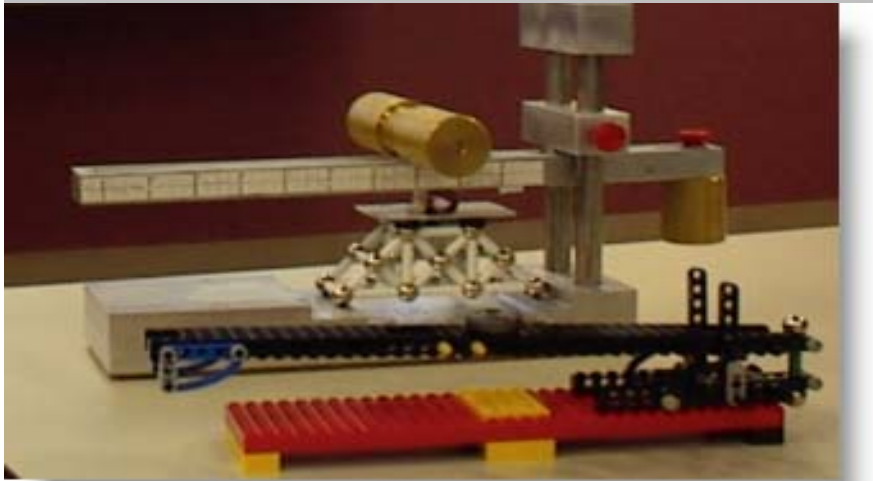


## Inquiry/Research Based ENGR 11X

“Tell me, I’ll forget. Show me, I’ll remember.  
Involve me, I’ll understand.”



**Donald A. Maxwell**

Professor, Civil Engineering  
Coordinator, ENGR 111/112

**Arun R. Srinivasa**

Assoc. Professor, Mechanical Engineering  
Director, NSF-STEPS Project

## ENGR 111-112 (11X): Basic Intent

- ENGR 11X is a project/design oriented introduction to the engineering analysis and decision making process. The aim of the course is to:
  1. Introduce students to the different engineering disciplines;
  2. Help them understand the process of design, analysis and problem solving by carrying out different engineering design tasks in an active, hands on learning environment, and
  3. Enable them to utilize mathematical and scientific knowledge to guide the decision making process.

# History

- We have been teaching an introductory course Freshman Engineers for at least 30 years.
- 1998 NSF FC Project
  - ENGR 111/112 formed from existing classes
  - Created the existing organizational\pedagogical framework
- 2003 Split **1,800** students into three tracks
  - A. Aero, Civil, Mechanical, etc.
  - B. Electrical, Computer Science, etc.
  - C. Chemical and Petroleum
- 2004 NSF STEPS Project (Mainly Track A)
  - Kept the best Framework features
  - Created new project oriented content

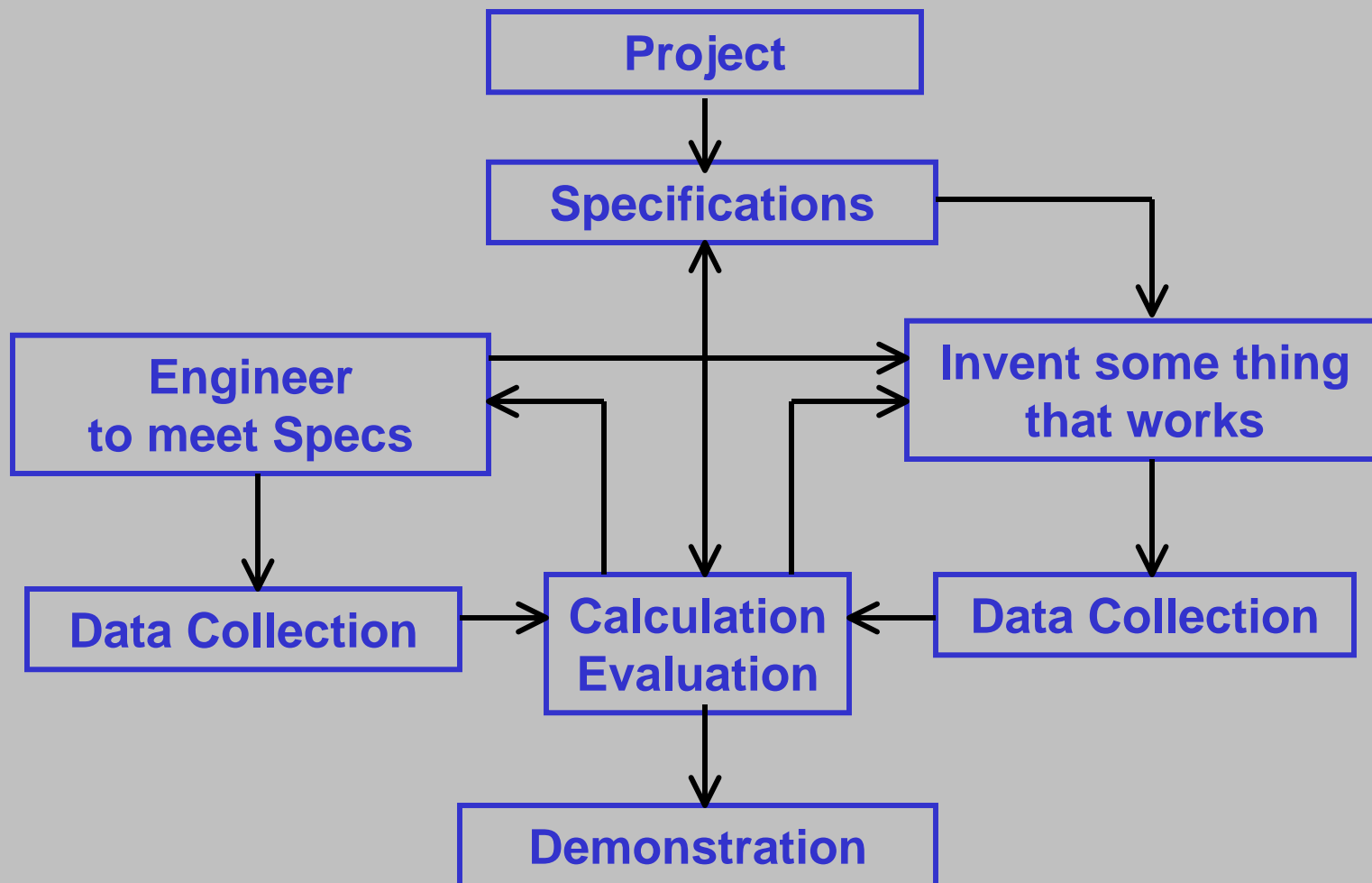
## Framework

- ENGR 11X is a 1-year, two 2-hour course sequence involving some 1,800 students:
  - Each course meets twice a week for two hours per class session
  - Each week has 1-hour of lecture and 3-hours of hands on work or tutorial
  - Each class is organized into teams of 3 or 4 students with class sizes from 16 to 96
  - Each class session is taught by an instructor with a Teaching Assistant and a Peer Teacher
  - Some sections are clustered with Math and Physics

# Typical Class



# The Project Inquiry/Design Process



# Project Guidelines

## Selection Issues (partial list):

1. Relevant to major and to some societal issue
2. Use the engineering design process to develop the final product
3. Must contain a significant programming component

## Implementation Issues

1. Success NOT dependent on student fabrication skills
2. May require some Instructor and TA training in administrating a large class in an interactive environment.
3. Projects should run 5-7 weeks with proper split with the graphics and writing component.

## Partial Project List (5 of 14)

Design, build and test a **truss-bridge** to span a 4.25" gap and carry a 2-pound load.

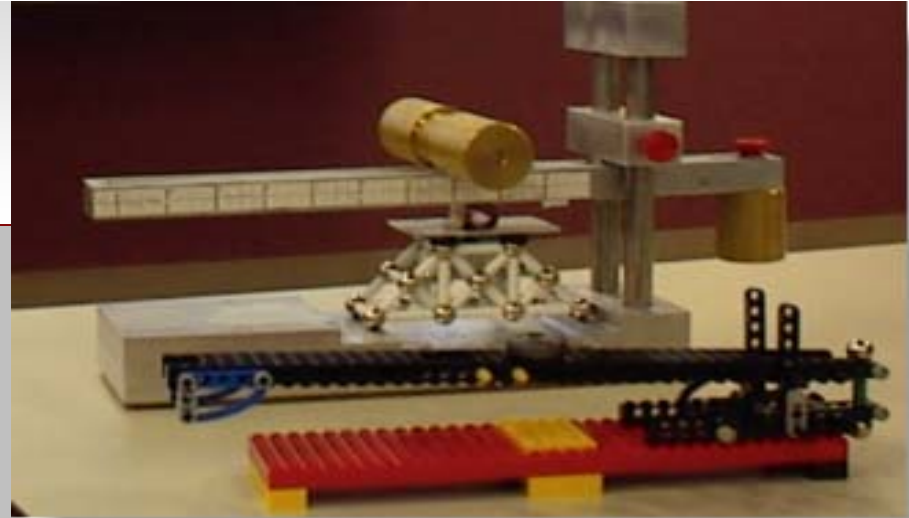
Design, build (to specifications) and test a prototype mechanism to mimic a **wheelchair lift**

Design, build, program and demonstrate an **autonomous vehicle** that will follow a curved black (2" wide) line up over a sloping and bumpy course carrying an upright and full 12-oz soda can.

Design, build, and test a **spring-mass simulation** of a building undergoing seismic vibration.

Determine the desired functions (room and board, etc.), the required size (sq-ft), configuration, cost and necessary student fees for an 600 bed engineering, living-learning community **dormitory**.

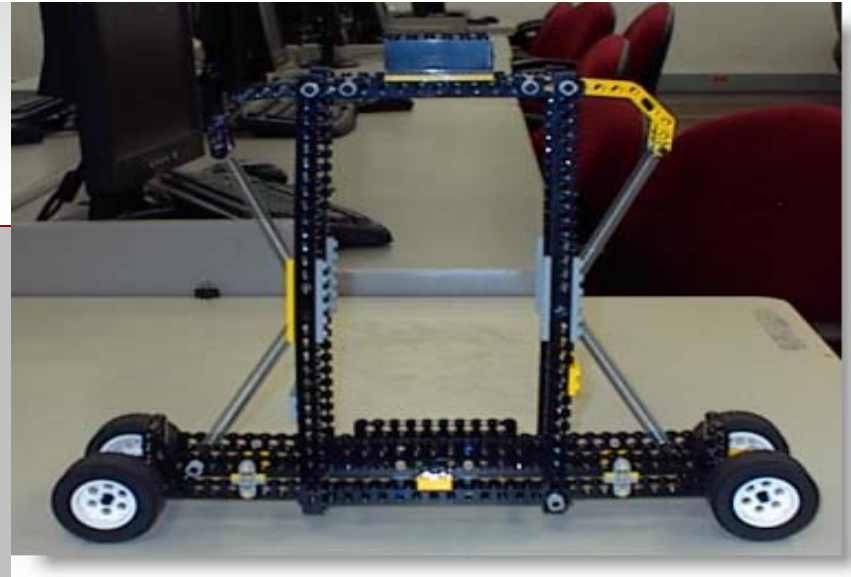
# Project #1



- Downstream impact: Sophomore Statics
- Clustered with: Math 151 and Physics 218
- Illustrates: Importance of Trig, Algebra, and Physics to engineering problem solving.
- Project activities: Design bridge, develop math model, predict failure load, fabricate, and test a simple determinate structure.
- We don't impose a specific truss design but you have to be able to compute the failure load and test it.

## Project #4

- Downstream impact: Sophomore Dynamics
- Clustered with: Math 152 and Physics 218
- Illustrates: Importance of Calculus and Physics to engineering problem solving
- Project activities: Design the model and shaker table, fabricate, predict the natural frequency, and design and test a simple retro-fit technique.



## Spring 2007 Survey of 247 Students in ENGR 111

### Broad Objectives

80% thought the class helped them figure out what engineers do.

70% said that the class helped them decide to continue in engineering.

90% said that the class helped them understand the role of physics and math in the engineering design process.

65% thought that the material was relevant to future classes.

# Spring 2007 Survey of 247 Students in ENGR 111

1=No help, 2=little, 3=some, 4=much, 5=very much help

Did the class help you acquire these skills:

3.00 Problem formulation

3.25 Problem solving

3.25 Technical Writing

3.25 Engineering design tasks

3.00 Time management

3.60 Working as a team

# Spring 2007 Survey of 247 Students in ENGR 111

1=No help, 2=little, 3=some, 4=much, 5=very much help

## Understanding Fundamental Concepts

3.8 Free Body Diagrams

3.6 Moments of Forces

3.5 Using Equations of Equilibrium

3.3 Engineering Design Process

3.0 Tangential and Normal Accelerations

2.8 Forces in Rotating Systems

3.5 Vectors and Trigonometry

2.5 Creating Flow Charts

# Spring 2007 Survey of 247 Students in ENGR 111

1=No help, 2=little, 3=some, 4=much, 5=very much help

Did the class activities help your learning?

3.0 Class Presentations including Lecture

3.0 Class Discussions

3.4 In Class Group Work

3.5 Hands-on Class Activities

2.6 Streaming Videos

3.4 Projects

3.4 Teamwork in Lab

2.6 Project Assignment Memo

# Spring 2007 Survey of 247 Students in ENGR 111

1=No help, 2=little, 3=some, 4=much, 5=very much help

## How well did the following support you as a learner?

3.0 Contact with the Instructor

2.7 Office Hours with the Instructor

2.5 Contact with the TA

2.2 Office Hours with the TA

3.5 Working with Peers Outside of class

3.5 Working with Team During class

3.0 Overall conduct of class

## Findings & Conclusions

1. Projects give students a context in which to learn and apply math and physics skills.
2. Today's entering freshman have astounding computer skills – We try to take advantage of this fact.
3. Conversely, freshman are weak in organizing problem solutions. An increased emphasis upon a formalized inquiry/design process is a possible counter measure that we would like to test.

“What you see on the computer screen has already been done by someone; you have to get outside of that to find the really new and important ideas.”