



Laser Pointer

Engineering Analysis

Jeb Duncan, Eddie Hoopingarner,
Cole Middlebrook, Michael Orrill

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Overview

- Background
- Concepts Chosen for analysis
- Structural Analysis
- Thermal Analysis
- Schedule
- Conclusion

Background

Client: Mr. Edwin Anderson

Problem: Desired Laser too powerful for handheld use

Project: Design indication system to safely point out the locations of stars

Concept 1

Insulated hand held system

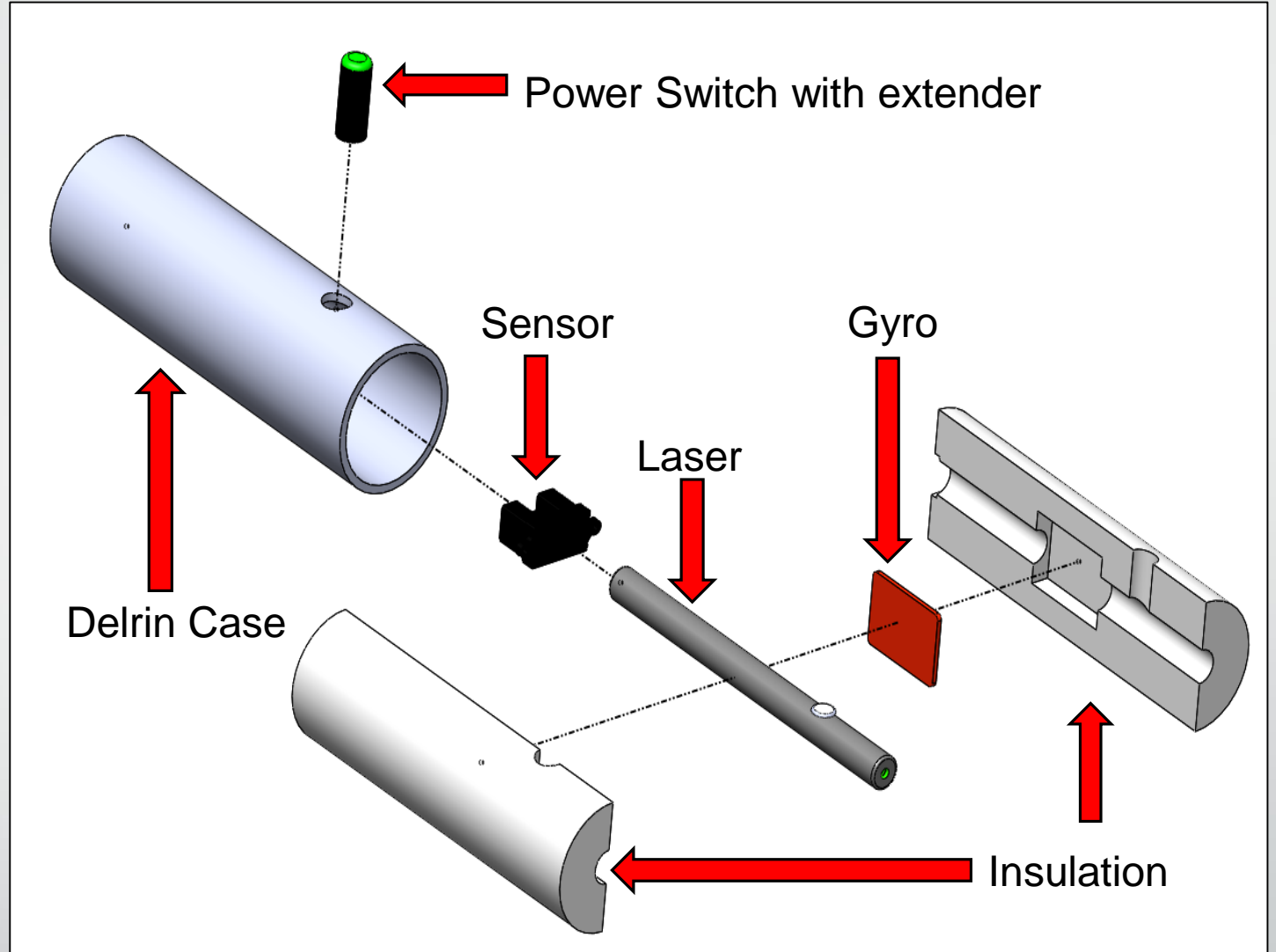
- Gyroscope / Accelerometer
- Infrared Proximity Sensor
- Insulated
- Integrated electronics



[1] "Laser Dimension Master II." *Laser Dimension Master II*. N.p., n.d. Web. 15 Nov. 2013.

Concept 1

Hand held system



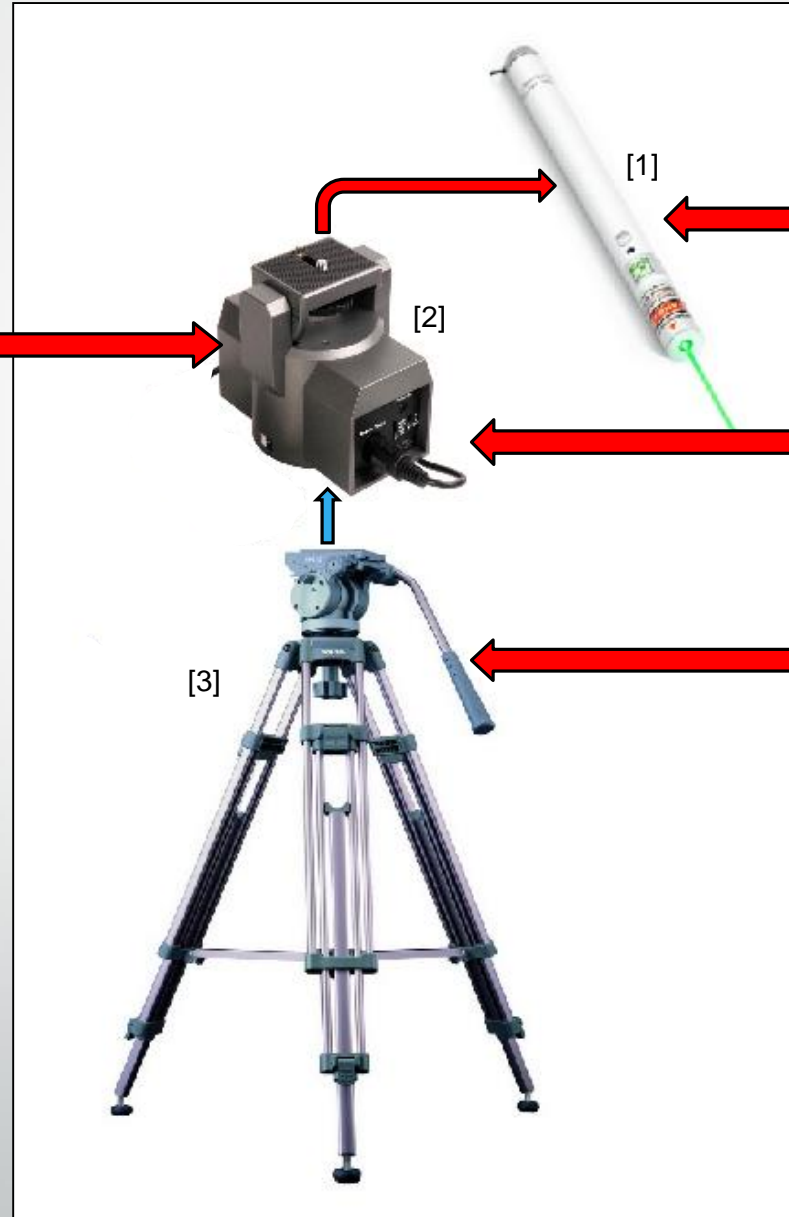
Concept 2

Joystick Turret



[4]

- [1] <http://www.highlasers.com/10mw-green-laser-pointer-w/>
- [2] <http://geb.ebay.in/g/ImportHubViewItem?itemid=121106016969&Bescor-MP-101-Motorized-Camera-Panhead-with-Remote-Control-MPH-1>
- [3] <http://www.made-in-china.com/showroom/wakotripod/product-detailBogxqRnbYtWM/China-Video-Camera-Tripod-KH-25II-.html>
- [4] "Laser Dimension Master II." Laser Dimension Master II. N.p., n.d. Web. 15 Nov. 2013.



20 mW laser

Two axis turret

6 Foot adjustable tripod

Concept 2

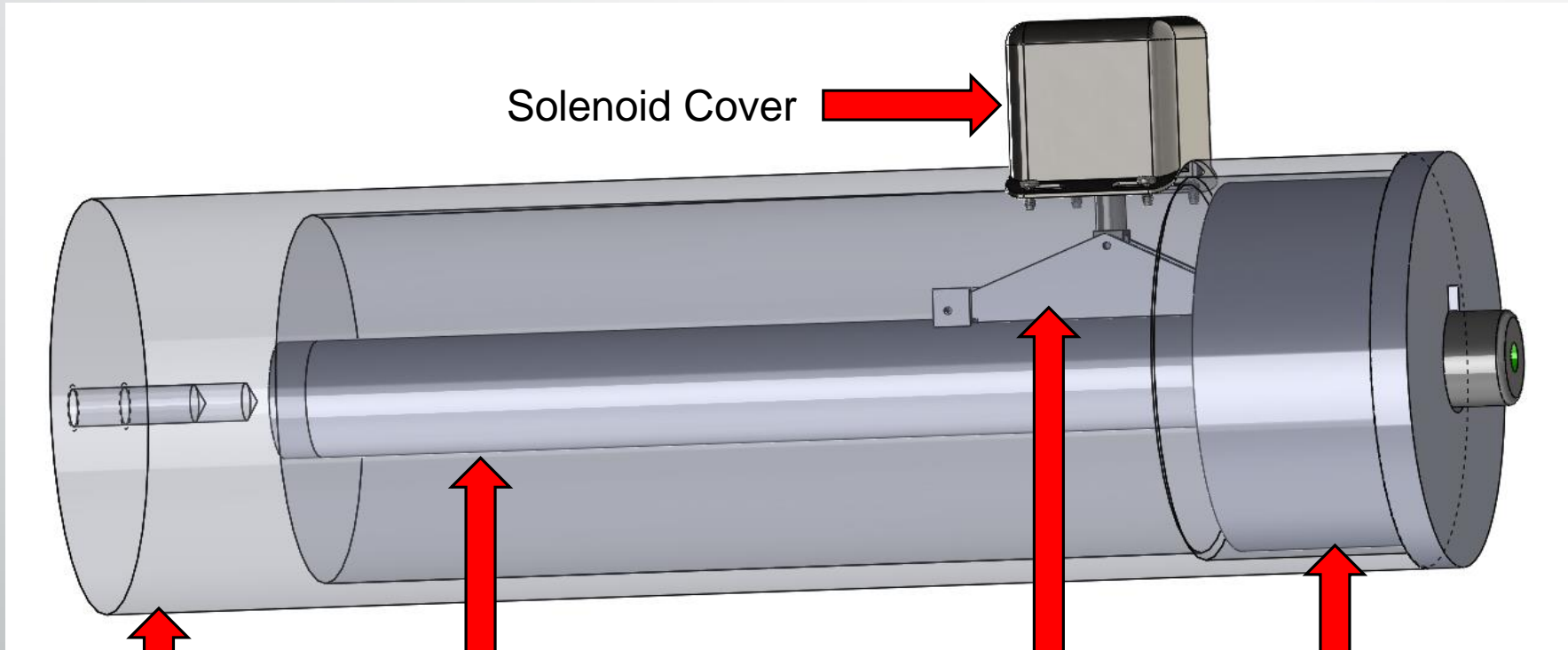
Insulated Tripod Mounted

- Delrin case
- Accommodates multiple laser designs
- Base mount design
- Insulated case
- Integrated switch mechanism



Concept 2

Insulated Tripod Mounted



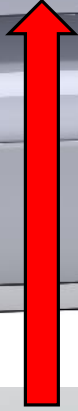
Solenoid Cover



Delrin Case



Inner Tube



Switch Trigger



Delrin Cap

Components Omitted from Analysis

- Tripod
 - Item is going to be purchased
 - Maximum capable load – 12 lbs.
 - Turret weight including laser assembly ~ 6lbs.
- Turret
 - Item is going to be purchased
 - Maximum capable load – 5 lbs.
 - Estimate of laser assembly weight

Structural Analysis

- Motivation: Event of dropping handheld design
- Two potential materials tested
 - Aluminum 6061–O
 - Delrin-100
- Process: Calculate stress that will cause plastic deformation

Calculations

- *Impact Velocity*

- $V_f^2 = V_o^2 + 2 * a * h$

- Acceleration due to impact

- $a = \frac{dv}{dt}$

- Force of impact

- $F = ma$

- Maximum stress before plastic deformation occurs

- $\sigma = E\varepsilon$

Maximum Stresses

Al: $\sigma = (68.9 \text{ GPa})(.0002) = 13.8 \text{ MPa}$

Delrin: $\sigma = (2 \text{ GPa})(.0002) = 0.4 \text{ MPa}$

Structural Analysis

Conclusions:

- Both materials adequate candidates for protective case
- Separating factor – Thermal conductivity
 - Aluminum 6061-O – $237 \text{ W/m} \cdot \text{K}$
 - Delrin 100 – $0.3 \text{ W/m} \cdot \text{K}$

Thermal Analysis

Motivation: Laser must remain within operating temperatures

Assumptions:

- Approximate coldest comfortable temperature for presentation : -5°F
- Laser pointer temperature isothermal
- No contact resistance from laser surface to polystyrene insulation
- Ambient wind in cross flow, used to find average value for heat transfer coefficient (h)

Thermal Analysis

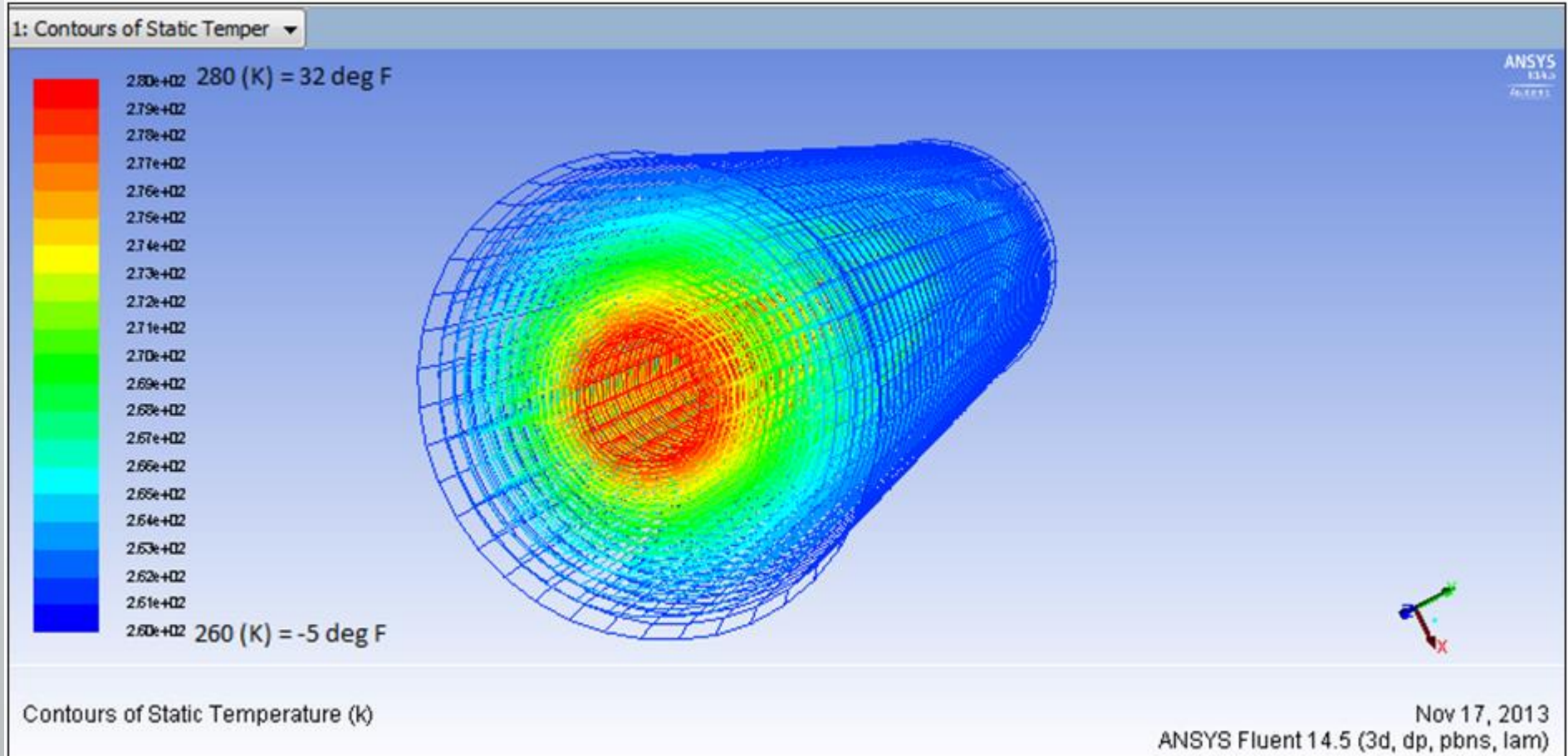
Derived equation for total heat loss in our system:

$$q = \frac{T_i - T_\infty}{\frac{1}{L\pi} \left[\frac{1}{hD_0} + \frac{\ln \frac{r_2}{r_1}}{2k_{ins}} + \frac{\ln \frac{r_3}{r_2}}{2k_{shell}} \right]}$$

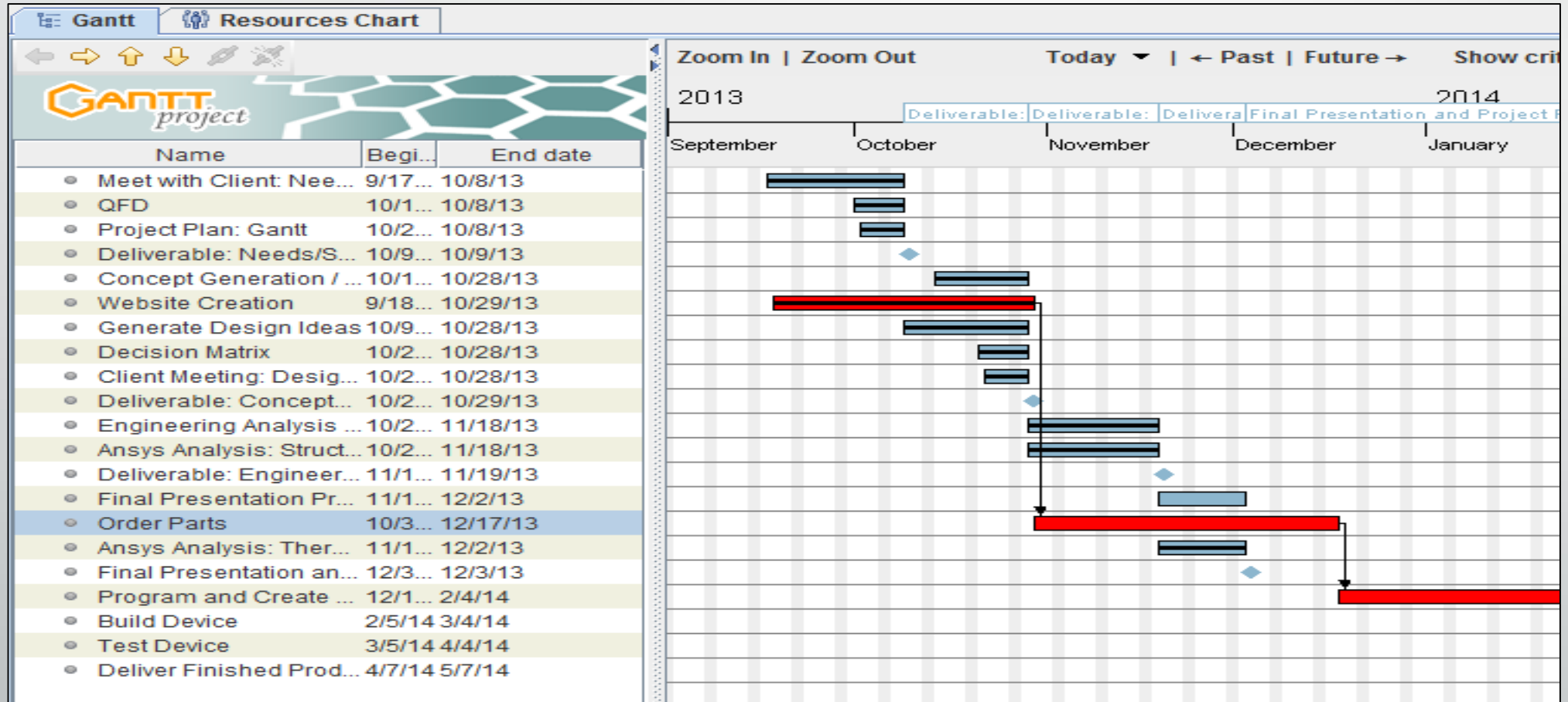
$$q = 0.35 \text{ W}$$

Thermal Analysis

Ansysis temperature distribution:



Gantt Chart



Conclusion

- Concept 1 - Handheld Unit
- Concept 2 - Tripod
- Structural Results
 - Delrin 100 chosen as case material
- Thermal Results
 - Delrin case and insulation will provide sufficient thermal resistance
- Project Plan
 - All tasks are still on schedule

References

- [1] <http://www.vectorstock.com/royalty-free-vector/people-pointing-vector-6316>
- [2] <http://www.highlasers.com/10mw-green-laser-pointer-w/>
- [3] <http://geb.ebay.in/g/ImportHubViewItem?itemid=121106016969&Bescor-MP-101-Motorized-Camera-Panhead-with-Remote-Control-MPH-1>
- [4] <http://www.made-in-china.com/showroom/wakotripod/product-detailBogxqRnbYtWM/China-Video-Camera-Tripod-KH-25II-.html>
- [5] <http://www.mikesjournal.com/July%202010/iPad%20Eclipse%20Star%20Walk%20App.htm>
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- [10] Stress Strain for Delrin source
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- [13] R.C. Hibbeler, "Kinetics of a Particle: Force and Acceleration," in *Dynamics*, 12th ed. Upper Saddle River, New Jersey, Pearson Prentice Hall, 2010, ch. 13



Questions?

Structural Analysis

Physical		Electrical	
Dimensions (WxHxD)	10" x 14" x 4"	Power Supply	110-230 VAC to 12 DC 1000 MA
Weight	4.5 lbs.	Connector	5.5 X 2.1 center Pos.
Cable Length	12 Feet	Capabilities	
Mounting	Upright or Inverted	Slowest Speed	1 rev in 10 minutes
Mounting Plate	3" x 3" with 3/8" hole	Max Speed	4 RPM @ 12 V
Controls		Pan Revolution	360° +
2 Axis Thumbstick P/T	30/30 degrees	Tilt Revolution	360° +
Ramp	none	Capacity	5 ponds/2.3 kilos
Linear	none	Overall Specifications	
Logarithmic	fixed	Max height	78" (1.98 m)
Speed Limit	0 to 100%	Min height	31" (0.7874 m)
		Folded length	34" (0.8636 m)
		Center post adjustment	15" (0.381 m)
		Weight	9 lb (4.08 kg)
		Max Tripod load	25 lb (11.34 kg)