Problem Formulation and Project Plan

10/8/13

Austin Chott, Saleh Alsadiq, Matt Beckham, Thomas Griffin, Chris Heine

Overview

- Introduction
- Need Statement
- Goal
- Objectives
- Timeline
- Quality Function Deployment
- House of Quality
- Conclusion

Introduction

- **Client: U.S. Environmental Protection Agency (EPA)**
  - **P3: People, Prosperity, and the Planet Award**
  - **Research, design, and develop solutions to real world challenges involving the overall sustainability of human society**

Need Statement

Current solar water heaters are too expensive and it takes a long period of use to make them financially sensible, therefore current solar water heater designs are financially impractical over a short period of use.

Project Goal

- **Design a low cost solar water heater that is efficient enough to produce a quick financial return**

OBJECTIVES

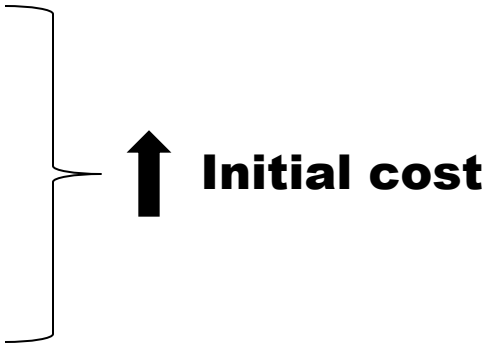
- **Heats Water**
- **Weather Proof:**
  - **Systems typically outside**
  - **Withstands the elements to reduce cost**
    - **Average storms**
    - **Average exposure to elements**
    - **Water doesn’t freeze in the system**

OBJECTIVES

- **Low Initial Cost:**
  - **Current consumer SWH systems in the US $5000-$10,000**
  - **Focused on performance**

OBJECTIVES

- **Low Initial Cost:**
  - **Cost multipliers that will be considered:**
    - **Quality of materials used**
    - **Quantity of materials used**
    - **Complexity of the design**
    - **Difficulty of construction**
      - **More skill and tools required**



OBJECTIVES

- **Quick Financial Return:**
  - **Break-even Cost is met within reasonable time period (2 Years)**
  - **Minor sacrifices in performance in order to significantly reduce cost (%/USD)**

OBJECTIVES

- **Easily Implemented into Current Heating Systems**
  - **Works with gas and electric water heaters**
  - **Easily buildable and installable with do-it-yourself level knowledge of plumbing and construction**

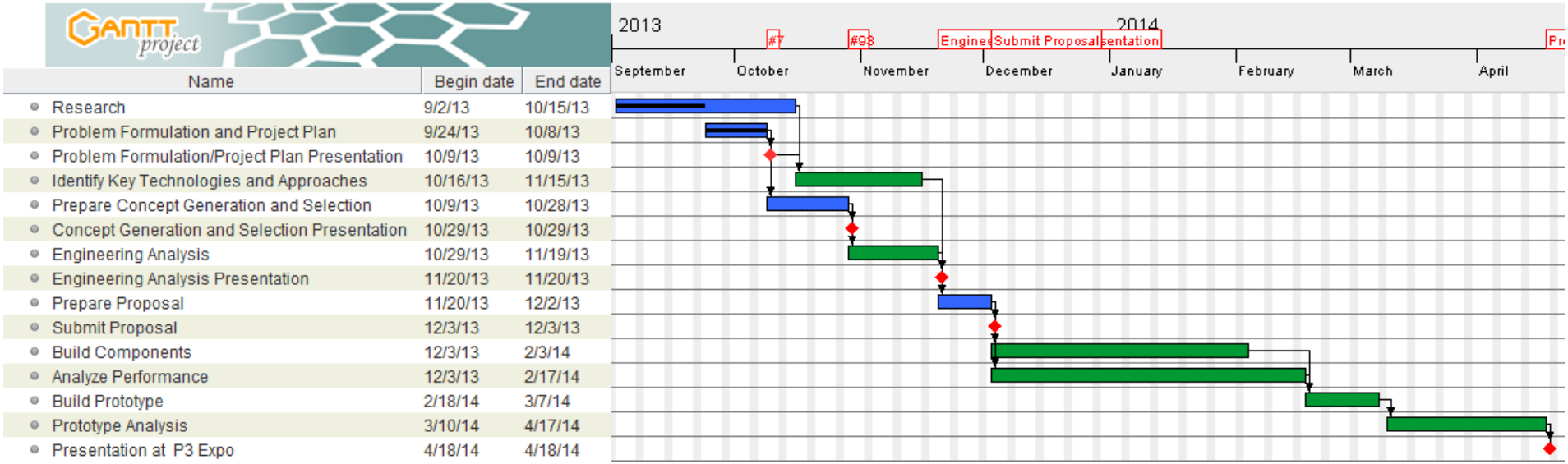
OBJECTIVES

- **Low Maintenance Cost:**
  - **Simultaneously and easily maintained with the current water heating system**

OBJECTIVES

- **Safe operation:**
  - **Safe in home operations**
  - **Meets all governments safety requirements**
- **Suitable system size:**
  - **Reasonable system volume for implementation**

Timeline

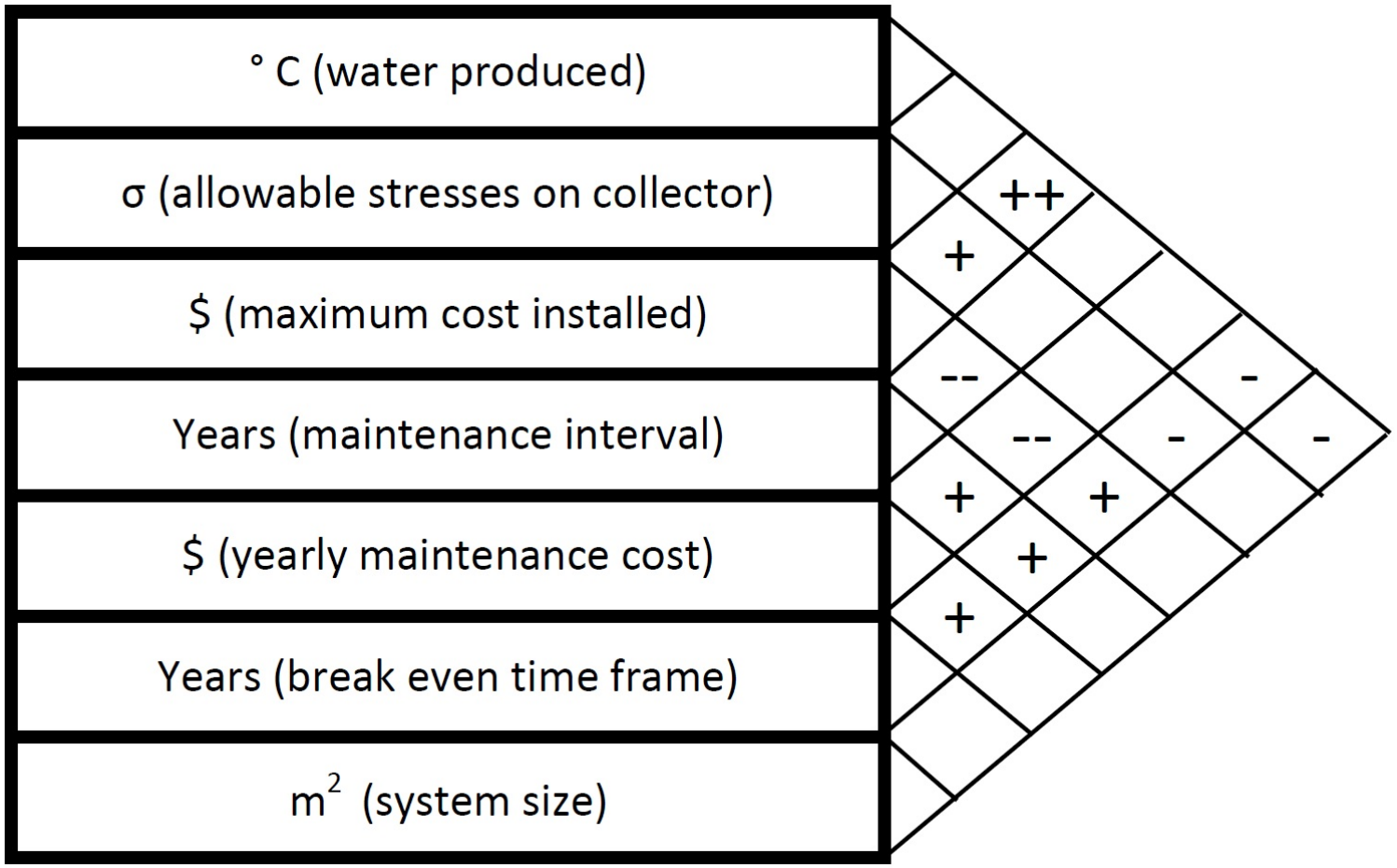


Name	Begin date	End date
Research	9/2/13	10/15/13
Problem Formulation and Project Plan	9/24/13	10/8/13
Problem Formulation/Project Plan Presentation	10/9/13	10/9/13
Identify Key Technologies and Approaches	10/16/13	11/15/13
Prepare Concept Generation and Selection	10/9/13	10/28/13
Concept Generation and Selection Presentation	10/29/13	10/29/13
Engineering Analysis	10/29/13	11/19/13
Engineering Analysis Presentation	11/20/13	11/20/13
Prepare Proposal	11/20/13	12/2/13
Submit Proposal	12/3/13	12/3/13
Build Components	12/3/13	2/3/14
Analyze Performance	12/3/13	2/17/14
Build Prototype	2/18/14	3/7/14
Prototype Analysis	3/10/14	4/17/14
Presentation at P3 Expo	4/18/14	4/18/14

Quality Function Deployment

			Specifications								
		Weighted Importance	Volume	Material Strength	Temperature	Cost	Efficiency	Weight	Heat Transfer	Pressure	Force
Objectives	1. Heats Water	10			9	9	9		9		
	2. Weather Proof	3		9				1			9
	3. Low Initial Cost	10		1	9	9	3				
	4. Low Maintence	9	1	3	1	9	3		3	3	
	5. Quick Financial Return	10		9	1	9	9		9		
	6. Implement Into Current Systems	9	3		1		1		3	9	3
	7. Safe Operation	3	1	3	3						1
	8. Sensible System Size	3	9			3		9			
	9. Easy to Use	1					3				1
	Score		66	163	217	360	249	30	234	108	58
	Relative Weight		0.18	0.45	0.60	**1.00**	**0.69**	0.08	**0.65**	0.30	0.16
	Unit of Measure		m^3	kPa	°C	$	%	kg	$W/(m^2K)$	Pa	N
	Technical Target		< 27		> 38	< 300				<101325	

House of Quality



Conclusions

- **Need: Better SWH**
- **Goal: Quick Financial Return**
- **Objectives**
- **Timeline**
- **QFD**
- **House of Quality**

References

- M. Raisul Islam, K. Sumathy and S. Ullah Khan, "Solar water heating systems and their market trends," *Renewable and Sustainable Energy Reviews,* vol. 17, pp. 1-25, 1, 2013.
- U.S. Department of Energy (DOE). (2005). *Residential Energy Consumption Survey 2005*. Washington, DC: Energy Information Administration. http://www.eia.doe.gov/emeu/recs/. Accessed October 2013.
- Energy Information Administration (EIA). (2005). *Office of Energy Markets and End Use, Forms EIA-457 A-G of the 2005 Residential Energy Consumption Survey.* Washington, DC: EIA.
- American Society of Heating and Air-Conditioning Engineers (ASHRAE). (1987). *Methods of Testing TO DETERMINE THE SOLAR PERFORMANCE OF SOLAR DOMESTIC WATER HEATING SYSTEMS*. Atlanta, GA: ASHREA Standard- 95.
- American Society of Heating and Air-Conditioning Engineers (ASHRAE). (1987). *Methods of Testing to Determine the Performance of Solar Collectors*. Atlanta, GA: ASHREA Standard- 93.
- M. Raisul Islam, K. Sumathy, Samee Ullah Kahn. (2012). *Solar water heating systems and their market trends*. Atlanta, GA: Renewable and Sustainable Energy Reviews. http://www.elsevier.com/locate/rser/. Accessed October 2013.
- Database of State Incentives for Renewables and Efficiency (DSIRE). (2012). *Arizona Incentives/Policies for Renewables and Efficiency*. Raleigh, NC: North Carolina State University. http://www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=AZ/. Accessed October 2013.
- U.S. Department of Energy (DOE). (2012). *Building Codes and Regulations for Solar Water Heaters*. Washington, DC: U.S. Department of Energy. http://energy.gov/energysaver/articles/building-codes-and-regulations-solar-water-heating-systems/. Accessed October 2013.
- U.S. Department of Energy (DOE). (2012). *Building Energy Codes Program*. Washington, DC: U.S. Department of Energy. http://www.energycodes.gov/adoption/states/. Accessed October 2013.
- Energy Protection Agency (EPA). (2013). *P3:People, Prosperity, and the Planet Student Design Competition for Sustainability .* Washington, DC: EPA. http://www.epa.gov/P3/. Accessed October 2013