

HANDPUMP SUSTAINABILITY STUDY

ANALYSIS AND TESTING OF HANDPUMPS IN AFRICA

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Introduction

Millions of Africans living in rural villages struggle to access clean water. In many communities, wells with handpumps are installed to reach safe drinking water. Unfortunately, mechanical failure leaves many of these pumps inoperable within a year of installation. The Handpump Sustainability Study (HSS) team is working to redesign and improve failure-prone components of the pump to increase their lifespan. HSS is currently in the process of testing two redesigned component prototypes.

Basically...

HSS redesigns and tests hand pumps...



by providing clean water for people in developing countries.



in an effort to improve the quality of life...



India Mark II Prototype Parts

Problems:

(1)



Manufactured pumps have ball bearings in the pivot. Here, the bearing is greased to reduce friction.



The limited rotation of the pumping motion causes the balls at the top of the bearing to constantly experience a high contact stress. This eventually causes fatigue failure underneath the surface, ultimately leading to cracking.

(2)



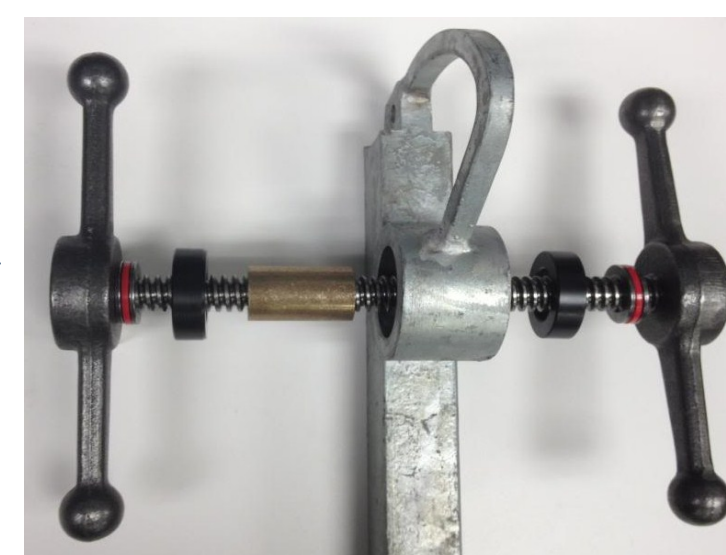
The poppet valve is positioned at the top of the cylinder to keep the water from back flowing while pumping. This valve's cap broke off due to repeated impact loading from the falling column of water.

These are cast parts containing many internal flaws, which reduce the material strength.

Solutions:

(1)

A press-fit iron bushing now replaces the ball bearings. This design will experience much less stress due to increased surface area.



Note: The bushing in this photo is made of bronze. Communication with the bushing supplier revealed that bronze and nickel will diffuse together. This would be detrimental to the purpose of the bushing. We are now using an iron bushing.

(2)



Machined steel replaces the cast parts in order to increase the part's strength and resistance to impact and fatigue.

Testing:

HSS constructed a test bench for the purpose of testing our prototype parts for the India Mark II. An electric motor turns fly-wheels connected to the handles. Lead chambers



simulate the weight of the water in the rising main, and pressure relief valves simulate a pumping head of 100 meters.

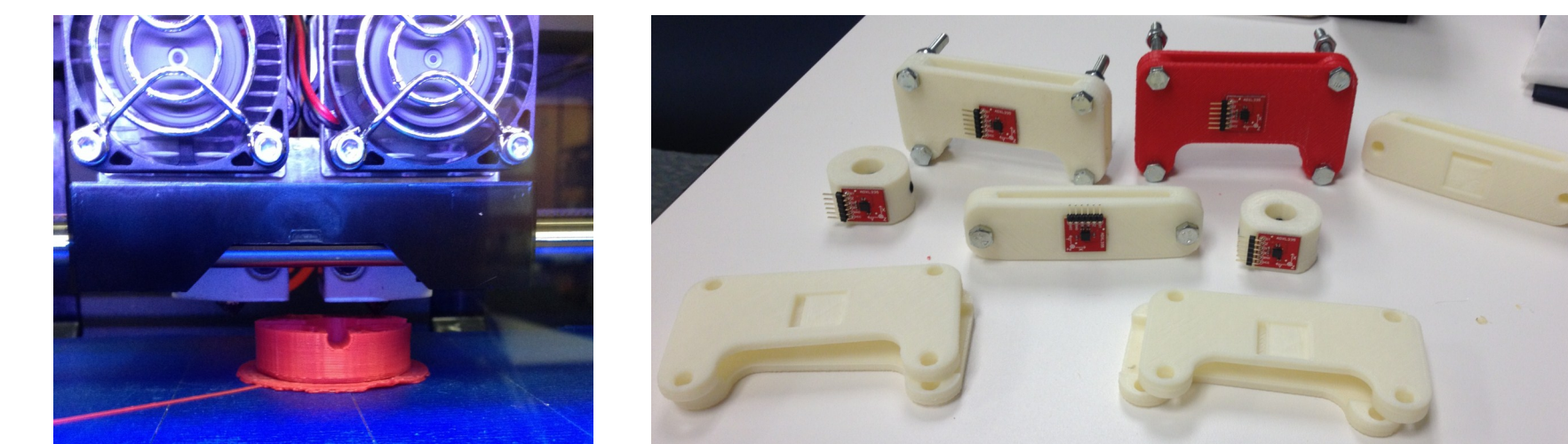
India Mark II Force Analysis

Goal:

To utilize accelerometers to measure the acceleration of different pump components.

Procedure:

- Accelerometer mounting fixtures were designed using SolidWorks and prototypes were built using a MakerBot 3-D printer



- Arduino code was written in order to collect usable data from a SparkFun ADXL 335 accelerometer chip and format data in Microsoft Excel

```

accelerometer_final_program
//
// simple sketch to output values on the
//
const int xPin = 0; // analog input
const int yPin = 1;
const int xPin2 = 2;
const int yPin2 = 3;

void setup()
{
  analogReference(EXTERNAL); // Conn
  Serial.begin(9600); // note the hi
}

void loop()
{
  int xValue1; // values from accel
  int yValue1;
  int xValue2;
  int yValue2;

  int timeStep = 5;

  int long startTime;
  int long duration;

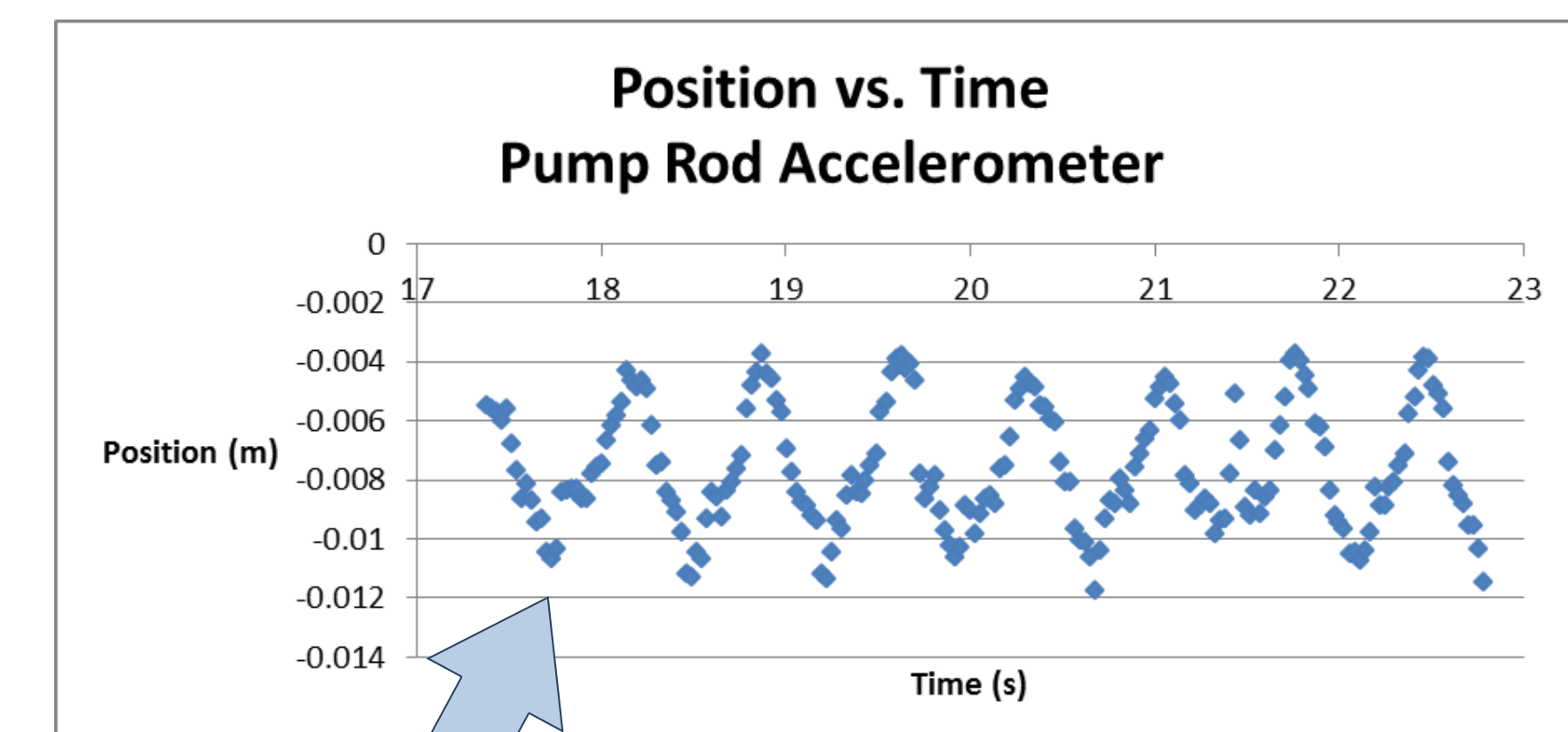
  startTime = millis();
  delay(timeStep);

  xValue1 = analogRead(xPin1);
  yValue1 = analogRead(yPin1);
  xValue2 = analogRead(xPin2);
  yValue2 = analogRead(yPin2);

  Serial.print("DATA, TIME,");
  Serial.print(xValue1);
  Serial.print(",");
  Serial.print(yValue1);
  Serial.print(",");
  Serial.print(xValue2);
  Serial.print(",");
  Serial.print(yValue2);
  Serial.print("\n");

  duration = millis() - startTime;
  Serial.print(duration);
  Serial.print("\n");
  
```

- Data was transformed into charts for analysis



Notice the sinusoidal motion that would be expected from pumping.

Clients

World Vision



DesignOutreach ← NEW

Future Work

The HSS team will assess the longevity of the new prototype parts through field and in-house testing. If the results from these tests reveal an increase in the lifespan of the pump, our designs will be introduced to pumps in Africa. The acceleration data will be studied further to gain insight on component failure. Testing of the Design Outreach Lifepump will begin this summer.

Further Information

For more information, please visit the HSS page on the Collaboratory wiki at:
http://www.thecollaboratoryonline.org/wiki/WA:India_Mk_II_Project

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