# E80 Intro & Flight Basics

Engineering 80 S 2013

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# Important Dates

- 24JAN 2013– Labs Begin (Section 4)
- 1 FEB 2013 – 1st LabVIEW Assignment Due
- 14 MAR 2013 – Final Project Begins
- 20 APR 2013 – Final Project Launch 1
- 27 APR 2013 – Final Project Launch 2
- 6 MAY 2013 – 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 28 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

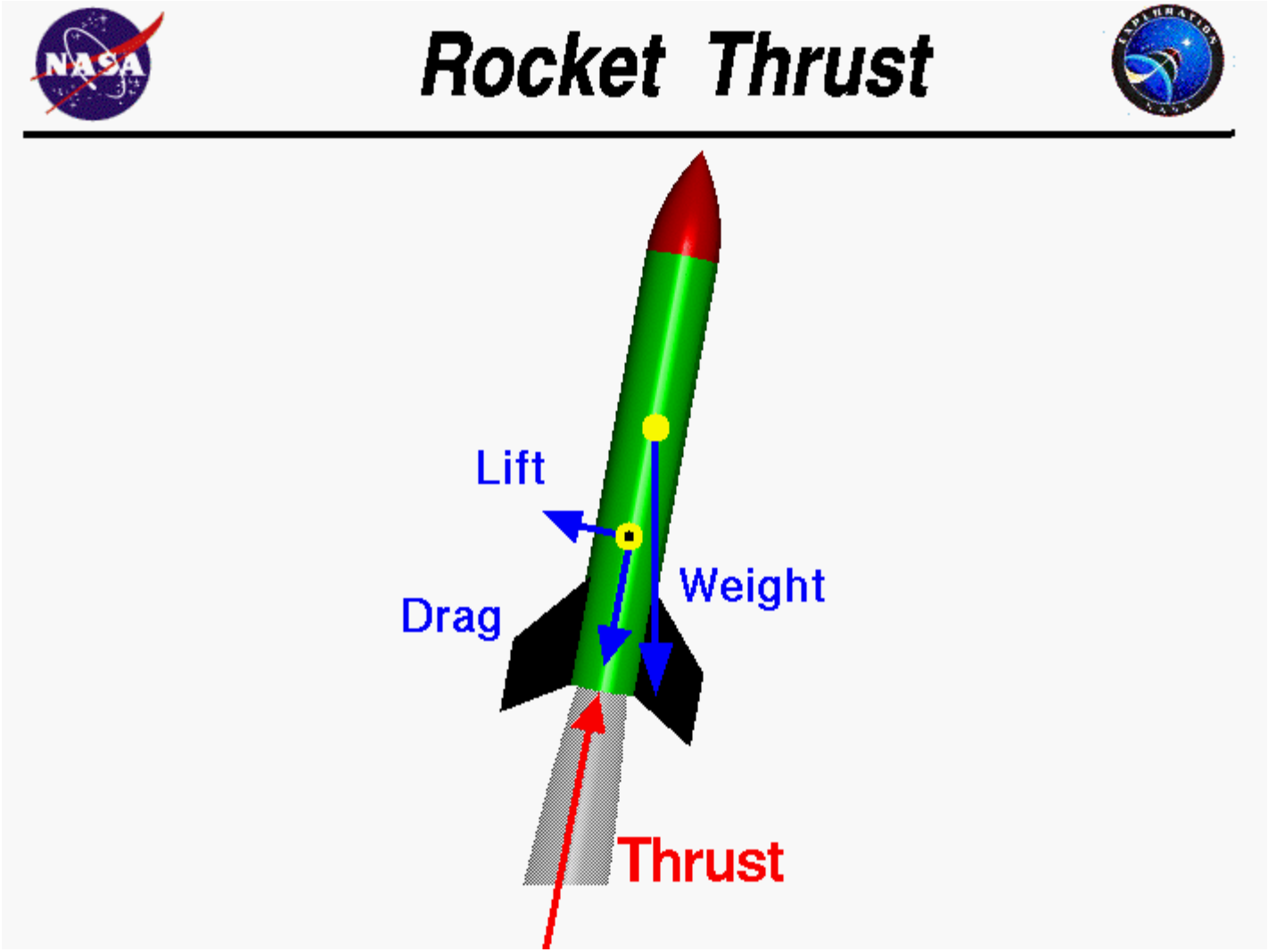
# The E80 Website

- 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




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

# Modeling and Measurement of Rocket Performance

- Full Full Model

$$\frac{d}{dt}\left(m\vec{v}\right) = \sum \vec{F} = Thrust + Lift - Drag - Weight$$

$$\frac{d}{dt}\left(J\vec{\omega}\right) = \sum \vec{T}$$

# Modeling and Measurement of Rocket Performance

- Full Model

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

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

- Rocksim

$$\vec{x}\left(t\right) = \vec{x}_0 + \vec{v}_0 t + \int_0^t \int_0^t \vec{\alpha}\, dt\, dt$$

# 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 $x_0, x_1, x_2, \ldots$ taken at times $t_0, t_1, t_2, \ldots$
- Forward Difference

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

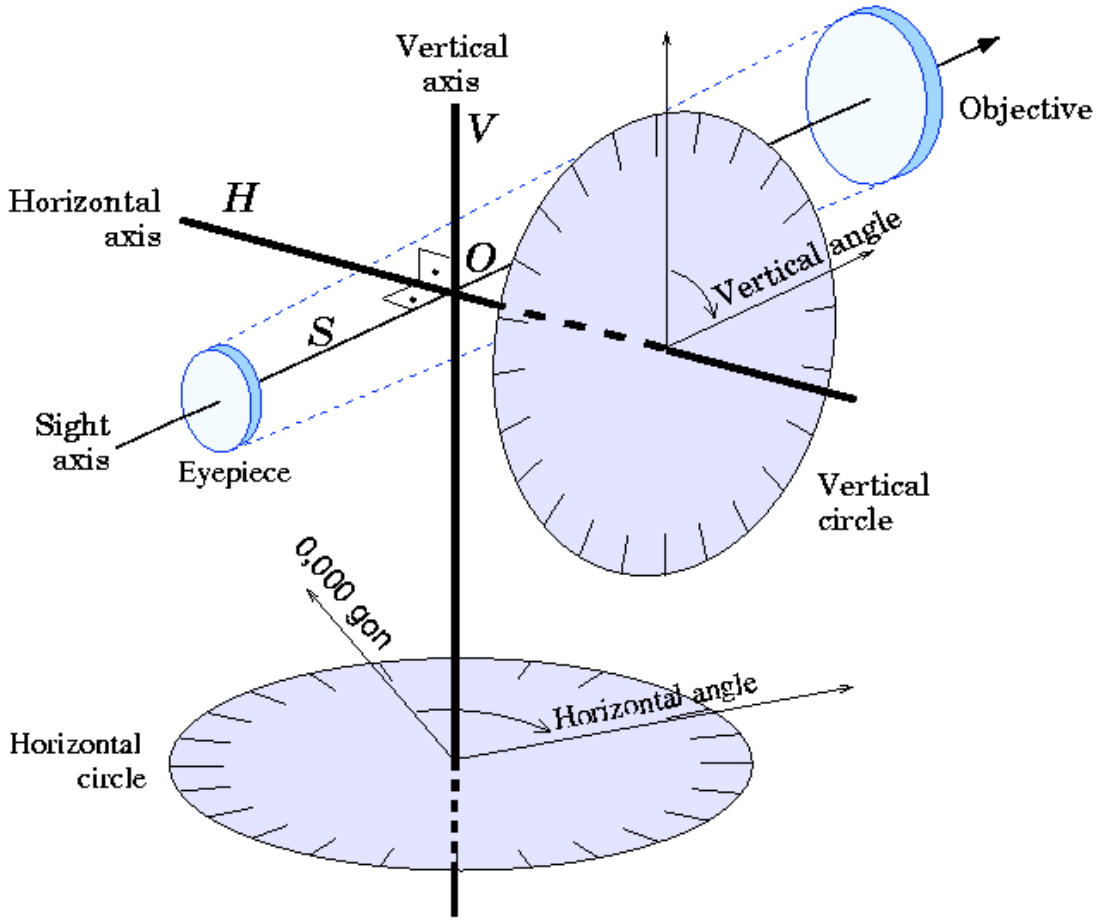
- Backward Difference

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

# Noise Reduction

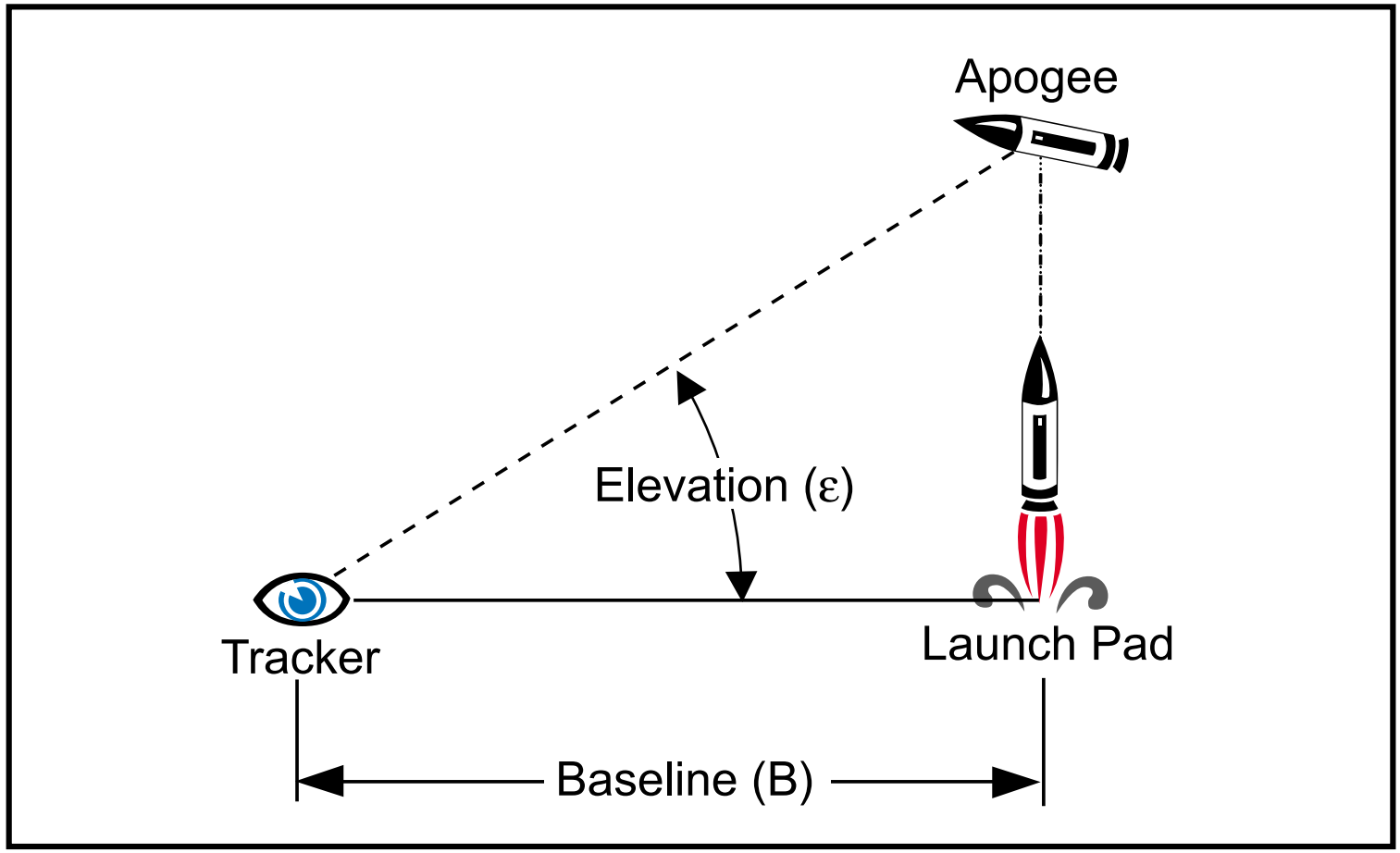
- Lowpass filter signal, derivative, or both
- Fit a smooth analytical function, e.g., cubic spline
  - Take analytical derivative

# Inclinometer or Theodolite



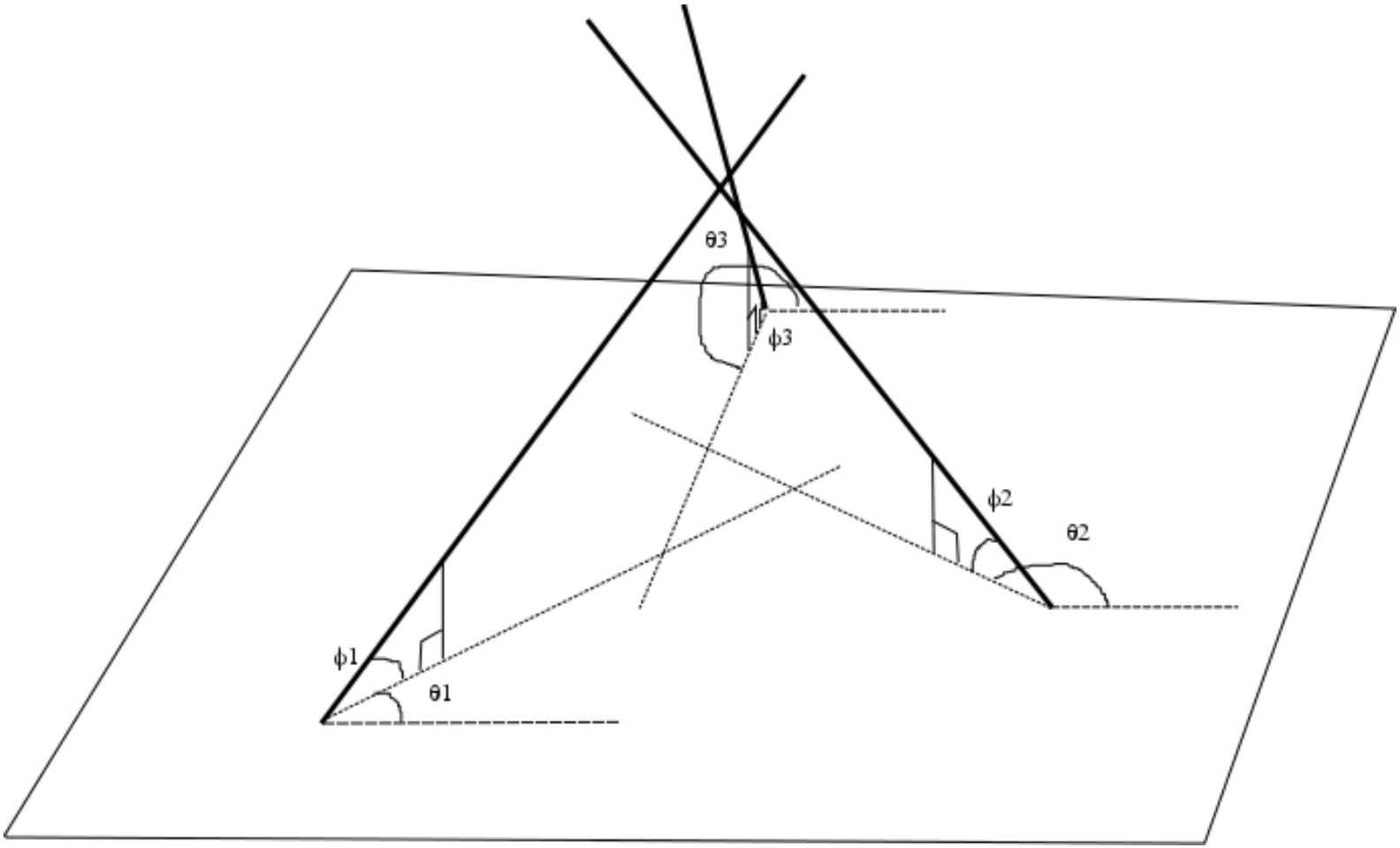

http://en.wikipedia.org/wiki/File:Theodolite_vermeer.png

# 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

# 13 APR 2013 ROC Launch

- 1 week before our first launch
- One team member can certify Level 1 .
  - 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
- Can test out rocket if desired.