Rubric

Details
https://orise.orau.gov/stem/k-12/competitions-for-students.html
Define the Problem - Context

Musicians across America and around the world come across problems with their instruments. One problem that can cause many issues is when you are unable to clean your instrument, or it is too time consuming to thoroughly clean the instrument. This is a very common complication that- I personally know well- occurs with mostly larger or more complex instruments, but it can occur with smaller instruments too. Reducing productivity and taking sucking up valuable time when the instrument is taken to be professionally cleaned.

- Several personal friends already don’t clean their instruments because of the hassle and work
- Cleaning rods don’t always reach the space near the cork in a flute (personal experience).
- No matter how much people clean, there will always be some sort of mold.
Define the Problem - Pain Points

If you have a moist/dirty instrument, whether it is filled with grime or mold, your instrument is at risk of breaking, such as rust and corrosion. That can get pretty costly, especially if you have an expensive instrument, affecting students, professionals, and anyone with an instrument. Excess filth can impair the tone of the instrument too, causing a fuzzy or watery noise. And, the inside of an instrument is an ideal habitat for microbes, buildup of that can cause illness or other health complications.

- “Moisture can cause corrosion on brass, nickel or rust on iron and steel, and can cause cracks in wood. The pads in woodwinds can become bloated if they soak up moisture, and then they will not cover the holes properly.” [5]
- “Sweat and oils from your hands contain acid that can eat through the metal of your instrument.” [5]
- “As food particles accumulate, it can cause a wind instrument to sound out of tune. In brass instrument, salts and dirt can collect on the valves, valve slides, hinges, screws, and springs causing them to not work properly, wearing away the metal.” [5]
- “A dirty instrument can have germs that are harmful to your health, whether they are from food or germs from a sick instrumentalist.”[5]
- “For those repeatedly exposed to airborne particles for long periods of time, the immune system can sometimes mount an attack that results in an inflammatory pneumonia, known as hypersensitivity pneumonitis or extrinsic allergic alveolitis, characterized by coughing and shortness of breath.” [3]
- “If they don’t clean out their instruments on a regular basis, black mold can build up inside and cause a condition called ‘Saxophone Lung.’” [4]
Define the Problem - Vision of Solution

But it will save time and money (reducing the amount of maintenance and medicine), allow us as a society to create, develop skills, and improve overall instrument quality. This cleaning bot will solve those costly problems. It cleans your dirty instrument quickly and efficiently. This machine can fit into all instruments because of the multiple sizes would be available. You can also purchase new swabs for your bot, just in case you have any problems with your swabs included with your bot. Control the robot with the app so that you can capture small or compact, hard to reach spaces. The robot should thoroughly clean the instrument and sanitize it. There is already an existing machine that bathes large, brass instruments but only once or twice a year, still allowing mold and other stuff to inhabit your instrument. This you could use every month, week, or even every day.

- The robot can reduce the negative effects
- Many students at school say they would like this robot
Background Research - The Problem

Moisture, body acids, oils, food particles, dirt, germs, these are only some of the things that can pose danger for you or your instrument. Without regular cleaning, buildup of these materials can lead to lung infections, corrosion, rust, damaged metal, acoustic problems and more. Chronic inflammatory lung problems can be linked directly to an unclean instrument.

- Moisture causes rust, corrosion, bloated pads, and a messed up airflow
- Saliva and food particles can lead to mold, which causes lung issues, such as asthma
- Germs, can result from any of the items listed above, causing pneumonia and lung infections
- Body oils and acids can eat away at your instrument, causing long term damage
- “Two small studies of brass players and their horns have found a solid evidence pointing to frequent fungal colonization of instruments, suggesting that hypersensitivity pneumonitis and other related inflammatory-related lung conditions such as chronic cough and asthma may be related to dirty horns.” [3]
- “As food particles accumulate, it can cause a wind instrument to sound out of tune. In brass instrument, salts and dirt can collect on the valves, valve slides, hinges, screws, and springs causing them to not work properly, wearing away the metal.” [4]
Background Research - Methodology

- During design, we must consider, mechanisms, electronics, programming, fabrication, and aesthetic.
  - **Mechanism**: the broom removes excess dirt, and the vacuum removes moisture, both sweeping and vacuuming is effective and this compact robot is taking advantage of all the benefits.
  - **Power Source**: the battery will supply power, to make sweeping more effective, and activate the vacuum. The lithium ion allows the battery to be recharged many times.
  - **Electronics**: the interconnections between the different parts, then the location benefits must be defined and put into a physical board layout. This would be small and compact, possible needing to layer the board more than it would be otherwise.
  - **Programming**: The programming surrounds the microcontroller of the circuit, choosing the right one is crucial to the function as it is how the robot will react to its surroundings.
  - **Fabrication**: The encasement is the fabrication, as well as the material of the robot. It is also what gives the robot a personality.
  - **Aesthetic**: A lot of things are taken into consideration while designing a robot, like the terrain it will navigate, whether it is waterproof, weight, and personalization.
Sources

Brainstorm - Prototype Design Criteria

- The solution must meet the following criteria:
  - Removes particles thoroughly
  - No damaging long term effects
  - Disinfects and removes germs
  - Removes moisture
  - Quick and easy to clean
  - No residue
- Cost to build
- Maintenance requirement
- Size
- Weight
- Reliability
Brainstorm - Prototype Design

Design A

Design B
## Design Evaluation - Design A

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removes Particles</td>
<td>All excess dust and dirt cleaned up</td>
</tr>
<tr>
<td>No damaging long term effects</td>
<td>Possible scratches left on inside</td>
</tr>
<tr>
<td>Disinfects and removes germs</td>
<td>Some germs/fungi will be left behind</td>
</tr>
<tr>
<td>Removes moisture</td>
<td>Removes all moisture</td>
</tr>
<tr>
<td>Quick and easy</td>
<td>No manual labor, fast</td>
</tr>
<tr>
<td>Residue</td>
<td>Small Possibility of spray left behind</td>
</tr>
<tr>
<td>Cost to build</td>
<td>About $50 - $100</td>
</tr>
<tr>
<td>Maintenance Requirement</td>
<td>Cleaning of brushes and compartment, batteries</td>
</tr>
<tr>
<td>Size</td>
<td>3.81cm wide, height is adjustable</td>
</tr>
<tr>
<td>Weight</td>
<td>About 50 grams</td>
</tr>
<tr>
<td>Reliability</td>
<td>Durable, not fragile</td>
</tr>
</tbody>
</table>
## Design Evaluation - Design B

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removes Particles</td>
<td>Possible particles left behind</td>
</tr>
<tr>
<td>No damaging long term effects</td>
<td>Possible scratches left on the inside</td>
</tr>
<tr>
<td>Disinfects and removes germs</td>
<td>Removes most germs/fungi</td>
</tr>
<tr>
<td>Removes moisture</td>
<td>Moisture can be left behind</td>
</tr>
<tr>
<td>Quick and easy</td>
<td>No manual labor, fast</td>
</tr>
<tr>
<td>Residue</td>
<td>Spray can be left behind</td>
</tr>
<tr>
<td>Cost to build</td>
<td>About $75 - $125</td>
</tr>
<tr>
<td>Maintenance requirement</td>
<td>Fixing limbs, limbs can break, batteries</td>
</tr>
<tr>
<td>Size</td>
<td>3.81cm in diameter, height can be modified</td>
</tr>
<tr>
<td>Weight</td>
<td>About 40 grams</td>
</tr>
<tr>
<td>Reliability</td>
<td>Arms can jam and malfunction</td>
</tr>
</tbody>
</table>
The Winner is Design A

- The most important criteria I went by is the particles left behind, because it affects both health and the tone of the instrument. Design B leaves more room for error during cleaning.
- The reliability and maintenance is also very important, the aim for this bot is to reduce work and save money, if the bot breaks, all of that goes out the window.
- Design A also is more thorough during cleaning
- Although Design A is heavier, it is better shaped to fit an instrument as well.
- Buyers may also pay less since people can already clean their instruments, so having a low cost, effective robot will promote more sales.
- It is overall cheaper
Strengths vs Weaknesses

Strengths

● The user is allowed to control the bot and see the inside of the instrument
● It achieves the purpose of cleaning an instrument quickly and effortlessly
● The brushes and vacuum compartment are easy to clean
● It can thoroughly clean the dirt and possible fungi

Weaknesses

● The robot may skip over certain areas, like if the robot is not adjusted correctly
● The robot can jam, and the wheels might stop working
● The vacuum compartment may be too small for everything
● It may not fit along the piping of the instrument
Test Plan

- Start off with cleaning a dirty metal pipe
- If success, move onto flute and clarinet.
- Begin implementing the programming and camera app
- Continue to a saxophone and trumpet
- Test inside a trombone and a euphonium
- Then finally, a tuba and french horn
  - Keep in mind to test multiple times under different circumstances
  - To get an instrument dirty, have several used ones and one with a mixture of dust and water run through it
In the future

- To add on more controls and ability to guide the robot
- Improve camera quality
- Better shape wheels to fit a rounded surface
- Find and remove bugs
- Make it easier for the user to adjust and fit the brush size
- Allow brushes to easily extend and retract
- Expand the vacuum compartment