OreSat Thermal Analysis

Learning Outcome Desired

Designer functions as part of a team

Project Management

Team Definition

ID	TEAM MEMBER	E-MAIL	NOTES
1	Parker Southwick	psouth2@pdx.edu	Team Lead
2	Jeremy Lowman	Jlowman@pdx.edu	
3	Katherine Popchoc	popchoc2@pdx.edu	
4	Tyler Benson	tybenson@pdx.edu	
5	Thomas Otero	otero@pdx.edu	
6	Griffen Johnson	gwj@pdx.edu	

Schedule

Requirement Gathering Phase

Project Goals

Problem Statement

Supporting Images

Customer Definition

ID	CUSTOMER	CATEGORY	MOTIVATION
1	Andrew Greenburg	Internal Customer	Primary Customer, Head of OreSat project

Product Design Specification

Original Customer Requirements

Finalized Customer Requirements

ID	REQUIREMENT	CUSTOMERS
1	1. Minimum and Maxmum Temperature	1
2	2. Minimum and Maxmum Operating Temperature	1
3	3. Minimum and Maximum Beta angle of revolution about earth	1
4	4. The times when the thermal state of the satellite are important.	1
5	5. specific deliverables for this project	1
6	6. Different scenarios to analyze	1

Link to the Technical Review Specifications

Engineering Requirements

Original Engineering Requirements

[Note that the same engineering requirement may appear more than once, if they are associated with more than one customer requirement.]

ID	REQUIREMENT
1	1.1: Temperature: Ideal = [List value]; Min = 0; Max = 70; Unit = Celsius
2	2.1: Temperature: Ideal = [List value]; Min = 0; Max = 70; Unit = Celsius
3	3.1: Beta angle: Ideal = [List value]; Min = [List value]; Max = [List value]; Unit = degrees

Finalized Engineering Requirements

ID	DESIGN VARIABLE	IDEAL	MIN	MAX	UNIT	CATEGORY	SIGNIFICANCE	CUSTOMER REQ	INCLUDED IN OBJ. FUNC.?
1	Temperature		0	0	Celsius	Function		2	Yes
2	Beta angle				degrees	Environment		3	Yes

Explanations

Phase Review

ID	DESIGN POINT ENTITY	COMPLETED? (Y/N)	LOCATION (PATH)
1	Project Goals	Yes	Ecosystem tab titled 'Project Goals'
2	Problem Statement	Yes	Ecosystem tab titled 'Problem Statement'
3	Customer Definition	Yes	Ecosystem tab titled 'Customer Definition'
4	Customer Interviews	Yes	Ecosystem tab titled 'Customer Interviews'
5	Customer Requirements	Yes	Ecosystem tab titled 'Product Design Spec'
6	Engineering Requirements	Yes	Ecosystem tab titled 'Engineering Requirements'

Gate Review

Conceptual Design Phase

Design Ideas
Canvas for New Design Ideas
Archived Design Ideas

Location of Design Sketches

Design Description
Designs Considered
Link to Documentation

Design Scoring
Scoring Tree

OreSat Thermal Analysis

Scoring Guidelines

Design Selection

House of Quality

CUSTOMER NEED	CUSTOMER	IMPORTANCE
Minimum and Maxmum Temperature	1	Unassigned
Minimum and Maxmum Operating Temperature	1	Unassigned
Minimum and Maximum Beta angle of revolution about earth	1	Unassigned
Absolute Importance:		
WEIGHTS:		
MIN:		
IDEAL:		
MAX:		
UNIT:		

Design Overview

Overview

Summary

Design Selection

Confiderence

Further Rationale

Phase Review

ID	DESIGN POINT ENTITY	COMPLETED? (Y/N)	LOCATION (PATH)
1	Sketches of Concept Ideas	No	Ecosystem tab titled 'Design Description'
2	Narration Describing the Concept Ideas	No	Ecosystem tab titled 'Design Description'
3	Analysis of Concept Ideas	No	Ecosystem tab titled 'Design Scoring'
4	Concept Selection with Rationale	No	Ecosystem tab titled 'Design Overview'

Gate Review

Detailed Design Phase

Risk Identification

Narration

Supporting Images

Model

Image Gallery

Explanations

Imported Settings
Full Path (Manual Insertion)

Root Directory (Automatic Extraction)

Calculations & Analysis
Analyses Conducted

Explanations

File Location

Phase Review

ID	DESIGN POINT ENTITY	COMPLETED? (Y/N)	LOCATION (PATH)
1	Risks Identified	No	Ecosystem tab titled 'Risk Identification'
2	Description of the Detailed Design	No	Ecosystem tab titled 'Narration'
3	Solid Model	No	Root directory for 'Part Management'' in the 'Model' tab
4	Analysis of Risk Factors	No	Ecosystem tab titled 'Calculations & Analysis' (including root directory for analysis files)
5	Project Schedule	No	Schedule under the 'Management' Menu

Gate Review

Final Design Phase

Narration

Supporting Images

Testing
Overview
Explanations
To be added

Requirement Validation

ID	DESIGN VARIABLE	IDEAL	MIN	MAX	UNIT	CATEGORY	SIGNIFICANCE	CUSTOMER REQ	INCLUDED IN OBJ. FUNC.?	SATISFIED?	METHOD	TEST RESULTS
1	Temperature		0	0	Celsius	Function		2	Yes			
2	Beta angle				degrees	Environment		3	Yes			

Bill of Material
Overview
File Location

Parts & Assembly
Drawings

Explanations

File Location

Manufacturing Options
Overview

Explanations
To be added
File Location

Cost Analysis

Phase Review

ID	DESIGN POINT ENTITY	COMPLETED? (Y/N)	LOCATION (PATH)
1	Summary of Build Plan	No	Ecosystem tab titled 'Narration'
2	Test Plan	No	
3	Validated Requirements	No	Ecosystem tab titled 'Requirement Validation'
4	Bill of Material	No	Ecosystem tab titled 'Bill of Material'
5	Parts & Assembly	No	Ecosystem tab titled 'Parts & Assembly'
6	Analysis of Manufacturing Options	No	Ecosystem tab titled 'Manufacturing Options'
7	Cost Analysis	No	Ecosystem tab titled 'Cost Analysis'
8		No	

Gate Review

Design Revisions

Appendix

References
Standards
Books
Papers

Patents
Websites
Other

Customer Interviews

DATE	CUSTOMER	INTERVIEWER	QUESTIONS	RESPONSE
2018-11-06	1. Andrew Greenburg	Parker Southwick, Jeremy Lowman, Katherine Popchoc, Tyler Benson, Thomas Otero, Griffen Johnson	What are the max and min temperatures the satellite can reach?	-Standard chips: -20 to 80 C -Industrial: -20 to 100 C -Military: -40 to 140 C Batteries: Standard: 0 to 60 C Lithium-ferrous-phosphate: -20 to 70 C Optimum case: 0 to 70 C during our time in space
2018-11-06	1. Andrew Greenburg	Parker Southwick, Jeremy Lowman, Katherine Popchoc, Tyler Benson, Thomas Otero, Griffen Johnson	How do the boards interact with the frame?	-Slots in the frame, and using springs as additional thermal contacts -Thermal grease that is vacuum safe (?) -Can we dump heat from ground planes into the satellite (?) -We love the idea of phase change stuff, wax could be sweet but also messy "Active control" -We might have to put a heater on the batteries, but specifically only the batteries
2018-11-06	1. Andrew Greenburg	Parker Southwick, Jeremy Lowman,	What is our timeline?	We really want info on the passive

		Katherine Popchoc, Tyler Benson, Thomas Otero, Griffen Johnson		mode ASAP, and the rest following
2018-11-06	1. Andrew Greenburg	Parker Southwick, Jeremy Lowman, Katherine Popchoc, Tyler Benson, Thomas Otero, Griffen Johnson	Are we essentially doing thermal simulations of the two worst states?	-We want to know about thermal behavior while orbiting around the planet -We want to know what our maximum beta angle is, what is the worst beta angle? -How much time are we spending behind the earth? -We have freeflier software available for our usage
2018-11-06	1. Andrew Greenburg	Parker Southwick, Jeremy Lowman, Katherine Popchoc, Tyler Benson, Thomas Otero, Griffen Johnson	What are the specific deliverables for this project?	-Thermal state of satellite during passive mode is the most important -Thermal state of satellite during 3 months of steady state -Some design reccomendations to aid in maintaining temperature within acceptable range
2018-11-06	1. Andrew Greenburg		What are the different times during the satellites operation where understanding the thermal state is critical?	-First 10 minutes we're shot out -First few days -During antennae deployment -During passive modes

Meeting Notes

DATE	ATTENDEES	SCRIBE	AGENDA	MINUTES
2018-10-18	Parker	Parker Southwick	HIgh level	Applying for

	Southwick, Jeremy Lowman, Katherine Popchoc, Tyler Benson, Thomas Otero, Griffen Johnson		information -Applying for UTEAP -Thermal analysis -Meeting to attend -Oresat Introductory Material -Onboarding -Overarching Goals:	UTEAP -Sent in pre-proposal to department on Tuesday -Final proposal/ grant due 10/26 -UTEAP team meeting at Sunday 10/21 @ 2:30pm - Rocket Room -Thermal analysis -Using Ansys to construct simulations for the thermal model of satellite -Physical verification of results done through lab 60-12 -Must provide actionable suggestions for operation, maintenance and construction of the satellite itself -Meeting to attend -PSAS: Tuesdays @7:00pm EB 86-01 or google hangouts -Capstone: Thursdays @10:00am EPL conference room -OreSat General: Fridays @2:00pm Rocket Room or

				google hangouts - OreSat Structural: Sundays @12:00pm Rocket Room - Google hangouts: psas.pdx.edu/hangout Oresat Introductory Material: - https://github.com/oresat/getting-started/blob/master/README.md Onboarding -Meeting with Andrew Greenberg -Discussion around meeting after PSAS general meeting at 8:00pm 10/22 -Most of us have Ansys downloaded and working -Everyone is nearly done with the reading on github -Everyone has been included on Asana and has full access to the project itself -Everyone has been signed up for PSAS, as required by sponsor

				Overarching Goals: -Extreme temperatures -High and low -Roll rate -Simplifying model -Material properties -Worst case scenarios for initial attitude, orientation and spin post ISS launch -Vacuum chamber
2018-10-25	Parker Southwick, Jeremy Lowman, Katherine Popchoc, Tyler Benson, Thomas Otero, Griffen Johnson	Parker Southwick, Jeremy Lowman	-Meeting assignments (OreSat General, OreSat Structural, PSAS general, UTEAP) -Meeting notes in general -Progress -Action Items	Meeting assignments (OreSat General, OreSat Structural, PSAS general, UTEAP): Katherine - PSAS General Meeting/ UTEAP Tyler - Structural/UTEAP Jeremy - OreSat General Parker - UTEAP and Pierros meeting (when applicable) Griffin - OreSat General Tom - OreSat Structural/ UTEAP Meeting notes in general: - Anything pertaining to Thermal specifically, or

				Thermal Testing (vacuum chamber type items) - General discussion of the OreSat meeting -If any other teams need to communicate with us about our work, or what information we may be able to provide them OreSat General - Fridays at 2pm - (Griffin/ Jeremy):N/A PSAS General - Tuesdays at 7pm - (Katherine): UTEAP budget meeting afterwards Thursday 5pm hangouts (PSAS) OreSat Structural - Sundays at 12pm - (Tyler/ Tom): N/A Pierros Meeting (Parker): Nothing since 10/16 Progress: Parker - UTEAP budget items are under discussion, which includes an addition to our project: Building a "test stand" for

				the vacuum chamber for the satellite to sit on -Check out the material "zeolite", found in meeting notes with Pierros - Started brainstorming budget, presenting to Andrew today at 5pm - https://en.wikipedia.org/wiki/Zeolite - Everyone look at Pierros meeting notes (10/16) found in OreSat Meeting Notes: https://docs.google.com/document/d/1mNIk4XnMYgLAWCJZSjRHi1wuyD29r9vJx4QHynhkO5I/edit?usp=sharing Katherine -Will be attending the PSAS general meetings via hangouts/person Tyler -Will be attending the structural meetings via hangouts/person Jeremy -Will be attending the google hangouts

				for OreSat general -Working on using Ecosystem Griffin -Met With Tretheway -Ansys Demonstration -Self paced online course through Cornell https://www.edx.org/course/a-hands-on-introduction-to-engineering-simulations -Can get a certificate after completion for $50 -Online tutorials https://studentcommunity.ansys.com/cat/support-resources-tutorials -Student community blog https://studentcommunity.ansys.com/ -For our project Ansys:Discovery Live recommended -Nvidia GTX 1080 required (?!) -How to use

				Ecosystem? - Github workshop Sunday 10/28/2018 @1:00 EPL room Tom - Created a pack and go for the OreSat satellite, making the model itself accessible (!!!!!111!1!1) Action Items: -Discuss vacuum chamber platform design for Jeremy to mill and create at some point (not now but good to think about) -Outline PDS - High level item -Reading needs to be done by 11/1, we should be done or almost done by now -Begin justifying parts on SolidWorks model, and make suggestions as to simplification of the model -Joe and Andrew are great resources to discuss this with -Lets figure out some simple Ansys models to practice -Also start taking their online

				course and maybe pay for a certificate? -Must plug in meeting notes to Ecosystem now - Jeremy, Griffin -GitHub meeting on Sunday - Tyler, Griffin (maybe), Parker (first ½)