Polyethylene Pipes Systems

The Environmentally Friendly Pipes
Motivation

Agriculture in developing countries:

• By 2025, cereal production in Africa is estimated to be ~50% less than demand

• Irrigation can increase yields of most crops by 100-400%

• More than 80% of the water consumed in Africa is used for agriculture

• Irrigation can cut down water use by 30-60%

• Current cost of irrigation: $500-1200 per acre

Potential of HDPE bags:

• Each year Americans throw away some 100 billion polyethylene plastic bags

• With this we could make more than 1 million km of pipe

Sources: Dyson. FAO
Goals

Ultimate Goal

Develop a low-cost and low-tech method to produce irrigation pipes, using recycled HDPE bags, which are:

1. Affordable for farmers in developing countries
2. Robust enough to withstand normal wear and tear during use
3. Able to efficiently irrigate small scale farms all year round

Success Criteria

• Producing a final deliverable that is a functional and scalable process and pipe prototype

Specifications for Pipe Prototype

• Length ~ 10m-20m
• Inner Diameter ~6mm-25mm
• Minimum Pressure ~20psi-30psi
Plan of Approach

- Sheets of Plastic
  - Hot Press
  - Ironing
  - Heat Rolling
- Sealed into Pipes
  - Side Welding
  - Gas Welding
  - Flat Bar Press
  - Soldering Iron
- Make Holes for Dripping
  - Pin Punching
Why Heat Welding?

- Cost efficient
  - Only need 122 Wh per 2Kg of bags, assuming 100% efficiency
  - Allows for many possibilities for cheap heat source

- Success of initial experiments
  - 8 layers yield 0.52 mm thick sheet via ironing
  - Elastic modulus of ironed sheet is ~100 MPa
  - Rough calculations: 2kg of bags yields ~360m of pipes of ~6 mm diameter
Energy Source for Processing

Heat Source
- Electric
  - Resistive Heating
- Non-Electric
  - Coals
  - Open-Flame

Pressure Source
- Electric
  - Electric Motors
  - Hydraulics
- Non-Electric
  - Man Power
Risks and Unknowns

Unknows

- Effect of impurities and inconsistencies in composition of bags on quality of pipes
- How to process dirty bags from landfills
- Environmental degradation of pipes

Plan to maximize chance of success

- Develop a procedure for cleaning bags before processing
- Research environmental conditions pipes will be used in and simulate them in the lab
- Possible field testing with early prototype
- Conducting numerous "fast and dirty" experiments
- doing back of the envelope calculations to estimate feasibility in terms of monetary/energy cost.
PEPS Gantt Chart

Weeks: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1. Decisions/Designs:
   1.1 Choose Project: 100% complete
   1.2 Initial Conceptualization of problem: 100% complete
   1.3 Brainstorming of possible solutions: 50% complete
   1.4 Creation of Final Design: 0% complete

2. Testing:
   2.1 Early "proof-of-concept" testing: 40% complete
   2.2 Prototype Testing: 0% complete

3. Design Construction:
   3.1 Idea Mock-Ups: 0% complete
   3.2 Creation of components: 0% complete
   3.3 Final Prototype: 100% complete
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