**Objective**

- **General Need for Product**
  - Clean water is a basic human need
  - Clean water is a limited resource
  - Team E.C.O. provides clean shower water without using electricity

- **Market Size**
  - 700+ million people lack access to an "improved water source"

- **Customer Requirements**
  - Remove dirt
  - Filter grey-water
  - Store water
  - Reuse water
  - No overflow
  - Anti-slip surface
  - Auto-expel dirty water
  - Self-contained

- **Engineering Characteristics**
  - Type of pumping method
  - Volume of reservoir tank
  - Size of containments filtered
  - Force to actuate shower lever
  - Gravity fed filter and shower
  - Flowrate
  - Physical properties
  - Net power required
  - Permanent fixture

- **Constraints**
  - Consideration for human factors
  - Cost
  - Safety
  - Gravity fed

**Concept Generation**

- **Pump Concepts**
  - **Piston Pump**: Rotational motion of a bicycle will be translated to linear motion of the piston displacing water with the use of check valves.
  - **Centrifugal Pump**: Rotation of impeller pushes water to the outside of the housing and through the outflow pipe.

- **Filter Concepts**
  - **Biofilter**: Slow Sand Gravity Filter with biofilm layer.

- **Final Concept**
  - Piston pump with bicycle generating power
  - Biofilter

**Prototype and Testing**

- **Materials**
  - Inexpensive materials that can be procured easily from standard sources
  - PVC – tubing, piston (w/rubber-foam gasket)
  - Steel crankshaft
  - Filter – sand, gravel, charcoal, five-gallon pails

- **Testing**
  - Proof-of-concept testing for piston (demonstrated success)
  - Flow-rate testing – time to pump water from lower to upper reservoir
  - Water quality testing to verify filter effectiveness – lead acetate paper to check for hydrogen sulfide present in filtered water

- **Operation of the Product**
  - The design implements a piston pump as a mean for displacing the filtered water from the lower reservoir to the upper reservoir.
  - The rotation of the bicycle gears are converted in to a translational motion which oscillate the piston.
  - Shower head is installed in the upper reservoir for flow control.
  - Over time natural bio layer forms that removes unwanted microbial.
  - Dirty water travels through a series of elements that continually filter out particles.

**Test Results and Future Work**

- **PDP Summary**
  - Performed benchmark research
  - Calculated the physics involved in the system
  - Developed alternative design concepts for filter subsystem, pump subsystem, and system integration
  - Applied AHP process to select final design

- **Recommendations for Future Design**
  - Subterranean biofilter and lower water reservoir
  - Permanent fixtures for upper water reservoir and piston pump
  - Auto-expel unusable water from filter
  - Integrate heating for the shower water

- **Process Reflections**
  - Limited by project budget
  - Constrained by required mobility

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**Mechanical Engineering**

**Design Day**

**May 7, 2013**

**Team E.C.O.: G-Force Rinse & Repeat**

**ENME472 - Integrated Product and Process Design and Development**

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