Manufacturing Design Challenge
CTHSS Precision Machining Programs
NSF Grant Final Concept
LaunchPad Profile Due: May 1, 2017
Expo Fest: May 20, 2017

The Manufacturing Mission
You are part of a startup entrepreneurial manufacturing team whose mission is to create environmentally friendly solutions to difficult problems in the world and to capitalize on them. Your team has been contacted by FEMA to present a hand-powered air compressor for use in areas devastated by natural disasters and without access to electricity.

Problem Statement: Areas affected by natural disasters have asked for assistance from FEMA to rebuild construction in areas that have no access to electricity.

Solution Statement: Design, machine, assemble and market a hand-powered air compressor that can aid in building construction.

Criteria:
- The finished compressor must function only from the hand power of an operator.
- The compressor design must encompass the dimensional specifications supplied in the technical specifications.

Technical Specifications:
1. If utilized, a piston designed compressor should limit the piston diameter to 1.250". This is to ensure the ability for hand or human movement of the compressor. Larger diameters will require a much higher strength level.
2. The weight should not exceed 15 lbs. since the device needs to be carried by a person long distances.
3. The size of the compressor and tank assembly must be easily carried by one person. Care should be taken to design ergonomic carrying devices which are required to separate from the final design. The carrying devices are not considered in the final weight of the compressor.
4. Care should be taken to not create pinch or crush point in the final design of the device. If required, shields or guards can be added to the final design. But the 15 lb. limit remains
5. The total dimensions of the final product should fit inside of a 12" cube of space.

Constraints/Assumptions:
- No outside or additional power devices are allowed.
- Any areas indicated on the technical specifications as "open" for individual design interpretation can be altered as each team sees fit. These areas will be judged as a separate line item in the evaluation.
- Teams are allowed to utilize any non-hazardous materials in the production of their compressor. The only exception is the storage tank.
- Storage tanks cannot be made from plastics or glass due to safety concerns from bursting. Only metals are allowed.
- Lubrication is allowed but must be contained in the device with no leaking or dripping.

Elements to Consider:

- Weight
- Cost
- Material selection
- Portability
- Durability against wide ranging environmental conditions

Project Requirements

- The finished compressor and storage tank must have a 1/8”- 27 NPT female thread for the testing of the finished assembly by a judge.
- The finished compressor and storage tank must store and maintain 20 PSI for 2 minutes. This can take place with the compressor static or with it under power (hand).
- The entire assembly must be mounted onto one base plate for ease of transportation and safety.
- The use or purchase of “off the shelf” compressed air components is restricted. Items such as regulators, backflow preventers or other devices cannot be used. If required as part of the design, the items can be designed and manufactured by the teams.
- A one page business brief to introduce the company that includes company name, details, mission statement, and logo
- A one page marketing document that describes product packaging as well the features and benefits that will differentiate the team’s solution from other prospective vendors pitching their design and prototype to FEMA.

Challenge Background

Many industries rely heavily upon energy to power their processes, light their factories and move materials and equipment. Energy comes in many forms. It can provide necessary heat in extreme cold, help to form raw materials into usable objects, provide power to make mechanisms operational, and help to move very small or massive objects. Some forms of energy can be stored in various quantities to provide an uninterrupted power source at the point of use. Some types of energy are more difficult to store than others.

Some common types of energy are:

- Electrical Energy - energy caused by charged particles moving through wire like when electricity creates light, mechanical energy, or thermal energy
- Gravitational Energy - when gravity causes motion like water falling (hydropower)
- Mechanical Energy - when energy is stored as tension in objects like a rubber band
- Thermal Energy - energy that comes from heat like when when molecules or water are heated up so they collide faster and produce steam to drive turbines
- Hydraulic Energy - energy in pressurized fluids to create movement in machines
- Pneumatic Energy - energy in pressurized air to create movement in machines

Many companies now strive to utilize sustainable and safe processes which do not jeopardize the environment by limiting the use of materials, chemicals and emissions that are hazardous to the natural world if released.

Compressed air is one type of energy that is being researched further as an environmentally friendly option for power plants, with a few already existing. Compressed air can be utilized within industrial facilities as “clean” energy because it does not use chemicals or fossil fuels within the walls of an

industrial facility. In the past, compressed air was used to power cars before the use of fossil fuels. It is a viable option to produce power because it can be stored in large quantities, within tanks or extensive piping networks. However, compressed air systems use electricity to compress the air, which is generated outside of most facilities and comes with a cost.

Compressed air systems can have very different efficiency levels. Efficiency can depend on the age of the system in relation to the operation of the system. In a good scenario, the air compressor might be new and contain sound mechanisms with low wear of internal components and close dimensional tolerances. An inefficient system can have old parts, high wear of internal components, and leaks from dimensional tolerances that are worn out of acceptable range. This can cause an added burden on the system and can also slow down or stop operations or make them too inefficient to be worth any benefit gained from them. Faulty piping networks and storage tanks can also cause an ineffective use of energy, resulting from multiple leaks, which can compound the inadequacies of the system.