HERC Vision Builder Adventures Rover Challenge Team

OPERATIONAL READINESS REVIEW 2021

MARCH 9, **2021**

VBA Rover Challenge Team

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Operational Readiness Review Report 2021

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INTRODUCTION

This Report serves to provide an assessment of readiness of the personnel, processes/procedures, and vehicle and components to safely execute the mission. It provides support of test and due diligence exercised in demonstration readiness of engineering operations, and processes and procedures.
There were not many changes made from the Design Readiness Report. The Rover changes that were made were changes made to improve overall performance on the course. The changes that were made where in the following areas; frame design and wheel design.

FRAME DESIGN

In the frame design, the following changes were made: springs in the seats were removed, another Idler was added, and the aluminum bar was shaved down. Early in the process springs had been incorporated within the seats to add additional suspension. The suspension was added for rider comfort. Upon testing, it was discovered that the springs decrease Rover performance. The seats decrease the torque that could be applied to the chain. With the passengers moving/wobbling in the seat, it hampered the leg drive. (Reference 1) A new small idler was added to the back of the Rover to improve performance. The idler was installed to provide more tension to the chain. (Reference 2) Lastly, the aluminum bar was shaved down to improve the opening and closing of the Rover. The bar was shaved less than ¼ of an inch, all the way around. In testing this bar, the collapsing time was approved. (Reference3)

Reference 1

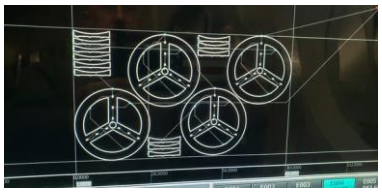
Reference 2

Reference 3

WHEEL DESIGN

In the wheel design, the only change made applied to the Rim. Within the disc of the Rim we added 3 holes. The cut out of the three holes decrease the weight in each tire by a pound. The Rim cut outs decrease the overall weight of the Rover by 4 lbs. (Reference 4)

Reference 4



Excursion Readiness

The Rover is ready to handle any mission challenge on the HERC course. In the beginning of the HERC, a map of the course was given. The map showed the different obstacles the course would have this year. With this map and previous Rover challenges viewed on You-tube, the Rover was designed to handle and complete each obstacle safely. While offering an effective speed through each obstacle.
Suspension, Seat belts, and Safety padding, was added to provide comfort and protection to the passengers. The suspension protects the passengers against violent jolts on the course. The suspension also aides in the stability of the Rover going over some obstacles. The Seat belts serve as a harness to keep passengers fastened to the vehicle. This keeps the passengers from flying out of the seats while going over obstacles. The safety padding is on the bar in which the passenger's straddle along with the handle bars. The padding provides safety should the Rover cause the passengers to fling or buck in the seats. We are excursion ready.

Mission Readiness

The Rover is mission ready. The Rover has been constructed and tested to meet the challenge of the HERC. The Rover's frame was constructed of Steel and Aluminum. The frame was tested at our local BMX track.

Vehicle Construction

The Rover is fully functional. The process of constructing the Rover went as follows:

- The frame
- The C-clamp and Axle
- The Drive-train
- Suspension and steering
- Brake installation
- Tire assembly and installation

The frame was constructed out of steel and aluminum. The steel part of the frame is hollow tubing, and the aluminum part of the frame is a shaft. The shaft is installed in the

center of the frame. These materials allow the Rover to be sturdy, lighter, and collapsible. (Reference 5)

The C-Clamp and the Axle are installed into the frame. The C-clamp enables us to add steering & suspension along with the front tires. The solid Axle gave us the ability to attach the Drive train and the braking system to the back wheel. (Reference 6)

The Drive-train powers the Rover. The drive train is powered by two passengers. The passengers apply pressure to pedal system and on a chain system, giving it, the Rover power to move. (Reference 7)

The Suspension and Steering system were designed for better Rover functionality. These components were also designed for the comfort of the rider. The suspension was added to the front tire, through the C-Clamp. The suspension system helps to eliminate some of the rigidness of the frame. The Steering system helps us navigate through course. (Reference 8)

The braking system is also a big component used in navigating the course. The brakes give us the ability to slow down and stop. The braking system we use is a disc braking system. The braking system is lightweight and effective on the Rover. (Reference 9)

The Wheels are a critical component for this competition. The wheel created were made out of Aluminum with Rubber over lay. The rubber over lay gave the grip needed to go through obstacles. The aluminum composite gave the durability needed to complete the course. Images below. (Reference 10)

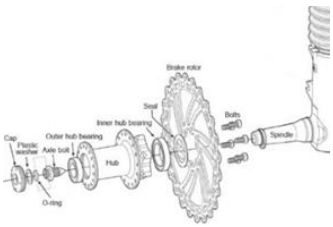
Reference 5

Reference 6

Reference 7

Reference 8

Reference 9



Reference 10

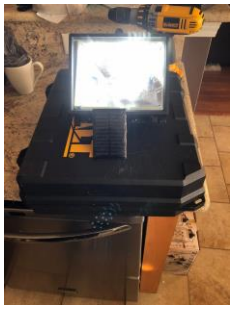
Task and other Mission Components

The Task and Mission Components outside of the Rover build, was to find and create tools to complete the missions. The objects we had to find were light Filter for the Spectrographic Challenge. The tools that we had to create was a scooping tool and a solar powered light.

The light filter that will be used are colored lenses. (Red, yellow, blue) Each filter will be used with camera will provide the results needed to complete the Spectrographic Analysis. (Reference 11) The solar panel light was constructed with several parts, Solar Power Panel w/ connectors, LED Light Panel, Connector board, Switch, Battery pack, and a lighting housing unit. (Reference 12) Lastly, the sample retrievals tool (Scooper). The Sample retrieval task mission components was a challenge. Due to Covid-19 many of our 3-D printing shops in our area were closed to the public. Because of this issue we had to create tool outside of 3-D printing. The scooping tool that was created of Aluminum. (Reference 13)

Reference 11

Reference 12



Reference 13

MISSION PERFORMANCE PREDICTION

Preparation for the course

To prepare the Rover to take on the HERC, testing was done. The Rover was tested at our local BMX track. At this BMX Track we tested for the following HERC obstacles. The Transverse incline, the High Butte, Undulated terrain, Ice Gayser Slalom, Lunar Crater, and the Sand Dunes. At the BMX track the Rover performed well structurally. The Frame hollow collapsing with-in capabilities was the biggest concern in testing. The frame was twisted and pounded. The track had a number of climbs, bumps and jumps. The Transverse incline, the High Butte, and Undulated terrain all put major stress on the frame. But we feel good about our success with these obstacles. The Track was also a little muddy in spots. This condition made drivers traverse cautiously using brakes and steering at time to complete course. The Ice Gayser Slalom, Lunar Crater, and Sand Dunes requires braking and steering disciple with the drivers. We also feel comfortable with this obstacle as well. Therefore, we predict success on these six obstacles.

To prepare for the other terrains the tire becomes the focal point. The tire created was based on the challenges of 7 obstacles. (1) The Crater with Ejecta, (2) Tilt Crater, (3) Loose Regolith, (4) Pea Gravel, (5) Bouldering Rocks, (6) Large Ravine, and (7) Crevasses.

The Crater with Ejecta, Tilt Crater, Loose Regolith, Pea Gravel, all deal with loose material. The tire we have constructed have grip designed to pull through these obstacles. The tires will be tested on gravel surfaces at shop (driveway (loose gravel)) before the HERC. The Boulder Rocks obstacle requires grip as well, but durability of the wheel is crucial for this obstacle. This will also be tested at the shop. Lastly, the Large Ravine and the Crevasses are obstacles in which the tire size will be an issue. The tire size is 30” which will enable us to pull over the Large Ravine, and the clearance to go over the Crevasses obstacle. We predict success on these 7 obstacles as well.

There are 4 obstacles that require actions outside of the Rover racing on the track. They are the Spectrographic Analysis, Instrument Deployment, Core Sample Retrieval, Solid Soil Sample, and Liquid Sample Retrieval. We understand what each obstacle requires, and we have compiled all the tools and supplies to pick up the max points for these obstacles.

Upon review of these obstacles we will continue to test up until March. There is no doubt that the VBA RCT will be ready for the challenge.

Hazard Analysis

Below is the Hazard Analysis chart used to review every obstacle at the HERC. Within the Analysis chart, the Specific Hazard is displayed, along with the Personal Protective Equipment used to protect each driver. The Rover control were also analyzed for personal safety over each obstacle. (Reference 14)

Reference 14

Task at HERC	Hazards	Controls	Personal Protective Equipment (PPE)
The Crater with Ejecta	Crater	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Tilt Crater	Crater	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Loose Regolith	Loose Materials	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Pea Gravel	Loose Materials	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Bouldering Rocks	Loose Materials	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Large Ravine	Loose Materials	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Crevasses	Cracks	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Transverse incline	Incline	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
High Butte	Incline	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Undulated terrain	Navigational	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Ice Gayser Slalom	Navigational	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Lunar Crater	Navigational	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,
Sand Dunes	Navigational	Steering and Suspension	Seat Belts, Padding, Helmets, goggles, gloves,

Failure Modes and Effects Analysis (FMEA)

Below is the FMEA chart used to help produce success at the HERC. Within the Analysis chart, failure of potential hardware of the Rover is analyzed. Failure mode, failure causes, and stress is considered, along with how to potentially mitigate. (Reference 15)

Reference 15

Hardware	Failure modes	Failure cause	Stress	Mitigate
Frame	Hollow Frame	Twisting of frame	uneven surfaces	Travel through slowly
Drive-Train	Chain	Chain breaking	Inclines	New Chain
Steering component	Steering radius	loosing control	Going to fast around obstacle	Slow travel though obstacle
Braking System	Unable to stop	Disc brake failure	Loose material obstacles with potential declines	Slow travel though obstacle
Wheels	Integrity of wheel	Hitting a large object	Large Boulders	Move at a moderate pace
Suspension System	Spring	Heavy pounding	Large Boulders, Bumpy surfaces	Move at a moderate pace
Seats and seat belts	Disconnecting from frame	Twisting of chairs	Uneven surfaces	Travel through slowly

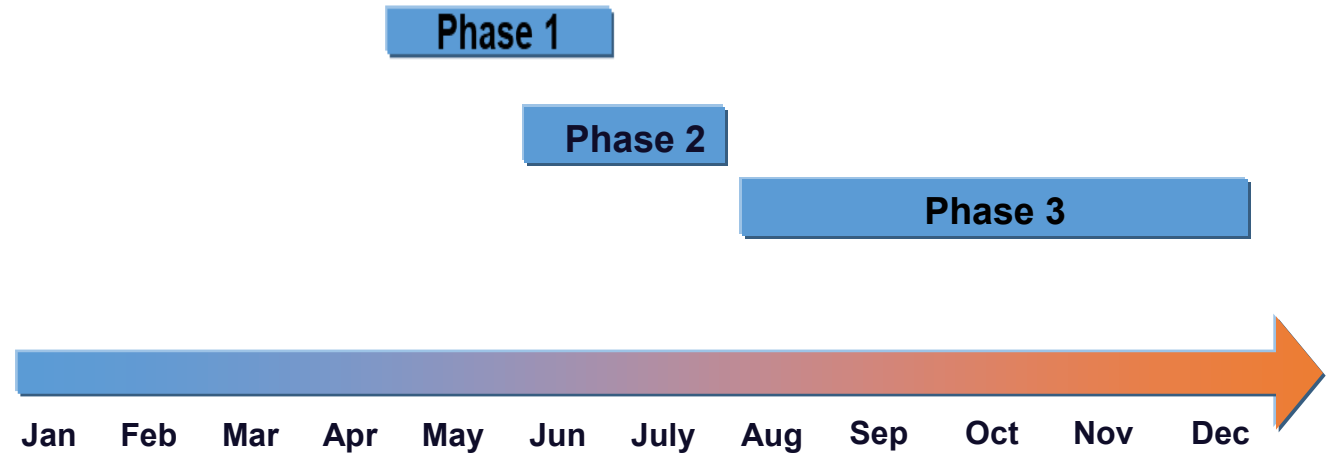
Project Plan

The project began on Wednesday June 24, 2020. The selected students met with the project leaders via Zoom to talk about expectations and the Project scope. The project scope was the time frame in which we will use to complete different goals. Each goal completion will lead us to our ultimate goal. Racing and winning the HERC in April 2021.

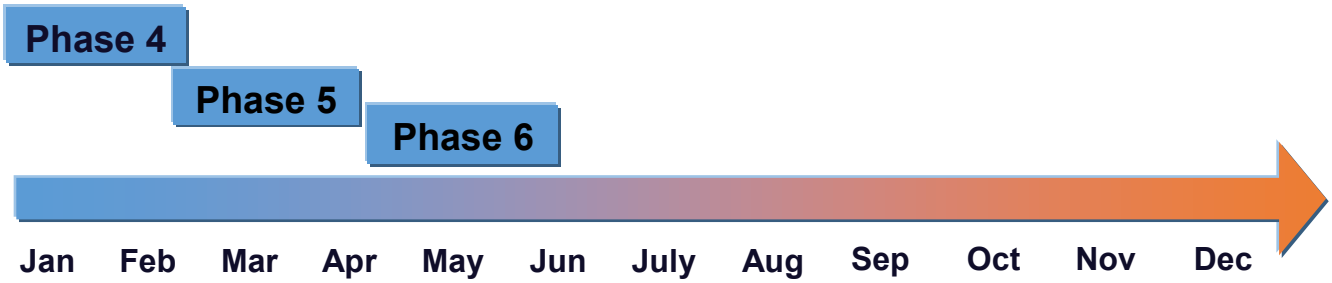
The Project Scope consisted of 6 Phases: Phase #1: Initiate, Phase #2: Reconnaissance, Phase #3: Fabrication and Review, Phase #4: Final Scope, Phase #5: Ready Forward, Phase #6: The Race. (Reference 16)

Reference 16

2020 Timeline Graph



2021 Timeline Graph



Phases Description

Phase 1 Initiate (Brainstorming Sessions), Phase 2 Reconnaissance (Research and Design), Phase 3 Fabrication and Review (Build and test), Phase 4 Final Scope (Reporting), Phase 5 Ready Forward (Project completion), and Phase 6 The Race (HERC Event).

Timeline Review status with Phases

Phase 1 Initiate

In the Brainstorming Sessions, each student was challenged to watch a Rover Challenge competition and design their Rover and write a Report about their Rover. The Reports were due on Saturday, July 11, 2020. The Design had to comply with the 2020 HERC guidelines.

Phase 2 Reconnaissance

On Tuesday, July 14, 2020 the students had a Zoom call with the Engineers at MC Polymers. On the call, engineers collaborated with students on practical design ideas. The engineers reviewed student ideas and shared insight from wheel composition to frame composites. Afterward, a student design was chosen.

Phase 3 Fabrication and Review

On Saturday, July 25, 2020, we met with MOBS Fabrication (Shop) to talk about a building and testing schedule for Phase 3. Rover parts from local bike re-cyclery were also delivered.
On Saturday, August 8, 2020 final Rover parts were delivered to the shop.
On Saturday August 15, 2020, all students had a Zoom call with resident engineer to discuss Mechanical Engineering and HERC Terminology.
On Saturday August 29, 2020, students meet at the shop, were the were taught about Safety guideline and the tools and equipment that will be used. The students also began the building of the Rover (Frame Collapsing).
On Wednesday September 2, 2020, Fabrication Students had a Zoom call to discuss progress.
On Wednesday September 16, 2020, Fabrication Students had a Zoom call to prepare for Saturdays project build.
On Saturday September 19, 2020, Students meet at the shop, the Fabrication Students worked on the Rover (Frame Collapsing and Seating alignment).
On Thursday October 1, 2020, Fabrication Students had a Zoom call to prepare for Saturdays project build.
On Saturday October 3, 2020, Students meet at the shop, the Students worked on the Rover (Suspension and Steering System).
On Thursday October 8, 2020, Fabrication Students had a Zoom call to prepare for Saturdays project build.
On Saturday October 10, 2020, Students meet at the shop, the Students worked on the Rover (Drivetrain and Braking System).
On Saturday November 14, 2020, all students meet at Hornets' Nest BMX track, the Students tested the Rover, as well as testing themselves for the competition.
On Thursday December 3, 2020, all students had a Zoom call to discuss repairs made from testing as well as testing results.
On Thursday December 17, 2020, all students had a Zoom call on the Design Review Report. (DRR)(Report assignments for students)

Phase 4 Final Scope

The Final scope is Reporting. The report was written by Hannah White.
On Thursday, January 7, 2021, all students meet on a Zoom call to prepare for Saturdays DRR Report wrap up.
On Saturday January 9, 2021, Students meet to wrap up DRR Report.
We are currently on track and guidelines are being met. On Thursday January 7, 2021, all students had a Zoom call on the DRR. (Report student abstract)
On Wednesday January 13, 2021, Design Review Report due.

On Thursday January 14, 2021, all students had a Zoom call on DRR presentation. (Student assignment review)
On Monday January 18, 2021, DRR student presentation.
On Thursday January 21, 2021, all students had a Zoom call on DRR presentation student recap.
On Thursday January 14, 2021, all students had a Zoom call on DRR presentation. (Student assignment review)
On Tuesday February 2, 2021, all students had a Zoom call on STEM Engagement programs.
On Tuesday February 9, 2021, all students had a Zoom call on STEM Engagement programs.
On Saturday February 13, 2021, STEM Engagement program in Gastonia NC.
On Tuesday February 16, 2021, all students had a Zoom call on STEM Engagement programs review.
On Tuesday February 23, 2021, all students had a Zoom call on Operation Review Report. (ORR)
On Tuesday March 2, 2021, all students had a Zoom call on Operation Review Report. (ORR)
On Saturday March 6, 2021, all students had a 4 hour Zoom call on the ORR. (Report Review)
On Tuesday March 9, 2021, all students had a Zoom call on Operation Review Report. (ORR)
On Wednesday March 10, 2021, Operation Review Report due.
On Tuesday March 16, 2021, all students had a Zoom call on Operation Review Report presentation. (ORR)
On Saturday March 20, 2021, all students had a 4 hour Zoom call on the ORR Presentation. (Presentation Review)
On Tuesday March 22, 2021, all students had a Zoom call on Operation Review Report presentation review. (ORR)
On Wednesday March 23, 2021, ORR student presentation.
On Thursday March 25, 2021, Completed Rover picture due.
On Saturday March 27, 2021, Final Rover video testing event.
On Wednesday April 7, 2021, Rover video testing Due.

STEM Engagement

Our STEM Engagement took place on Saturday, February 13, 2021 at Lynn Planetarium in Gastonia NC. On that day we meet with over 400 students and parents. Per Candice Jordan, Director of the Planetarium. General Admission tickets sales on that day was 468 visitors. At the event we talked about the Rover, the HERC mission requirements, and how it works. We allowed students of all ages to get on the Rover and experience it first-hand. While on the Rover, the students got a chance to see how it was powered through the

Pedals. They also learned about the vehicle dynamics (i.e. vehicle suspension, turning radius, etc.). While we were going through demonstrations, there were a number of other activities going on. The Planetarium was promoting the Mars Rover landing. The actual STEM activities were student building paper helicopters. The Helicopter idea was symbolic of Ingenuity. There were also a lot of Mars Rover color sheets for younger attendees.
The event was a Planetarium Event. The expectation of our team was to talk and engage students with our Rover and comment on the Mars Rover landing. We did not conduct any evaluations, nor receive any comprehensive feed-back from Patrons. But we did receive feedback from Candice Jordan, the Planetarium director. She was very pleased with our student engagement, and blown away by the community turnout. (Reference 17)

Reference 17