Pico Hydro:

Powering Developing Communities with Run-of-Stream Hydroelectricity

Tyler Criddle
Daniel Loefstedt
Joshua Pardoe

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Mission Statement

We believe that all people deserve an opportunity to pursue financial prosperity for themselves and their families. We believe small-scale hydro can bring jobs and economic prosperity to underdeveloped communities.

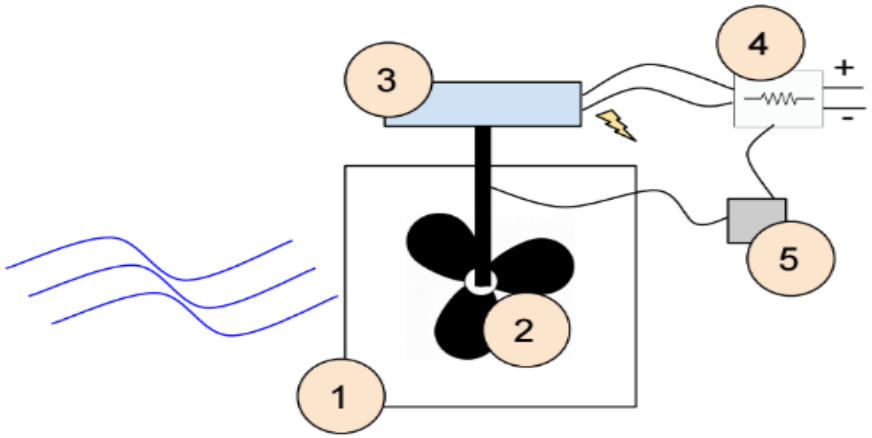
What is the Problem?

The lack of renewable and affordable electric power in small, off-grid communities in the developing world limits both educational and economic opportunities. This makes it difficult for people to flourish and for these communities to prosper.

According to a 2016 study, there are roughly 1.7 billion people on earth without access to electricity, most of them living in developing countries. This is nearly 23% of the human population!

Solution - Hydro Power

What is Hydro?



1	Water Passage	Direct Flow (Vs = Stream Velocity)
2	Turbine	Capture Hydrokinetic Energy (KE -> Torque)
3	Generator	Generate Electricity (Torque -> EE)
4	Transformer	Charge Controller / Shunt Load Regulator (Variable -> Controlled Output)
5	Data Collection	Measuring and Analyzing Variables

Why Hydro?

Advantages of Pico-Hydro over other forms of alternative energy:

- 24/7 year-round power generation
- Predictable source of energy production
- Cost-effective, low-maintenance systems
- Little to no environmental impact

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Engineering Ministries International (EMI)

EMI is a non-profit organization that seeks to serve the global Church to glorify God through design, discipleship and diversity.

Mission: To develop people, design structures, and construct facilities which serve communities and the Church.

Since 1982: 1000+ projects in 90 countries

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W.E.D.G.E.

Water **E**nergy **D**evice for **G**enerating **E**lectricity

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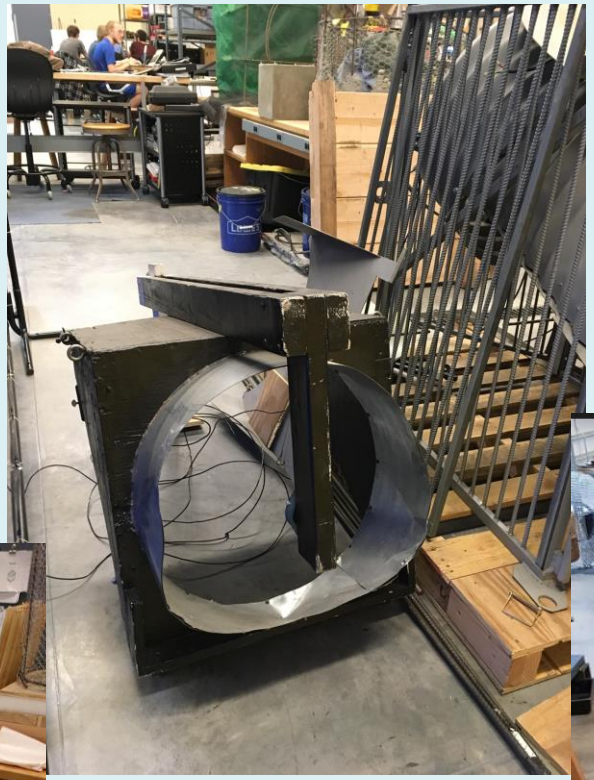
Project Goals

- Test WEDGE prototypes (1.0, 2.0, and 3.0) in the Yellow Breeches Creek and “in-house” to evaluate performance and identify design improvements.
- Construct and deliver a final design for an optimized, field-tested prototype (WEDGE 4.0) that meets EMI’s design specifications



WEDGE 1.1

WEDGE 3.0

WEDGE 2.0

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W.E.D.G.E 2.0

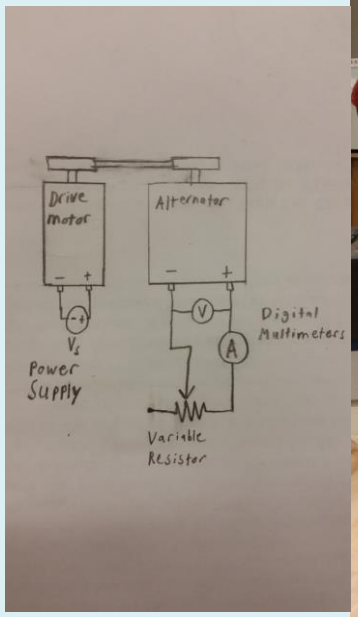
- Came with a data collection system that needed to be trouble shooted.
- Main question was how to get the data collection system to work.
- Problems solved by :
  - *Using an external battery pack attached to the data collection system*
- Reasons for Data Collection:
  - *Comparison of shaft RPM to Power production*
  - *Comparison of stream flow speed to shaft RPM*
- Future of Data Collection:
  - *New system that incorporates more transferable (to excel) data collection method*

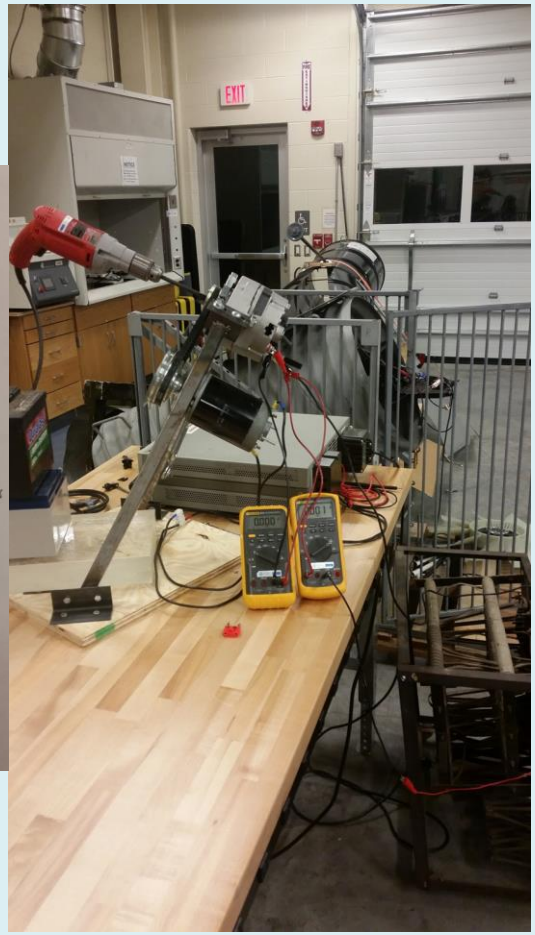
W.E.D.G.E 3.0

- Tested the existing WEDGE 3.0 design in order to get a better understanding of our production capabilities.
- This involved draining a battery using a resistor bank, like the one pictured, and then hooking it up to the WEDGE 3.0 while it was submerged in the Yellow Breeches.
- Purpose of testing was to provide us with information about the outputs of our machine.

W.E.D.G.E 3.0 Cont.

- Continued testing on the alternator attached to the WEDGE 3.0 by constructing a controlled testing method.
- Used a DC motor and a DC power supply in order to control the voltage to our motor and therefore find the power output of our machine.
- This was tested together using a constructed testing rig, as shown on the right following a testing schematic (also shown right).





WEDGE 4.0

- Applies knowledge from the 3 EMI prototypes
- Specifications
  - 300-800W of power generation
  - Able to be run constantly
  - Last at least 3 years
  - Cost less than $500 or an efficiency of less than $.08/Watt
  - Easy to install, move, and maintain
  - Safe

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Water Passage

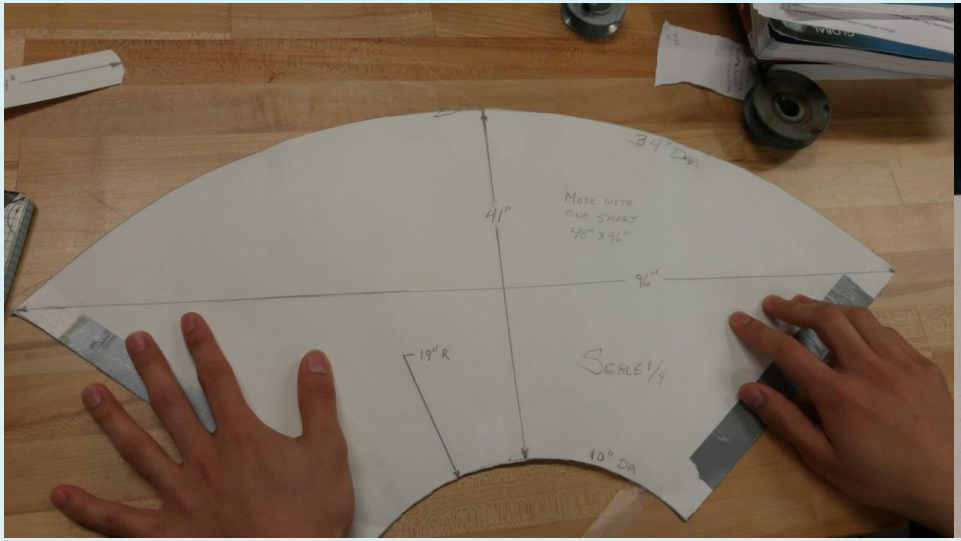
- Water Passage can be broken up into 2 categories
  - *Hydraulic Profile*
  - *Anchoring*
- Design Factors
  - *Materials*
  - *Size*
  - *Cost*
  - *Durability*
  - *Portability*

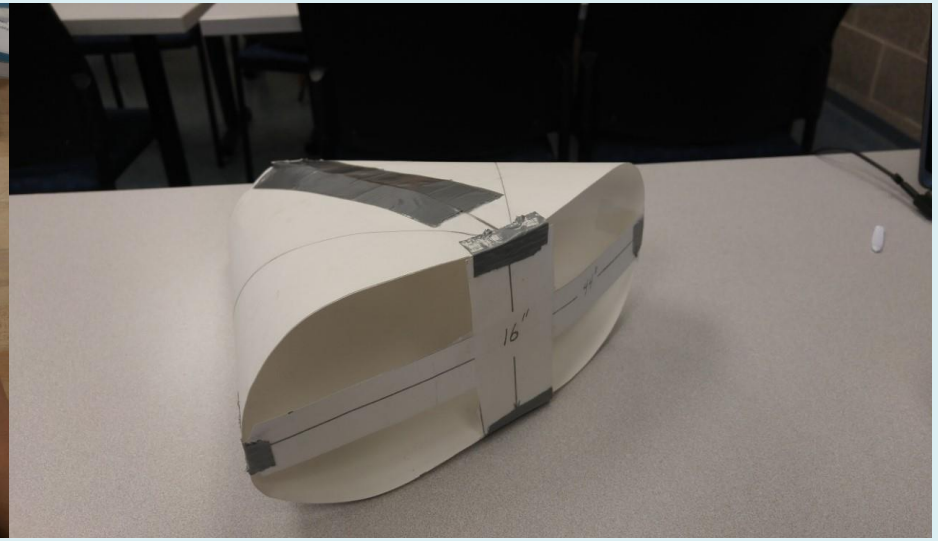
Main Body

- PVC material
  - *Smooth surface*
  - *Standardized connections*
- 10in diameter pipe
  - *Compatible with a majority of Propellers*
  - *Cost effective*
- 36in long
  - *Space for shaft to exit the hydraulic profile*
  - *Long enough to help flow*

Entrance Funnel

- Goal of the funnel is to guide as much volume of water into the turbine propeller as gently as possible to avoid head losses due to turbulence.

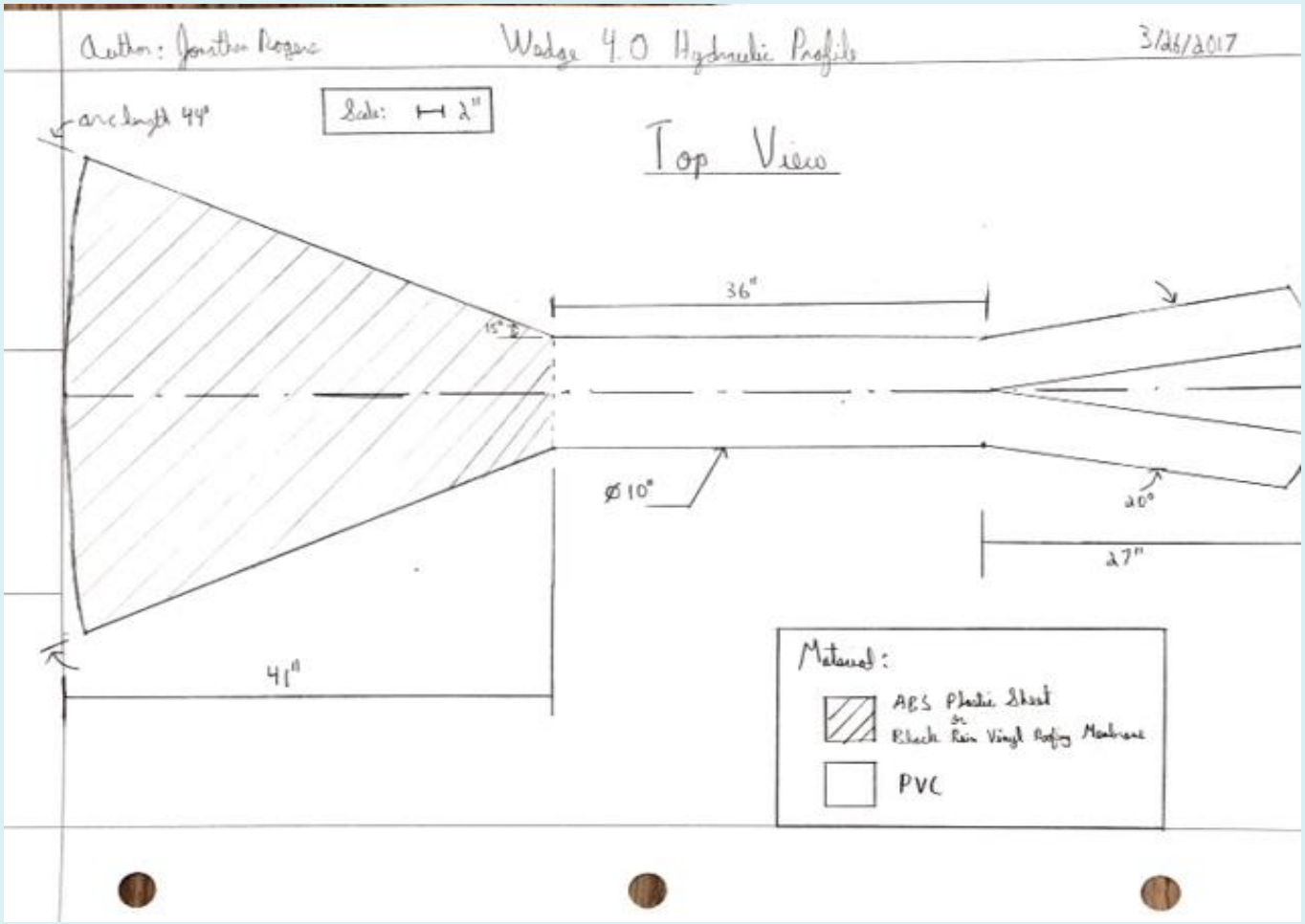




Exit Funnel

- Split PVC design
- 2:1 ratio of cross-sectional areas
- Angled 10^{o} from centerline
- 26.89in axial length
- Maintain flow immediately after the turbine

Current Design



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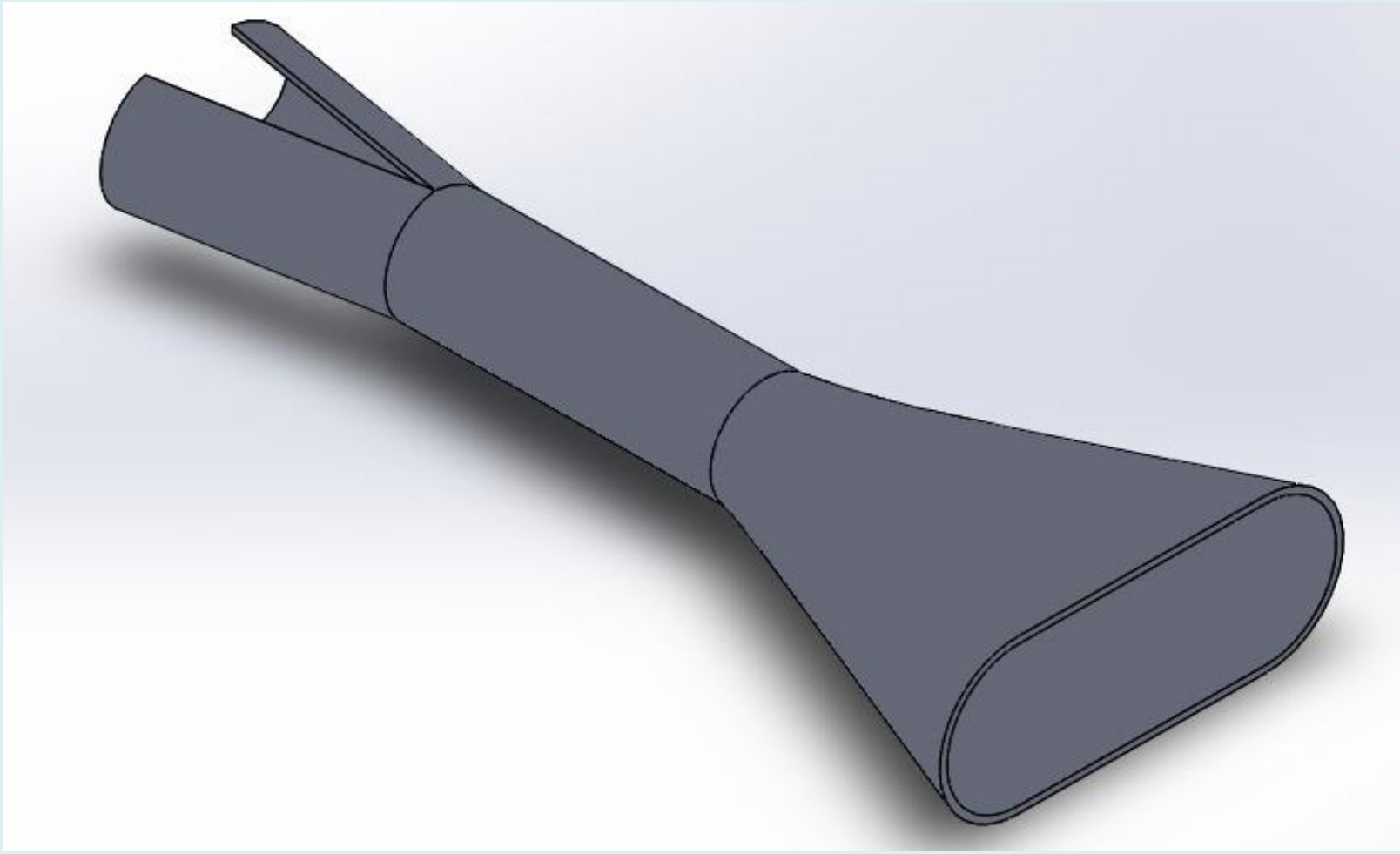
Current Design



Future Work

- Finalize the housing design
  - *Both hydraulic profile and anchorage*
  - *Build and test prototype of new design*
- Determine most efficient propeller/turbine
- Choose the appropriate shaft
- Select generator based on performance from the rest of the system.
- Create system to store/utilize power generated

Questions?