no-one is familiar with
  - Perhaps start with a c-motion suspension or similar which would have more room



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# END OF UPDATE



- Questions Or Discussion



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