

# Pipe Loss Experiment Redesign

Team 10

Keith Caton

Mark Frankenberg

Michael Garelick

Cole Nielsen

# Project Description

- ▶ Client: Dr. Constantine Ciocanel
- ▶ Evaluate and redesign current experiment
- ▶ Measure pressure at different points to calculate head loss
- ▶ Use measurements to physically teach students about concepts introduced in fluid dynamics.
- ▶ The table is about 15 years old



*Figure 1: Current Design*

# Design Description - Analysis

- ▶ **Materials:**
  - ▶ Originally were to use plastic or polycarbonate pipes.
  - ▶ This brought up some issues:
    - ▶ Less durability
    - ▶ Hard to adapt reliable pressure taps
    - ▶ Difficult to connect to other system components
  - ▶ Decided on copper pipes
    - ▶ More robust for constant use
    - ▶ Easily applicable to pumps, pressure taps, and flow sensors
  - ▶ Copper has a very similar roughness to PVC; allows for same flow calculations.

# Design Description - Analysis

## ▶ Sensors:

### ▶ 2 invasive

#### ▶ Manometer

- ▶ Placed at two points to measure the pressure difference over the distance between the taps
- ▶ Measures the differential pressure

#### ▶ Pitot Static Tube

- ▶ Applies Bernoulli's equation to obtain total pressure and velocity of the liquid

### ▶ 1 non-invasive

#### ▶ Keyence Ultrasonic Flow Sensor

- ▶ Uses the correlation between time duration and speed of the flow to measure the instantaneous flow rate
- ▶ Applicable with iron, copper, PVC, and many others

# Design Description - Analysis

## ▶ Pump

- ▶ Maximum power draw: 2400 W.
- ▶ Highest flow rate and pump head as possible.
  - ▶ Model 4UB80. Best efficiency at 70 gpm flow rate at 70 ft head.
    - ▶ 240 VAC, 10 Amps.
  - ▶ Model 4JMX6. Max flow rate at 130 gpm at 5 ft head.
    - ▶ 115 VAC, 18.0 Amps.
  - ▶ **Model 4XW85. Best Efficiency at 38 gpm flow rate at 120 ft head.**
    - ▶ **120 VAC, 20 Amps.**

# Pump Vs System Analysis

- ▶ Maximum flow rate for each segment of the system:
  1. 55.61 gpm
  2. 44.81 gpm
  3. 48.92 gpm
- ▶ Change flow rate by varying:
  1. Pump Power
  2. Head Loss of System
- ▶ Pump Analyzed: GOULDS WATER TECHNOLOGY - Mfr. Model # 1MC1G1A0

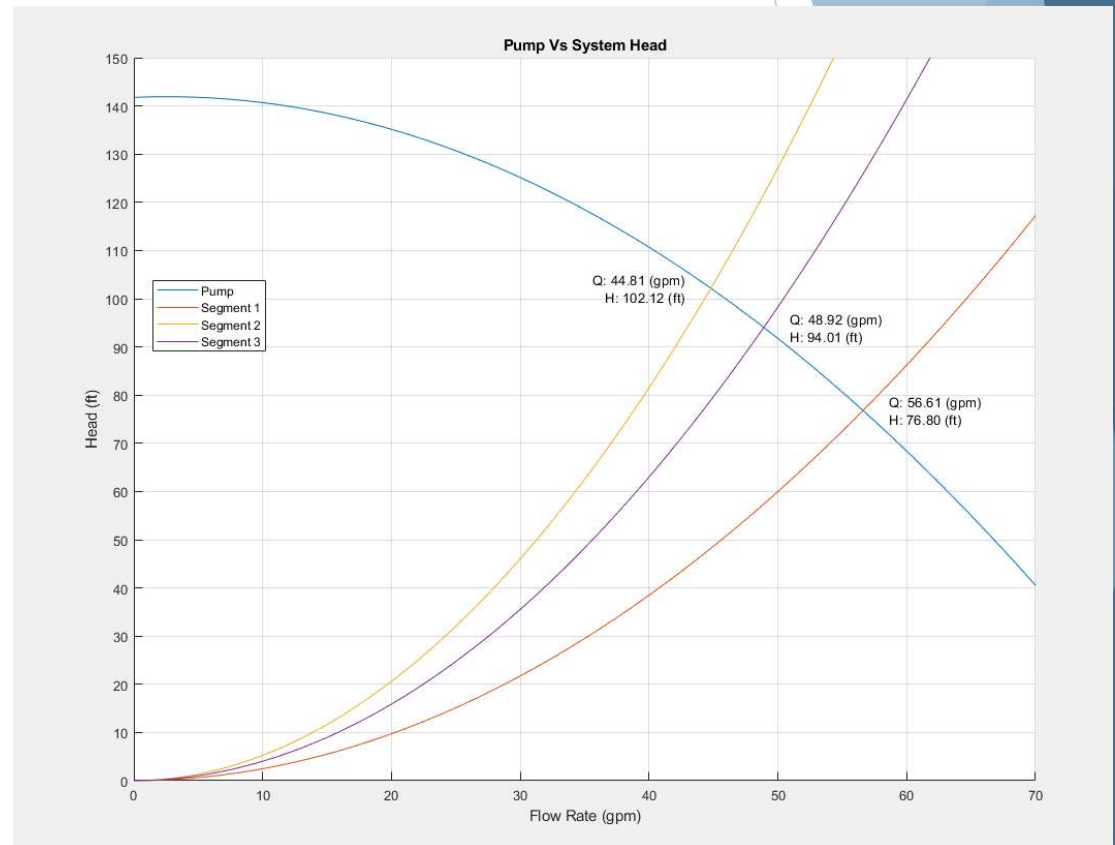
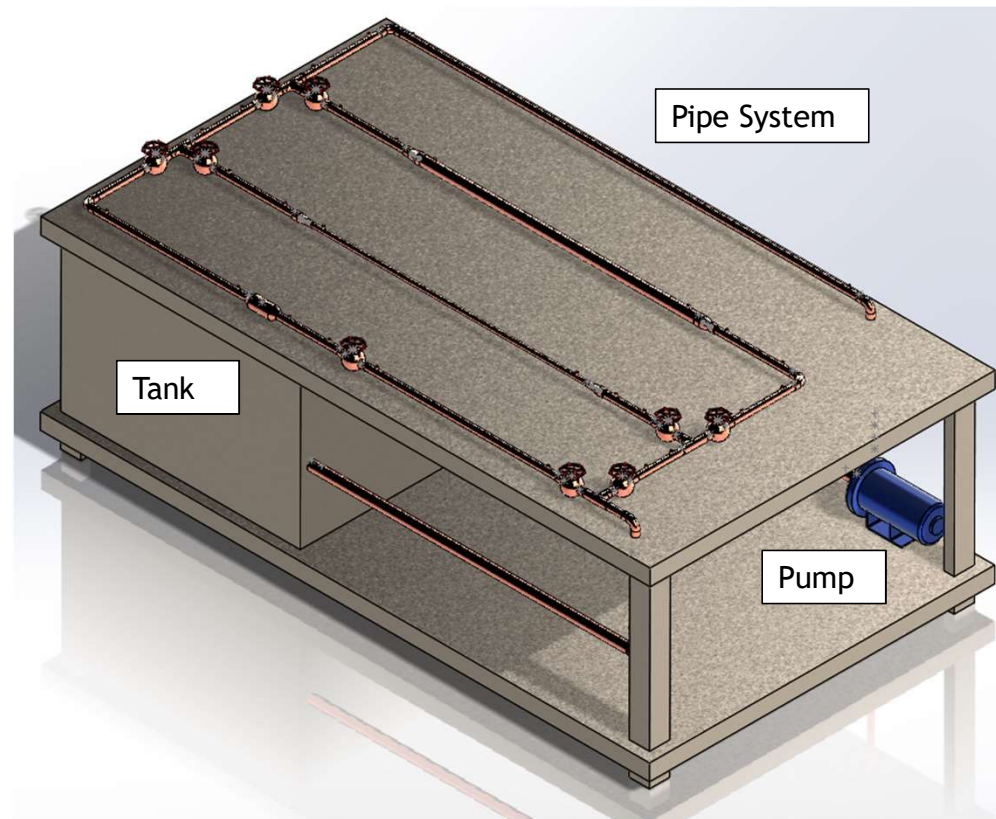


Figure 2 - Pump Vs System Curves

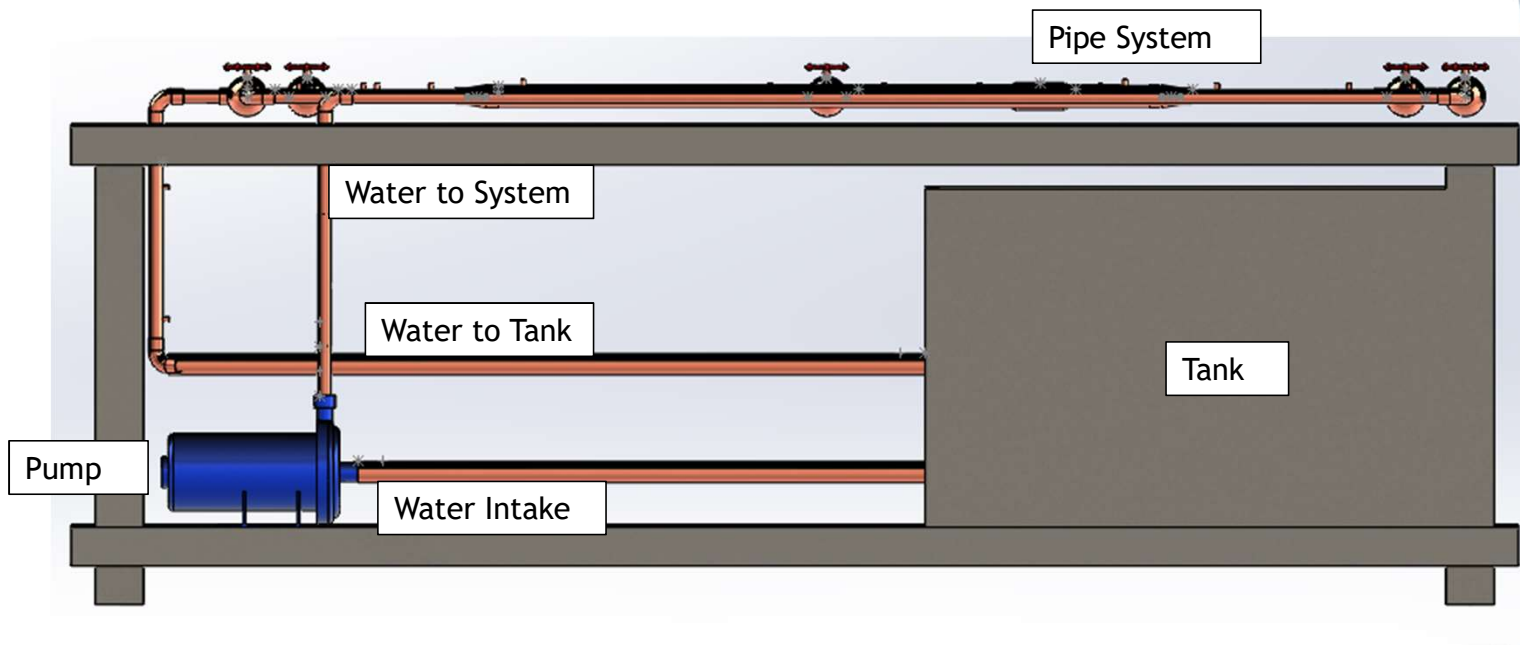
# Design Description - CAD Model



Team 10 -- 4/19/2018 - Keith Caton

*Figure 3 - Isometric view of model*

# Design Description - CAD Model



*Figure 4 - Side view of model*



# Design Description - Bill of Materials

Item	Quantities	Price (\$)
1 in x 10 ft Copper pipe	3	107.79
½ in x 5 ft Copper Pipe	1	6.84
1 in Copper Elbow Joint 90°	3	14.94
1 x ½ in Copper Reducer	1	4.51
1 in Copper Tee Joint	4	46.32
Keyence Flow Sensor	1	790.00
Dwyer Digital Manometer	1	217.08
Pitot Static Tube	1	15.72
Centrifugal Pump	1	775.00
Table	1	100.00-800.00
Total		2,078.12-2,778.12

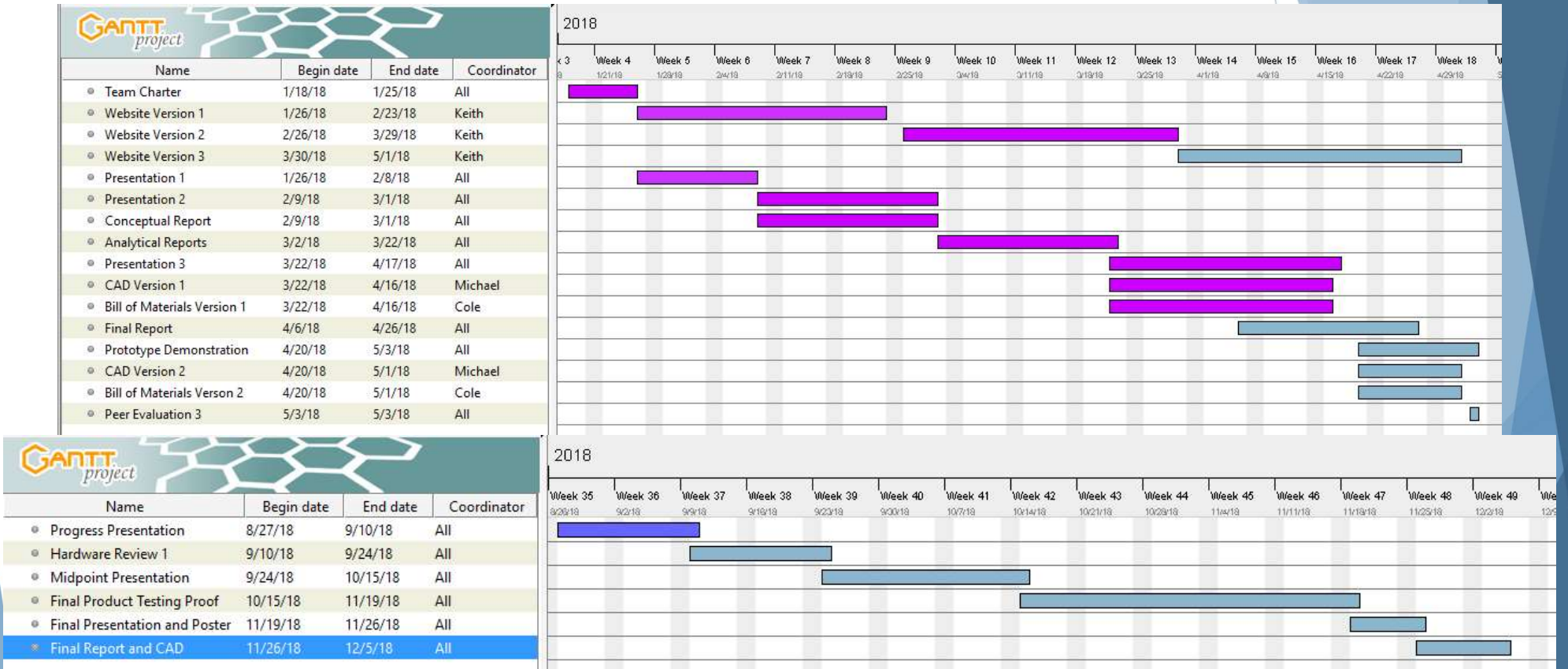
# Design Requirements - Customer Needs

- ▶ Durability
- ▶ Variable control
- ▶ Contraction, expansion, elbow, and T joint fitting.
- ▶ Three forms of flow rate measurement
- ▶ Reliable measurements
- ▶ Representation of moody diagram curve
- ▶ Chose copper piping and a more robust pump.
- ▶ Implemented a gate valve after pump outlet.
- ▶ Pipe layout includes all types of required fittings for measurement.
- ▶ To invasive and one non-invasive flow meters.
- ▶ Pressure taps placed at reasonable distances and more precise monometers and sensors.
- ▶ Our flow covers a wider range of pressures and larger head losses.

# Budget

- ▶ Two separate budgets:
  - ▶ Dr. Ciocanel
    - ▶ Includes: sensors
    - ▶ Undisclosed amount
  - ▶ Capstone
    - ▶ Includes: copper piping, fittings, pump, and the table
    - ▶ \$2,500 price cap
    - ▶ Estimated to be between \$1,054.6 and \$1,754.6
    - ▶ Currently nothing has been purchased

# Schedule



Team 10 -- 4/19/2018 - Michael Garelick

Figure 5 - Year Gantt Chart Schedule

The slide features abstract blue geometric shapes on the left and right sides. On the left, there is a solid blue trapezoidal shape. On the right, there is a complex arrangement of overlapping, semi-transparent blue triangles and trapezoids in various shades, creating a layered effect. The central area is white and contains the text "Questions?".

Questions?