

E80 Intro & Flight Basics

Engineering 80 S 2012

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Important Dates

- 19 JAN 2012 – Labs Begin (Section 4)
- 27 JAN 2012 – 1st LabVIEW Assignment Due
- 8 MAR 2012 – Final Project Begins
- 14 APR 2012 – Final Project Launch 1
- 21 APR 2012 – Final Project Launch 2
- 30 APR 2012 – Final Presentation, Final Project Due

Course Objectives

By the end of the course students will:

1. Demonstrate hardware and equipment skills
2. Demonstrate experimental and analytical skills
3. Demonstrate the beginnings of professional practice

Course Structure

- Informational Lectures
 - T Th from today through 21 FEB + 2
- Pre-lab
 - Modeling and Data Manipulation Prep
 - VIs & Code, Equipment Manuals, Ask Professors
- 6-hour Lab Sessions
- LabVIEW assignments
- Tech Memo
- Final Project
 - Launches
 - Final Report
 - Final Presentation

The E80 Website

- Fount of almost all knowledge (sort of like Wikipedia but harder to search)
- Sakai used for submission of LabVIEW assignments, but almost nothing else

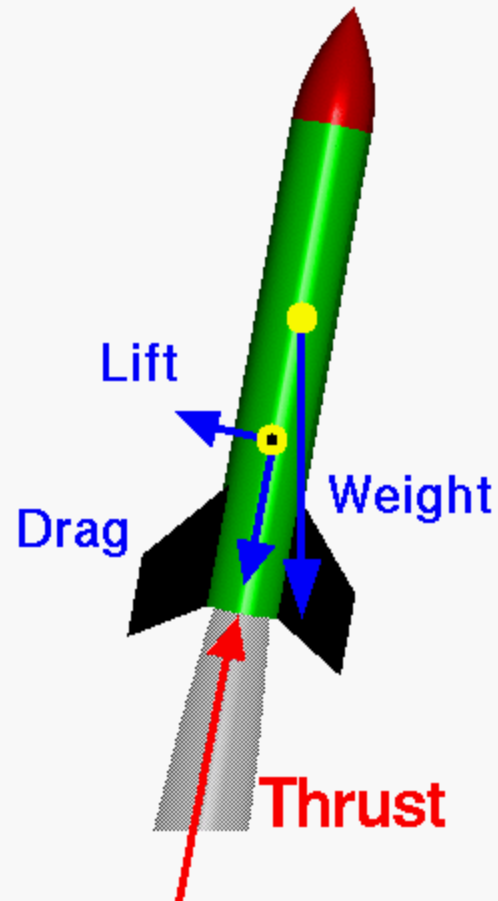
<http://www.eng.hmc.edu/NewE80/index.html>

Rocketry Basics

- Modeling and Measurement of Rocket Performance
- FAA
- Rocketry Certification



Rocket Thrust



<http://exploration.grc.nasa.gov/education/rocket/bgmr.html>

Modeling and Measurement of Rocket Performance

- Full Model

$$m\ddot{\vec{x}} = \sum \vec{F} = \textit{Thrust} - \textit{Drag} - \textit{Weight}$$

$$J\ddot{\theta} = \sum \vec{T}$$

- Rocksim

$$\vec{x}(t) = \vec{x}_0 + \vec{v}_0 t + \int_0^t \int_0^t \vec{a} dt dt$$

Altimeter Data Analysis

$$v(t) = \frac{d}{dt} x(t)$$

$$a(t) = \frac{d}{dt} v(t) = \frac{d^2}{dt^2} x(t)$$

Numerical Derivatives

- For a set of points x_0, x_1, x_2, \dots
taken at times t_0, t_1, t_2, \dots

- Forward Difference

$$U_n = \frac{x_{n+1} - x_n}{t_{n+1} - t_n}$$

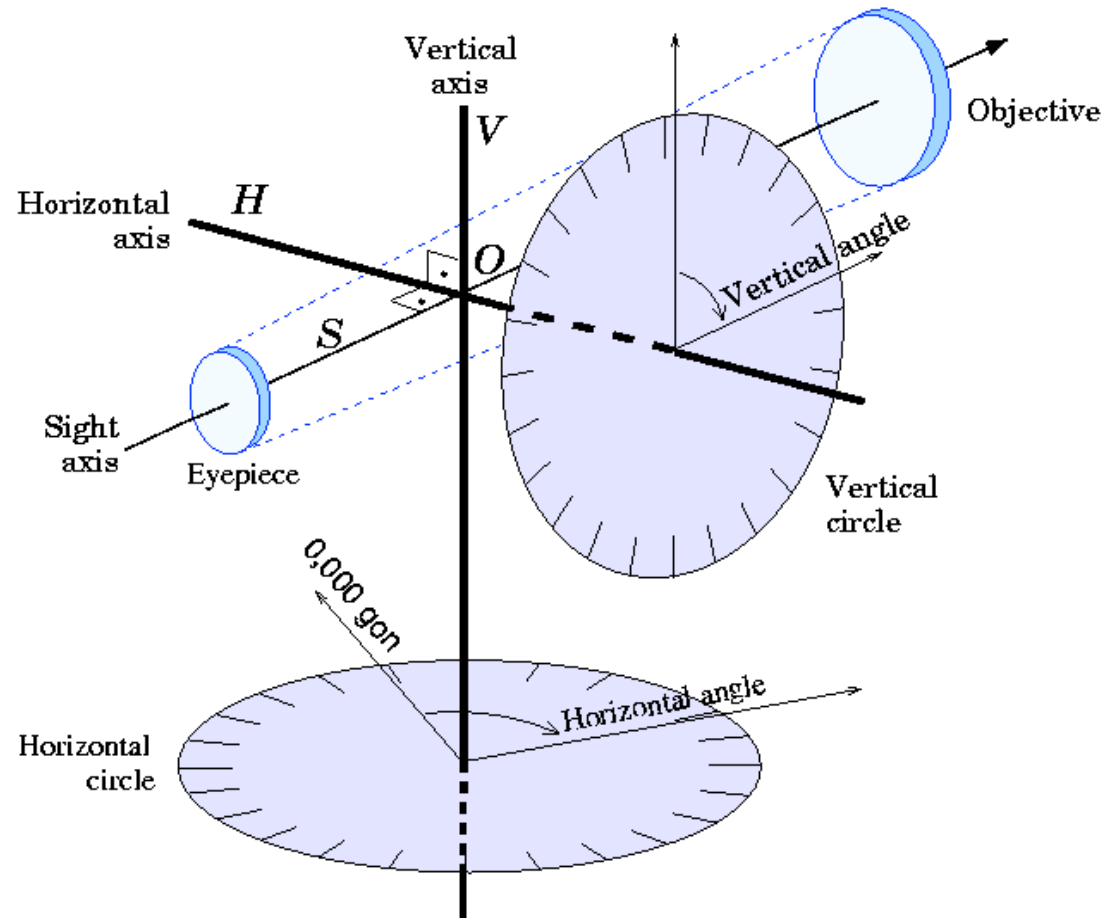
- Backward Difference

$$U_n = \frac{x_n - x_{n-1}}{t_n - t_{n-1}}$$

Noise Reduction

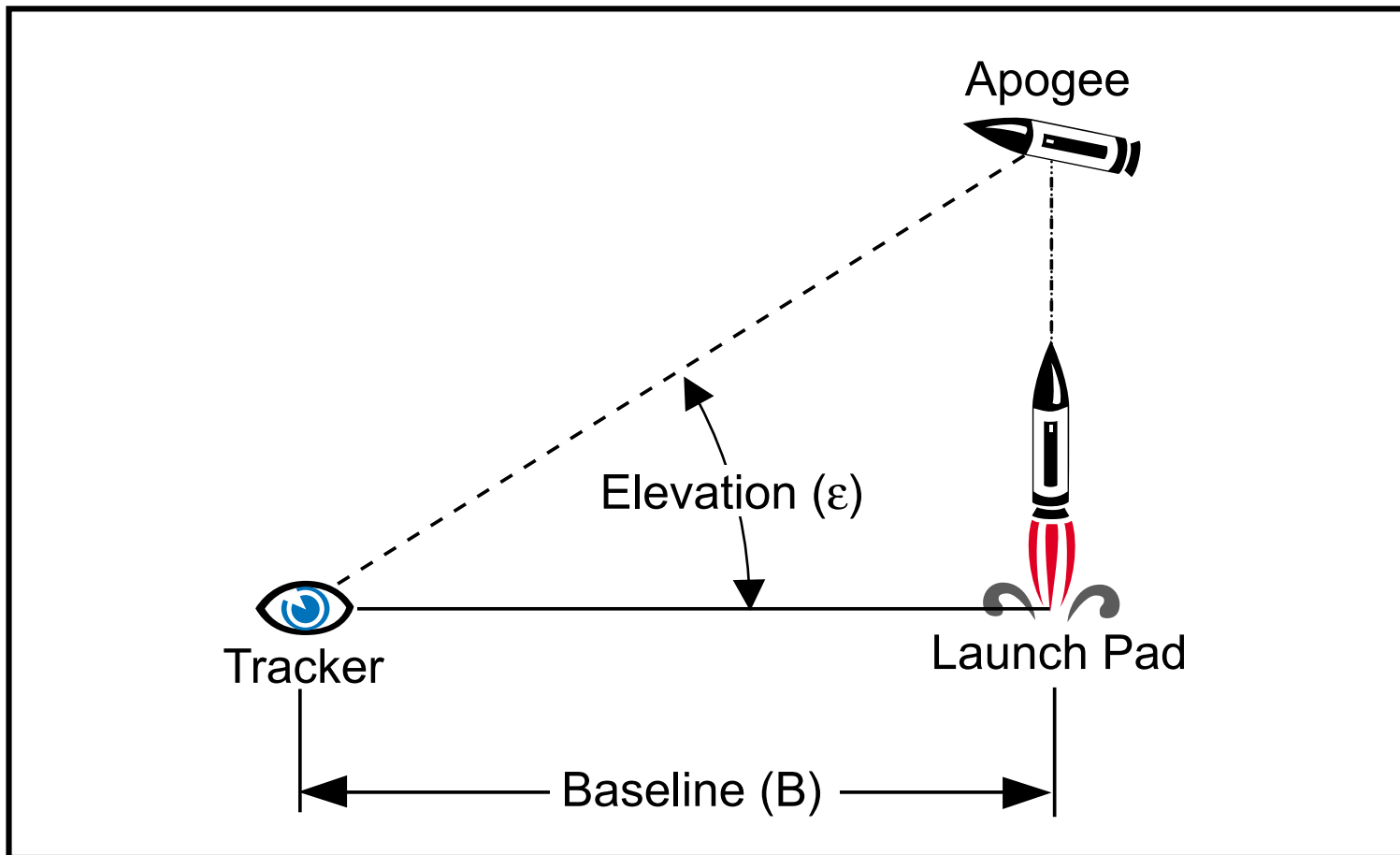
- Lowpass filter signal, derivative, or both
- Fit a smooth analytical function, e.g., cubic spline
 - Take analytical derivative

Inclinometer or Theodolite



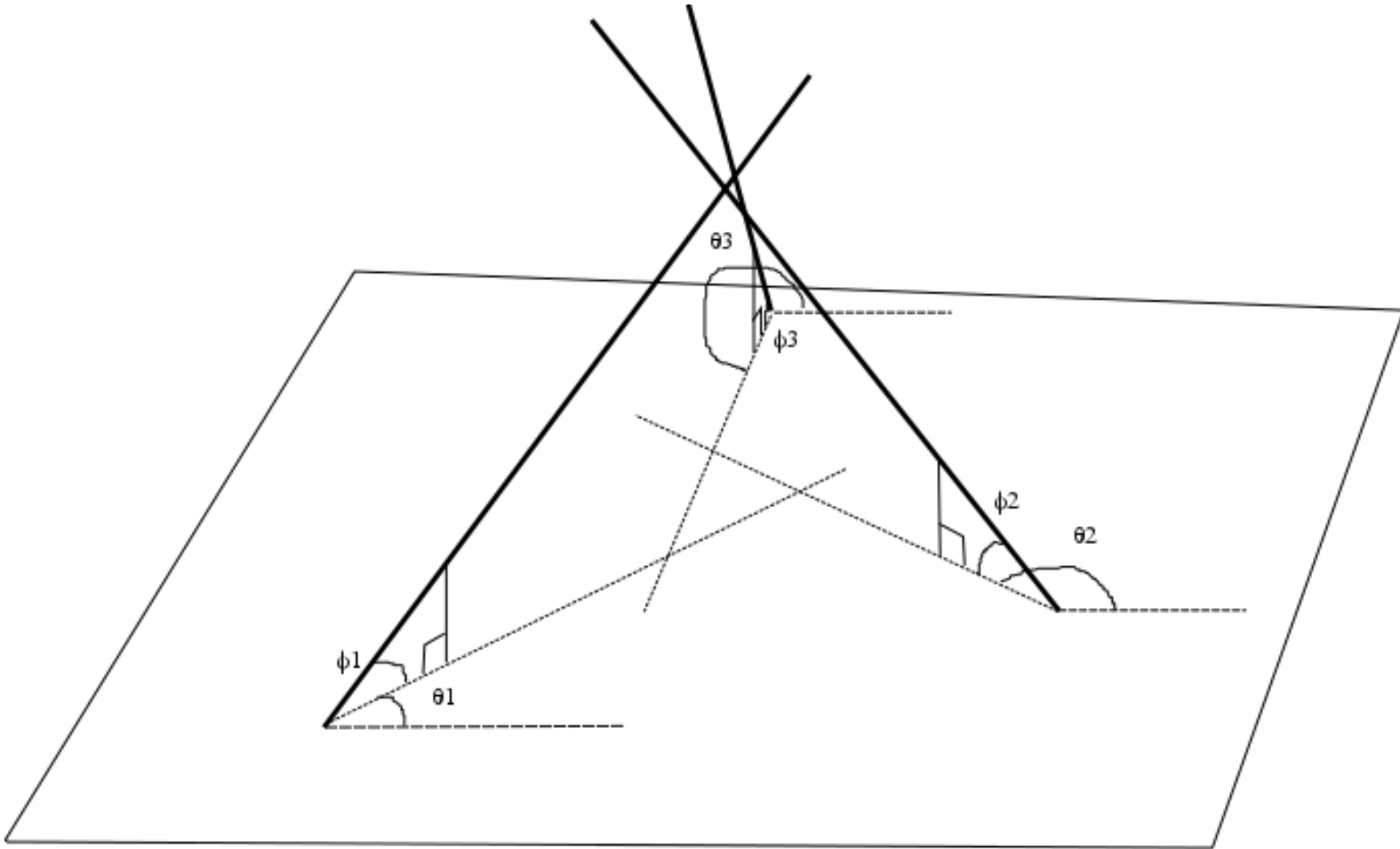
http://en.wikipedia.org/wiki/File:Theodolite_vermeer.png

Inclinometer



<http://www.apogeerockets.com/education/downloads/newsletter92.pdf>

Three Theodolites



Lines in 3 Space

- Rarely intersect
- Use points of closest approach
- Details of calculation and VI to do calculation are on website

FAA Regulations

- **Class 1** - a model rocket that uses no more than 125 grams (4.4 ounces) of propellant; uses a slow-burning propellant; is made of paper, wood, or breakable plastic; contains no substantial metal parts; and weighs no more than 1,500 grams (53 ounces) including the propellant – Requires permission of the Fire Department and the property owner.
- **Class 2** – a high power rocket, other than a model rocket, that is propelled by a motor or motors having a combined total impulse of 40,960 Newton-seconds (9,208 pound-seconds) or less – Requires permission of FAA, Fire Department, and property owner. Operator must also be TRA or NAR certified.
- **Class 3** – an advanced high power rocket, other than a model rocket or high-power rocket – Has lots of regulatory restrictions.
- Rockets flown in California require either State Fire Marshall certified motors or a bunch of permits.

NAR or Tripoli Certification

- Level 1
 - Can fly H and I impulse motors
- Level 2
 - Can fly J, K, and L impulse motors
- Level 3
 - Can fly M and above

14 APR 2012 Launch

- Joint with [ROC](#)
- Can certify [Level 1](#) (one per team)
 - Have to construct the Final Project rocket yourself
 - Have to prep and load the motor yourself
 - NAR best for general rocketeers
 - Tripoli best for BIG rockets