Solar Autoclave for Rural Areas

Concept Generation & Selection

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Presentation Overview

- Problem Statement
- Concept Generation
- Concept Selection
- Updated Gantt Chart
- Conclusion
- References

Problem Statement

- NEED STATEMENT: Certain developing areas around the world have limited availability to sterilized medical equipment.
- Our goal: To create a solar autoclave that can be easily used at remote clinics in rural areas.

Western Design Autoclave

Courtesy of SciVerse
http://www.sciencedirect.com/science/article/pii/S0195670112000230

Concept Generation

- Thermal Capture
- Heat Transfer into Fluid
- Maintaining High Pressure
- Lightweight Insulation
- Thermal Storage

Thermal Capture

- Parabolic Trough and Dish

Courtesy of Tech Bells
http://techbells.blogspot.com/2012/07/working-of-csp-parabolic-trough.html

Courtesy of Inhabitat
http://inhabitat.com/19-year-old-teenager-makes-homemade-solar-death-ray/solarray2/

Thermal Capture

- Fresnel Lens

Courtesy of WN
http://article.wn.com/view/2008/01/16/Fresnel_lens_sheet_rear_projection_screen_and_rear_projectio/

Heat Transfer into Fluid

- Fins
- Metal pipe in parabolic trough
- Boiler at focal point of parabolic trough

Courtesy of Pencom
http://www.hellotrade.com/peninsula-components/forged-fin-heat-sinks.html

Maintaining High Pressure

- Wing Nuts
- Clamp

Courtesy of ElectriDuct
http://www.electriduct.com/Arlington-Industries-Steel-and-Iron-Beam-Clamps.html

Courtesy of Pressure Cookers Best
http://www.pressurecookersbest.com/all-american-15-12-quart-pressure-cooker.html

Lightweight Insulation

- Thermablok® Aerogel Insulation

Courtesy of Thermablok
http://www.thermablok.com/thermal-insulation/thermablok-contact-form.htm

Lightweight Insulation

- Clay-coated straw
- Mineral Wool
- Styrofoam
- Fiberglass
- Phenolic Foam
- Liquid Cement
- Cork

Courtesy of Unipro
http://www.alibaba.com/product-tp/12283858/FiberGlass_wool_Insulation

Courtesy of Thermafiber
http://www.thermafiber.com/InsulationProducts/CommercialInsulation

Thermal Storage

- Sensible heat storage
- Latent heat storage
  - phase-change materials (PCM)
    - Molten salts

Courtesy of Green Cleaning Ideas
http://www.greencleaningideas.com/2011/09/top-10-green-technology-ideas-set-to-change-the-world/

Concept Selection

Decision Matrix – Thermal Capture

Table 1: Thermal capture decision matrix

Thermal Capture Design Options	Criteria	Column1	Column2
	Reliability	Cost	Flexibility
Parabolic Dish	2	2	3
Parabolic Trough	1	1	2
Fresnel Lens	3	1	3

Table 2: Numerical rating

Judgment of Importance	Numerical Rating
Best Option	1
	2
Worst Option	3

Concept Selection

Decision Matrix – Insulation

Table 3: Insulation decision matrix

Insulation Design Options	Criteria	Column1	Column2
	Weight	Cost	Thermal Conductivity
Aerogel	1	3	1
Mineral Wool	2	1	3
Fiberglass	2	1	2

Analytical Hierarchy Process

Table 4: Numerical rating

Judgment of Importance	Numerical Rating
Extremely more important	9
	8
Strongly more important	7
	6
Moderately more important	5
	4
Slightly more important	3
	2
Equally important	1

Table 5: Pairwise comparison matrix

Column1	Thermal Capture	Heat Transfer into Fluid	High Pressure Maintenance	Insulation	Thermal Storage
Thermal Capture	1	1	2	5.00	9.00
Heat Transfer into Fluid	1	1	2	4.00	9.00
High Pressure Maintenance	0.5	0.5	1	6.00	9.00
Insulation	0.2	0.25	0.17	1	5
Thermal Storage	0.11	0.11	0.11	0.2	1
Total	2.81	2.86	1.28	16.20	28.00

Table 6: Overall importance matrix

Column1	Thermal Capture	Heat Transfer into Fluid	High Pressure Maintenance	Insulation	Thermal Storage	Overall Importance
Thermal Capture	0.36	0.35	1.56	0.31	0.32	2.90
Heat Transfer into Fluid	0.36	0.35	1.56	0.25	0.32	2.84
High Pressure Maintenance	0.18	0.17	0.78	0.37	0.32	1.83
Insulation	0.07	0.09	0.13	0.06	0.18	0.53
Thermal Storage	0.04	0.04	0.09	0.01	0.04	0.21

Updated Gantt Chart

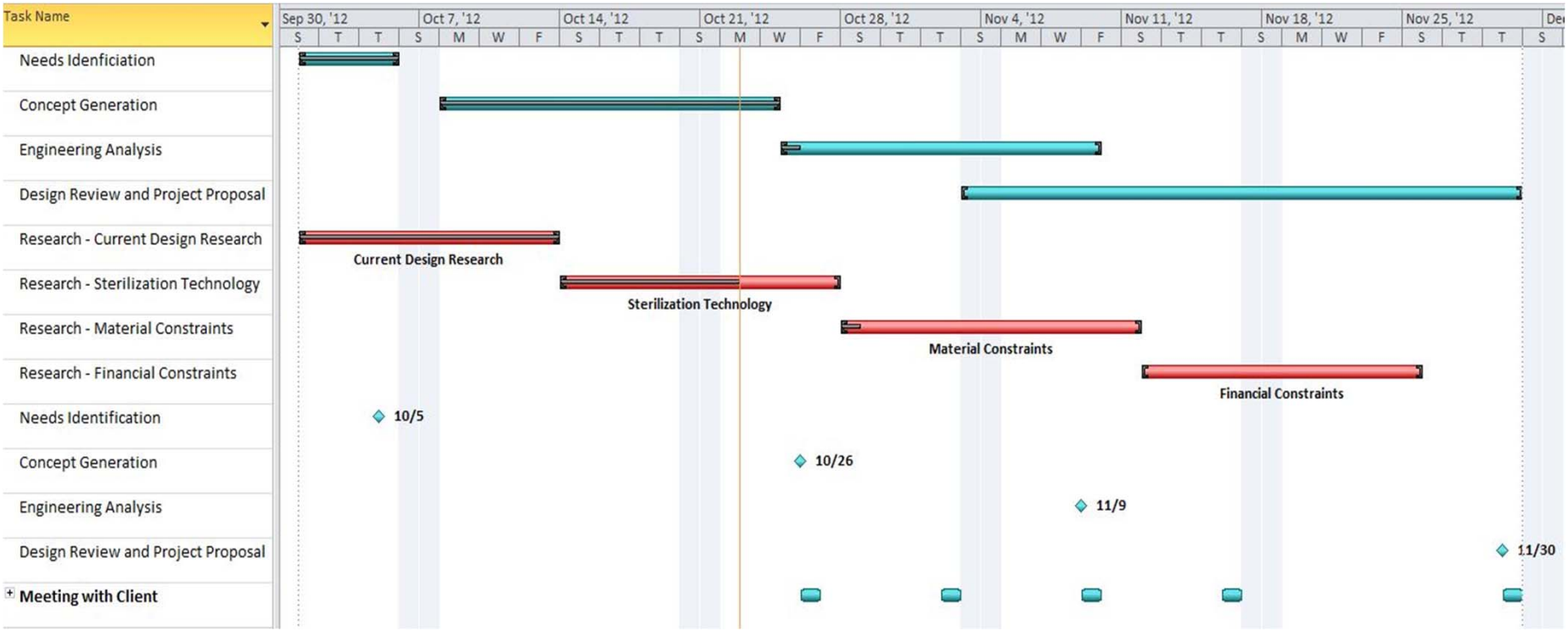

Figure 1: Gantt chart

Conclusion

- Thermal capture and heat transfer into fluid are most important
  - Parabolic Trough
- Safely maintain pressure
- Designing for rural, remote clinics
  - Flexible design for different regions

References

- Sponsor: Dr. Brent Nelson (Brent.Nelson@nau.edu)
- Project website:
  - http://www.cefns.nau.edu/interdisciplinary/d4p/EGR486/ME/13-Projects/SolarAutoclave/
- Resources:
  - http://globalchallenge.mit.edu/teams/view/171
  - http://www.solare-bruecke.org/projekte-Dateien/Solarsterilisator/summary%20english.html
  - http://www.travel.state.gov/

Questions?