Client Needs and Problem Statement

General needs of robotic arms task abilities

The robotic arm must be able to hold a reasonably sized camera, pen, and nozzle. Having the ability to withstand high-pressure nozzles to water blast corrosion is necessary. An end effector 3D path must be included for mapping the route it'll take to paint and blast.

Main idea: The robotic arm must hold a reasonably sized pen, camera, and water blaster that can withstand high pressures.

Practical Needs(fitting into small spaces and its' needs to complete tasks etc)

It must be able to fit into small dark spaces to complete tasks. Also, should be able to see in the dark, a flashlight or night vision would work but a light attached to the robot would be the easiest. The code should be 3D Printable, and it must be easy to attach and detach the robot head (end effector). The arm should be easy to fix by having accessible parts for maintenance. The client is fine with minor repairs and modifications every three months, and major repairs and modifications every 6 to 12 months. It should be usable with little or no technical skills. The total weight needs to be 750g (or less than 1 kg), and have heat tolerable plastic, especially near heated gears. Disassembled components should be able to fit in a carrying space less than 1 meter squared, and must be able to fit under a ladder.

Main idea: Should be easy to build, operate and repair, even for less experienced users.

Technical needs(What it must have to complete tasks etc.)

Having a 3 DOF arm to enable better movement is necessary to complete tasks. Inverse Kinematics is necessary for the robot arm to complete its tasks. A precise movement when painting to get around complex pipes and curved walls is essential.

A camera must identify a point-coordinate system that can scan the nearby space, software that can interpret G-code can be used for this and the system in general. The system should be built off a common language such as c++, python, GRBL, etc.

Main Idea: The arm should be precise in its movement and identify the nearby space to ensure it completes its programmed tasks.

Safety needs(Automatic turn off when it senses the motion of people etc)

The ability to shut off once it senses the motion of people walking around is an asset, this is due to there being 250 people on a 150m long ship. Lights should be attatched to avoid people tripping over it. Limiting the maximum speed of the arm will avoid crashing into people. A *Caution hot surface* sign could be useful due to gears creating heat. The arm should be made of durable and low thermally conductive material to ensure the arm does not catch fire.

Main Idea: Should be able to withstand everyday tasks all while making sure it operates safely and up to standards.

Efficiency Needs

Less power consumption through better parts for a more efficient arm would be great (keep in mind of gear ratio). Being able to use power at a slower rate would decrease cost and energy

consumption. Using a vacuum and disposable containers that can capture water that comes out of the nozzle after being sprayed would significatly decrease water waste. On top of all this, ensuring the arm is cost-efficient while printing material would be very beneficial.
Main Idea: Ensuring it is cost and energy-efficient.

Creative needs (Ways to make the robotic arm stand out and be better based on what they said during the meeting)
The ability to be stored in small spaces in the ship is an asset. The design must be towards energy efficiency (or must conserve energy). The client prefers water blasting end-effectors rather than sandblasters because sand creates contaminants. Having sensors within the code of the robot to avoid crashes would be a great safety feature.

Benchmarking:
Compared to the Microbot, including a twisting and tilting axis within our 3 DOF abilities would enhance movement and flexibility. Ensuring stability and precision is something other robot arms look for and would be beneficial to include in ours. Easy use and being open source increases simplicity when being used by non-technically inclined employees. Microbot has the ability to record and replay complex motion which is an ability we could include in our design. Microbot uses, Blockly, G Code, and Python in the Software, and uses C C++ and JAVA while programming API. These are useful abilities we could include in our design.

Source of Benchmarking design: (2019). *YouTube*. Retrieved January 27, 2022, from https://youtu.be/SisrRUX_Zfk.

Problem Statement: The robotic arm must hold a reasonably sized pen, camera, and water blaster that can withstand high pressures, all while ensuring it is cost and energy-efficient. The easily accessible robotic arm should safely operate to complete its everyday tasks.

Issues that were not addressed in the initial client meeting
Our group is unsure what the exact measurements of the robotic arm are or how to reduce energy usage through coding? The main issue we are uncertain about is how a small to mid-sized robotic arm could withstand pressures of a water blaster without falling? These are questions that must be asked to the client to ensure satisfaction and functionality of the final project.