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1. INTRODUCTION
    a. Intro:(David)(15s)
        i. Good Morning Judges
        ii. We are the WarriorWaves, and this year we present to you our first ever ROV: The Water Goblin!
    b. Team Members:(All)(50s)
        i. I'm _____, my position is ___
            1. David
            2. Connor
            3. Ananya
            4. Jonathan
            5. Ida
            6. Marcus
            7. Rhea
            8. Meher
            9. Zack
            10. Ryan
            11. Nathan
    c. Safety Philosophy(Jonathan)(1m)
        i. Safety First
        ii. Safety Features
            1. Shrouds
                a. All openings are smaller than a finger
            2. Fuse
                a. Following MATE ROV guidelines
            3. Hazard Tape
                a. Potential, but already protected parts like thrusters
            4. And other safety features
        iii. Methods
            1. Training on all heavy machinery by a mentor or certified professional
            2. Closed toed shoes+proper attire
            3. Gloves when working with chemicals
            4. COVID
                a. Masks, scanned temperatures, sanitized workspaces
    d. Organizational Philosophy(Connor)(10s)
        i. Coleads
            1. President, CEO
        ii. Subteams

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            1. Mechanical, Electrical, Software, Business
    e. Mission Tasks(Ananya) (30s)
        i. Implications in the real world
    f. Design Rationale(David, Connor)
        i. Marketability(Connor)(40s) /
            1. Aesthetics+Functionality
            2. How it meets theme
        ii. Organizational Decision Making(David)(1m)
            1. In our team, communication is key. We use slack to text and make announcements, and this year we used Zoom and Microsoft Teams for meetings. For scheduling and event planning, the entire team would meet and develop a Gantt chart that identified when certain subsystems would reach specific milestones or major goals. We took this mentality of inclusivity into other decisions as well, and made sure to weigh the pros and cons of each decision, sometimes using tools like a decision matrix.
        iii. Technical Development(David)
            1. All subsystems and their individual components are developed using the engineering design process. We first come up with a concept, or need, and then create a design to solve it, often in CAD or as a digital model to save time and money. The design is then reviewed within subsystems and by leads, or by mentors. Once it's approved, it gets fabricated and repeatedly tested.
        iv. Build vs Buy(David)
            1. When choosing to build or buy components, we would buy when it was cheaper, safer, or necessary. Otherwise, we would do our best to build our own components to serve a certain purpose. An example of build vs buy would be buying our thrusters because they were cheaper and more efficient than built, and building our claw in order to fit specific needs.
        v. New vs Used(Connor)(10s)
            1. No "reused" components as this is our first year
2. ROV
    a. Name(Ananya)(20s)
        i. Originally a proposition for a team name
        ii. Homage to that
    b. Mechanical:
        i. Frame(Connor)(1m30s)
        ii. Hanger (Connor)

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1. Hanger holds the manipulator
   a. Bottom camera
   b. Claw

iii. Claw(Nathan)(30s)
   1. We made the claw relatively small so that it would not weigh a lot and throw off the buoyancy of the rest of the ROV while still being able to complete the tasks
   2. The claw grippers are designed to grab 1/2 inch pvc pipe but can open wider to grab even larger objects.
   3. This is necessary as it is one of the few manipulators so it needs to be very versatile.

iv. Camera Mounts (Zack, Ryan)
   1. Front Camera Mount(20s)
      a. We decided to put the front camera mount inside the enclosure so we would not have to worry about waterproofing it
      b. We also decided to add the ability to rotate the camera angle vertically 360 degrees so that we can adjust the angle of the camera for whatever situation we encounter.
   2. Back Camera Mount(20s)
      a. The second camera is housed in the back camera enclosure, which is mounted on the backside of the "hanger" to view the claw at a vertical position and the surrounding area. The enclosure is made out of a resin material to utilize its water resistance qualities, and is also manually adjustable, allowing it to view different surrounding angles when required.

v. Buoyancy and Propulsion (Ryan)(1m)
   1. Considering the negative buoyancy of the ROV due to its weight, we chose to use polyethylene foam to counteract the negative buoyancy, resulting in an overall neutral buoyancy. We utilized pool noodles cut in disks as a cheap way to do this, while allowing for the material to maintain its form under high pressure and a high operating depth.
   2. To propel our vehicle, we placed 6 Blue robotics t100 thrusters in specific positions to obtain 5 degrees of freedom, which include yaw, pitch, sway, surge, and heave. This allows for the ROV to move in different directions at different altitudes. The thrusters are

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   attached using connectors that allow for easy maintenance and removal when the orientation needs to be changed.

vi. Trade-Offs/Lessons Learned/Challenges(Connor)(1m)
   1. Measuring

c. Electrical:

i. **Topside**(Rhea) A major component of our electrical system is topside
   - We optimized the space in our topside station by compartmentalizing it into a lower electronics section where we secured the topside electronics and an elevated platform to make the computer and controller more accessible.
   - The topside electronics consist of a Fathom-S topside board, an RCA to HDMI converter, a monitor, computer, Xbox controller, power supply, as well as the tether.
   - The topside main power supply powers the electrical systems of the entire ROV besides the monitor which relies on power from a 120 ADC standard outlet.
   - The RCA-HDMI converter converts camera feed to be displayed by the monitor.
   - The Xbox controller is connected to our computer to send serial signals through the Fathom boards in order to control the ROV
   -

Tether(Meher)(30sec)
   - We used a BlueRobotics Fathom tether since it is neutrally buoyant, has high visibility and included connectors
   - For our tether management protocol we used a spool to prevent tangling and be more organized.
   - We included strain relief on the ROV side to prevent the back plate from being pulled and to prevent the wires from receiving extra stress.
   - Additionally, we included a mesh sheath to prevent knots and protect the wires.

ii. Onboard Control System(David)(1m30s)
   1. The onboard control system has three main functionalities: power distribution, signalling, and video. We use ESCs for the thrusters and a DC step down converter for the claw servo, from 12V to 6V. For signalling, all PWM/Motor control signals come from an onboard arduino mega, which communicates with the topside station through a Fathom-S board using differential signaling. Video is transmitted through the Fathom-S as well, and comes

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   from a multiviewer which combines feeds from 3 different cameras into one video signal to send to the topside station.To make the process of maintenance and troubleshooting easier, many of our connections are not permanent, and are connected through crimps or adapters. We also make use of electrical buses and other accessories to make our life easier.

iii. Trade-Offs/Lessons Learned/Challenges(David)
   1. We faced many challenges during the season, but the most predominant one was working with the Fathom-S boards. While these are excellent boards, the fact that they were PCBs made them hard to fix and maintain, which led to boards breaking or not working consistently, leaving us with only one spare set. We created a dependency on a discontinued product, meaning we were in serious trouble if all of our fathom boards broke. We were also unable to perform thorough analysis and troubleshooting on the board because we weren't familiar with using more complex tools like an oscilloscope, and all our tests with multimeters and ammeters revealed nothing new. Tradeoffs we made included decreasing thruster power and quantity to make fuse limits, and we learned many lessons, like to leave room for wires in the enclosure.

d. Software:
   i. Python Script(Marcus)(1m)
      1. For our software, we are using an Xbox controller to control the ROV in the water.
      2. We used the Pygame library in our python script to get inputs from the controller and we used the joysticks and triggers from the controller.
      3. The Python script also uses the serial library to establish a connection with the arduino to communicate.
      4. The script waits for when a joystick is moved. Once a joystick is moved, through the serial port, it will send a message to the arduino including the directory of which joystick was moved and the amount that it was moved to determine the speed of the thrusters or the angle of claw.
   ii. Arduino Code(Marcus)
      1. Once the arduino receives a message from the Python script, it breaks down the components of the message.
      2. Depending on the directory, which is either sway, surge, heave, yaw, or open and close the claw, the arduino code will move certain motors with a certain speed or angle depending on the

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values received in the message. To perform these actions, our arduino code uses the servo library which allows us to control motors through the arduino. This entire process runs continuously in order for the ROV to move and run.

iii. Trade-Offs/Lessons Learned/Challenges(Jonathan)(30s)
    1. One of the biggest challenges we faced was creating a functional PID/IMU. Although there were resources online to help us create a PID that would let us automatically recalibrate the ROV, they were limited and most were not applicable to our situation. This led to the trade-off of not having a PID that would make driving the ROV easier. Another challenge we faced earlier in the year was making sure that all the joysticks/axes would change correspondingly in the xbox controller output. Overall, the software team learned how to efficiently problem-solve and communicate to work towards a common goal.

e. Testing
    i. Test Procedure(Rhea, Meher)(45sec)
        1. Each working system was tested individually throughout the ROV construction and assembly process to ensure that they are functional. Examples include the testing of the thrusters, servo and claw, and the cameras and monitor system. We also made sure that each enclosure, including camera enclosures, were sufficiently waterproofed.
        2. Pool Tests:
    ii. Troubleshooting(David)(30s) /
        1. Obviously, our ROV and its subsystems didn't function perfectly every time we ran it, or them, so we had to solve the issue by troubleshooting. We would identify the issue, and potential relationships or parts that were causing the issue. We would then eliminate each of these potential factors/reasons, until the problem was solved or there was one left to solve.

3. MISC
    a. Corporate Responsibility(Ida)(1m)
        i. Outreach
            1. Coding workshop
                a. 3hr total Python course
            2. CRYP
                a. North Dakota Reserve
                b. Coding and Electrical Engineering Workshops

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      c. 5h 30m of classes taught

3. ROV Kits
   a. In the future, we plan on developing mini-rov kits for students so they can get a hands on experience of making a functional vehicle

b. Interpersonal Lessons(Connor)(1m)
   i. Leadership during COVID
c. Acknowledgements(Ananya)(30sec)
   i. Mr. Sousa
   ii. Valley Christian
   iii. Parents/Family
   iv. MATE ROV
   v. Thanks(to the judges)
d. Conclusion(David)
   i. "Any Questions?"