Underwater Wireless Power Transfer

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Overview

- Problem Formulation
- Solution Generation
- Top Design Selection
- Final Solution Product
- Progress Made thus far
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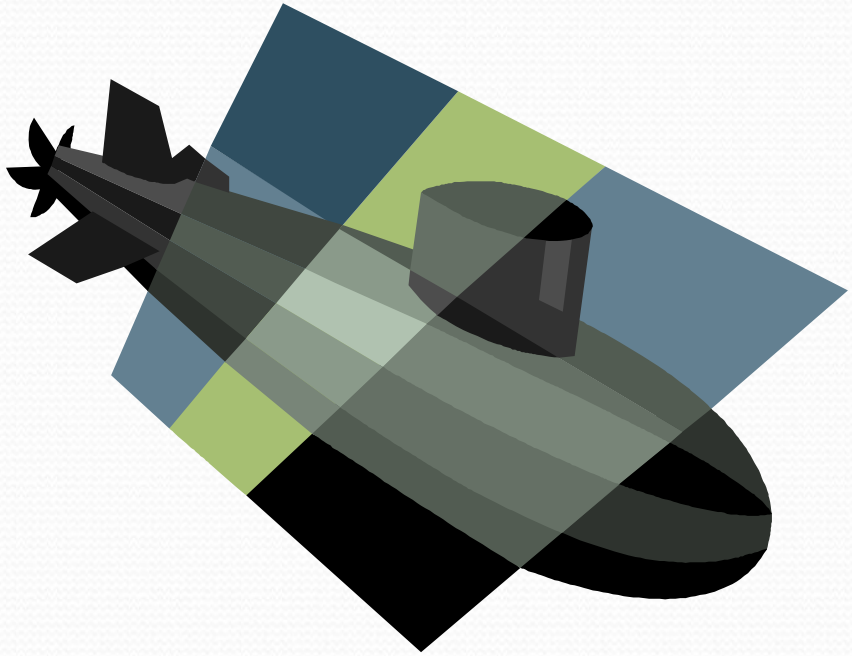
- Milestones and Outcomes
- Future Plans
- Conclusions
- Questions



Problem Formulation

- Design a system to wirelessly connect to and power up UUV

- System must work optimally in following conditions
  - 300 feet under water
  - Transmit in a range of up to 1 meter

- Transfer 100 VDC, 10 amps, with high efficiency

- No official underwater constraints found
- Be safe in underwater conditions

Solution Generation

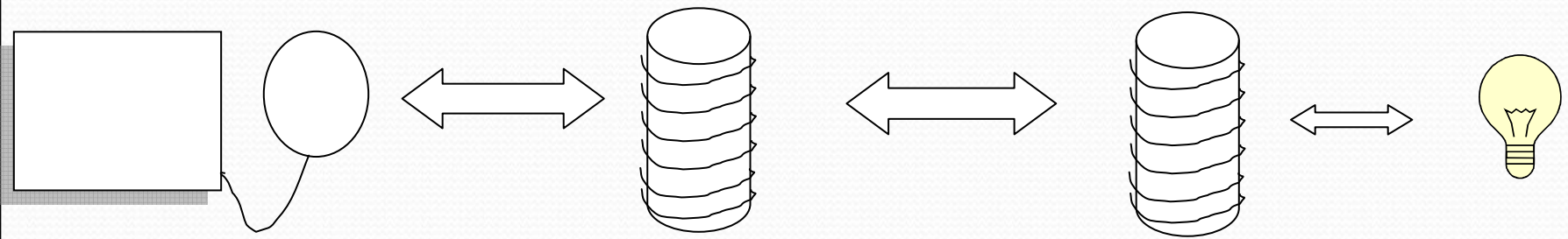
- Air Tube- Laser Power Transmission
  - Air tube would extend from the base station and connect to the UUV creating an “in-air” medium.
  - Parts Needed: Laser, Photovoltaic Cell, Air Tube
- UUV Turbine Powered – Self Powered UUV
  - The turbine system utilizes ocean currents while in motion to charge a power source used to propel the vehicle.
  - The tidal currents would be converted from mechanical power to electrical power and the UUV would not have to surface to recharge its power source, creating a “wireless” power transfer system.
- Radio Wave Power Transmission
  - Radio waves can transmit at low frequencies underwater
  - The efficiency of the power transfer is dependent on environmental conditions such as water pressure, purity of the water, and temperature.
- Magnetic Inductive Coupling
  - Uses inductive coupling between primary and secondary coil that have the same resonant frequency

Design Matrix

S.A.A.M.ay 09		Underwater Wireless Electrical Connector Decision Matrix							
		Laser		Turbine		Radio Wave		Inductive Coupling	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Performance	40%	4	1.6	5	2	6	2.4	8	3.2
Price	30%	8	1.6	1	0.2	5	1	9	1.8
Power Generation	20%	3	0.6	7	1.4	5	1	5	1
Durability	10%	7	0.7	8	0.8	9	0.9	5	0.5
Total Score			4.5		4.4		5.3		6.5
Rank			**3**		**4**		**2**		**1**

Final Solution Product

RESONANCE FREQUENCY

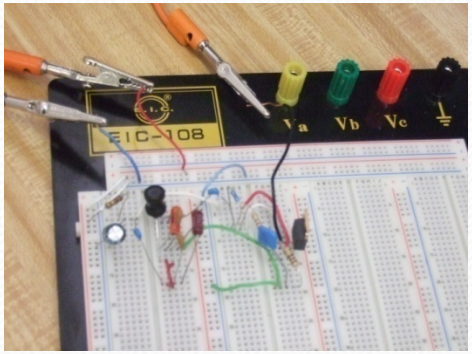


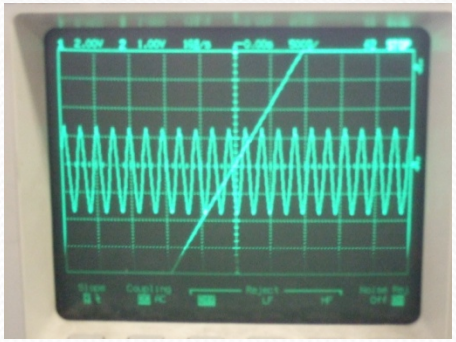
Colpitt's Oscillator | **Single loop coil** | **Medium** | **Primary coil in packaging** | **Medium** | **Secondary coil in packaging** | **Medium** | **Bulb**

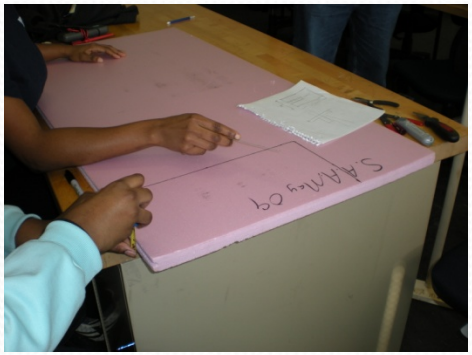
MAGNETIC INDUCTION

Progress made for Demo

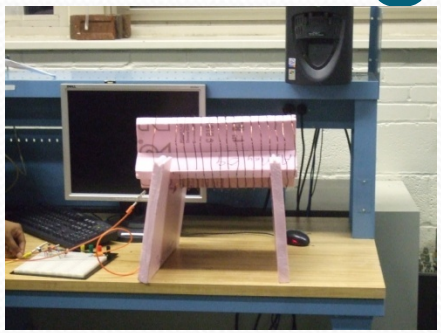
- All parts ordered and received
- Built and tested source oscillator (Colpitt's) from schematic
- Built and measured inductance of primary and secondary coils





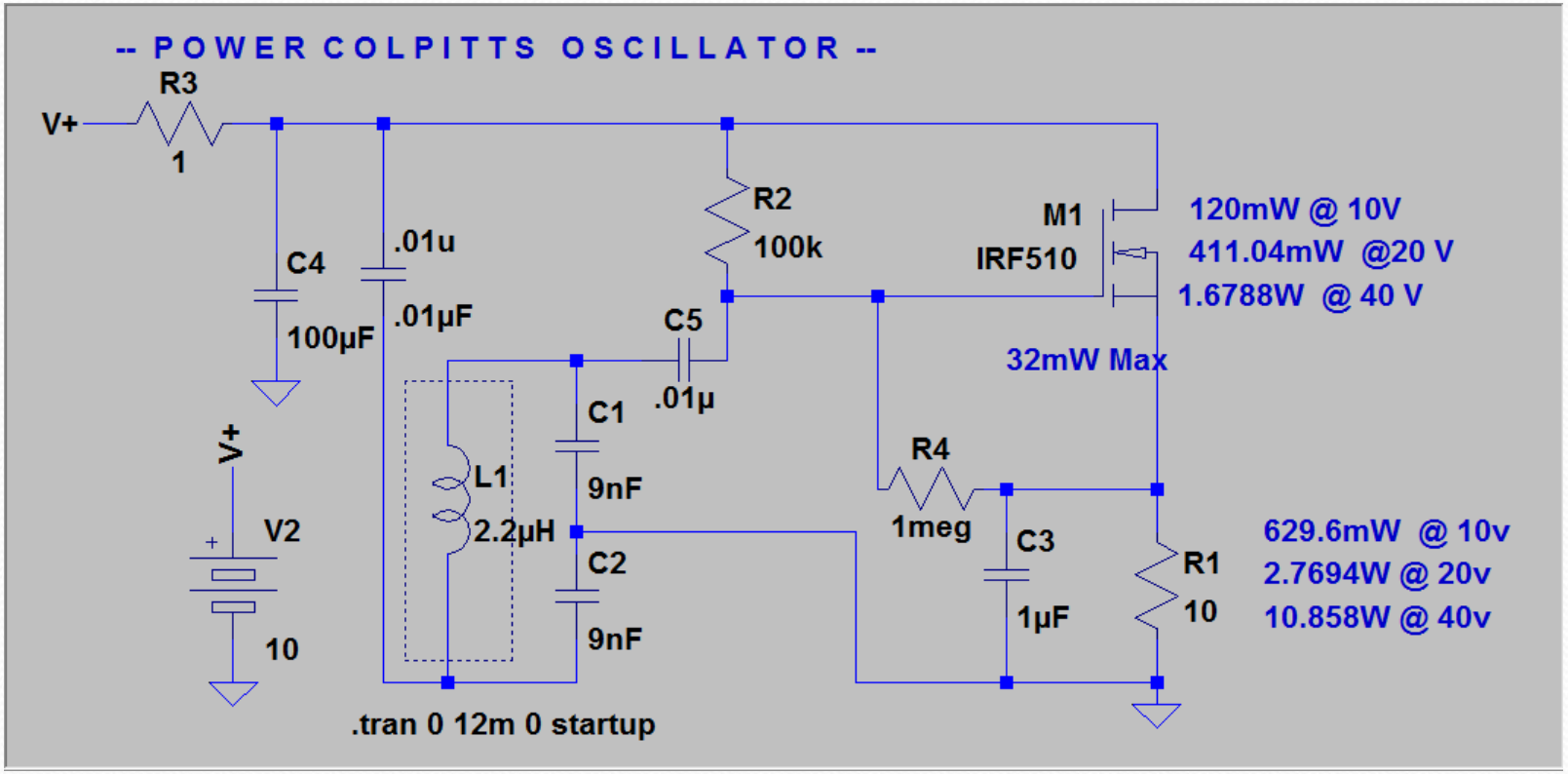


Progress Made for Demo



- Built the system and currently testing in air
- Attempted to transfer power wirelessly in air
- Tuned the primary and secondary coils to the source oscillator

Schematic used on LT Spice IV



Power Colpitts Oscillator

Issues

Barriers

- Lack of adequate daytime lab space
- Burned out parts
- Incorrect parts

Problems Beyond Team's Scope

- Lab space availability during the day (Schedule Conflicts)
- Late Part Delivery

Issues Responsible to the Lowlights

- Learning Curve
- General Experimentation
- Behind schedule

Risk Management

Risks	Prevention and Repair
1. Team does not receive funding	Complete funding proposal early
	Personal / Team fundraiser
	Beg parents
	Simulation only approach
	Bone Marrow donation (extremely last resort)
2. Parts do not arrive on time	Order parts early
	Get more expensive overnight shipping
	Use test components and manipulate to create desired design

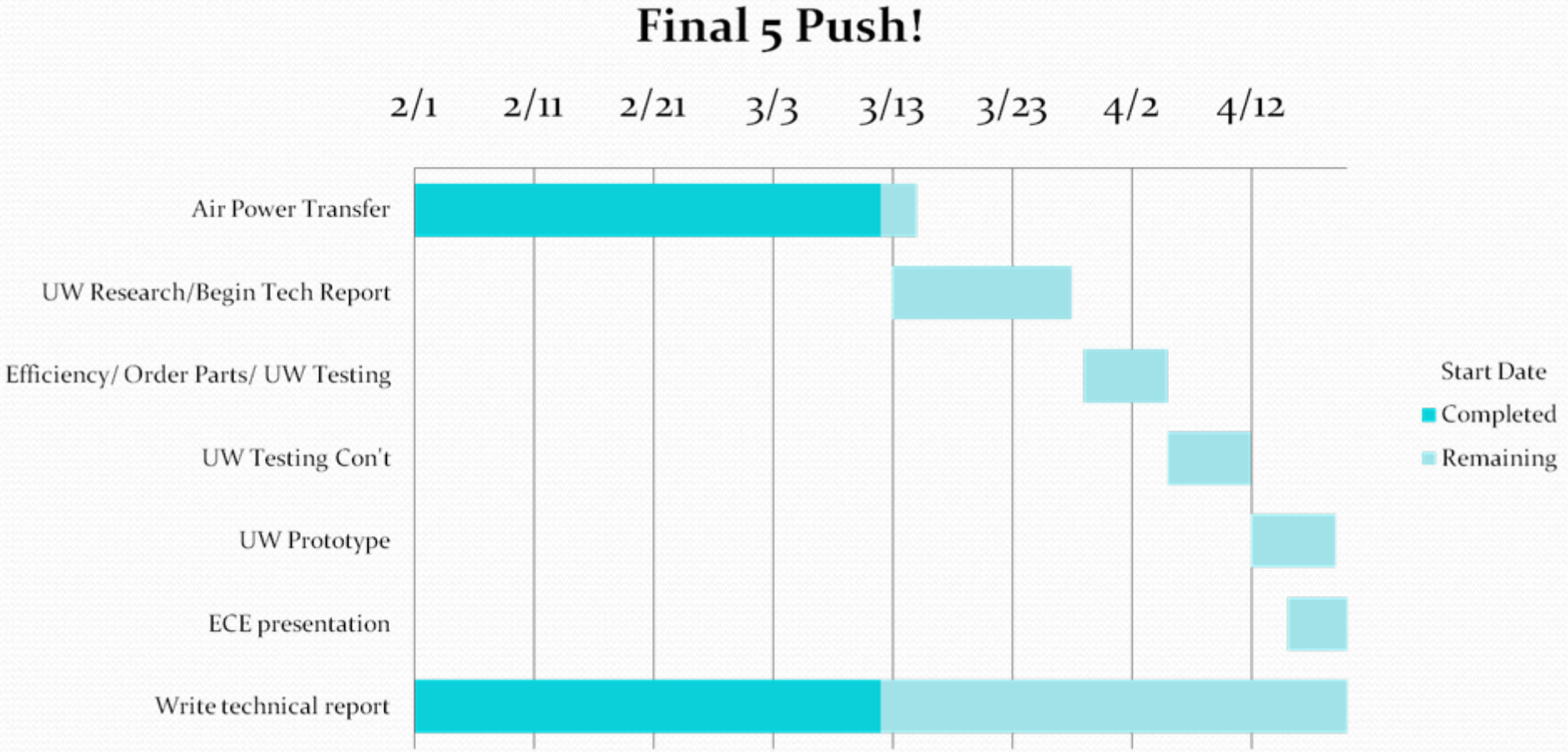
Risk Management (Cont.)

Risks	Prevention and Repair
3. Miscalculations	Check and double-check calculations before building design
	If valuable time has been wasted with wrong values, adjust values appropriately
4. Storage or part damage, or vandalism	Find and use a secure storage space
	Rebuild quickly and efficiently
5. Underwater packaging fails	Build a back up test model
	Rebuild quickly and efficiently (once parts are available)

Milestones vs. Outcomes

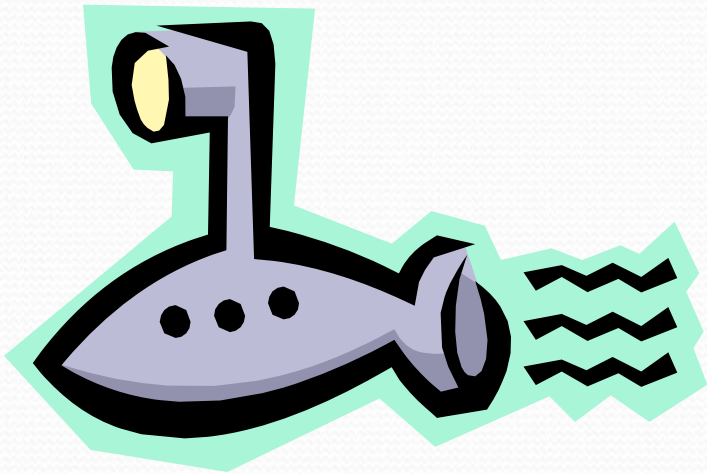
Milestone	Outcome
1. Project Proposal Approved	Done – 12/10/2008
2. Successful Simulation of Design	Done – 1/24/2009 Simulated Colpitts Oscillator at 1.3 MHz
3. Working Colpitts Oscillator	Done – 1/31/2009 Oscillations at 2MHz
4. Constructed Inductive Coils	Done – 2/28/2009
5. Complete In-air testing	In Progress – In the process of coupling the system

Further Steps



Conclusion

- Wirelessly transfer power underwater
- Recharge battery without resurfacing
- Main Solution: inductive power transfer
- System Requirements:
  - Transfer 100 V dc with 10 amps
  - Transmit in a radial range of at least 1 meter
  - Should have relatively high efficiency
- Completed by:
  - April 15, 2009



Questions