

# An ecoSystem for Every Student

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# The Need for Theory is Indisputable ... but Theory can be Detached

P Wave

$$v_p = \sqrt{M/\rho}.$$

$$P = I^2 R = \frac{V^2}{R},$$

Power Output

S Wave

$$\beta^2 = \frac{\mu}{\rho}.$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

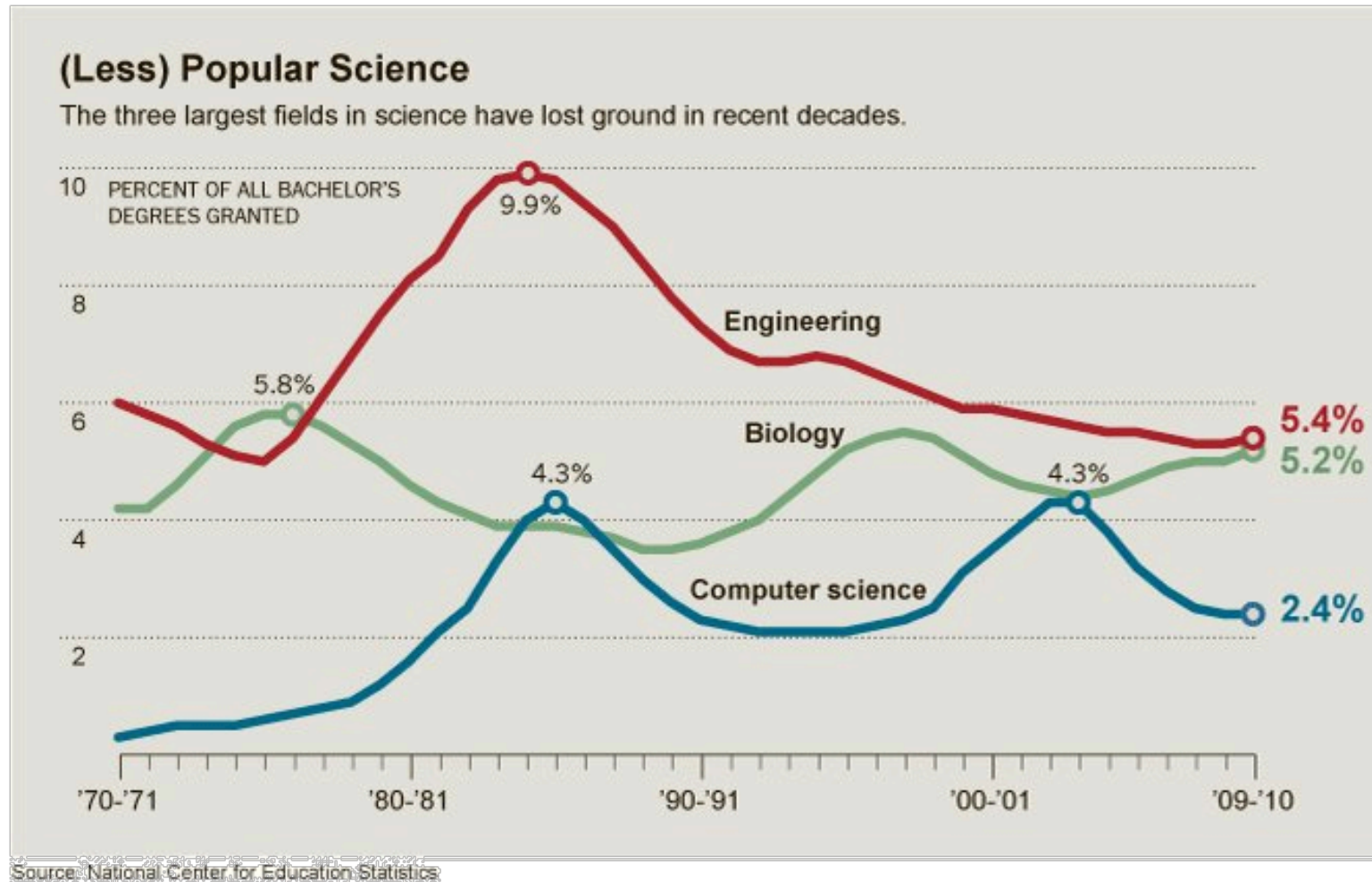
Transformer

$$C(s) = (K_P + K_I \frac{1}{s} + K_D s).$$

PID

# The Consequences of Detachment

The New York Times



# Constraints on Bridging the Detachment



Cost



Time



Space

*"A problem well-defined is a problem half-solved."  
—John Dewey*



“Any **sufficiently advanced** technology  
is *indistinguishable from magic*.”

—Arthur C. Clarke

# The Answers are in a Rich Profession



# How Do I Make a Difference?





# Clues from *FIRST*

*For Inspiration and Recognition of Science and Technology*



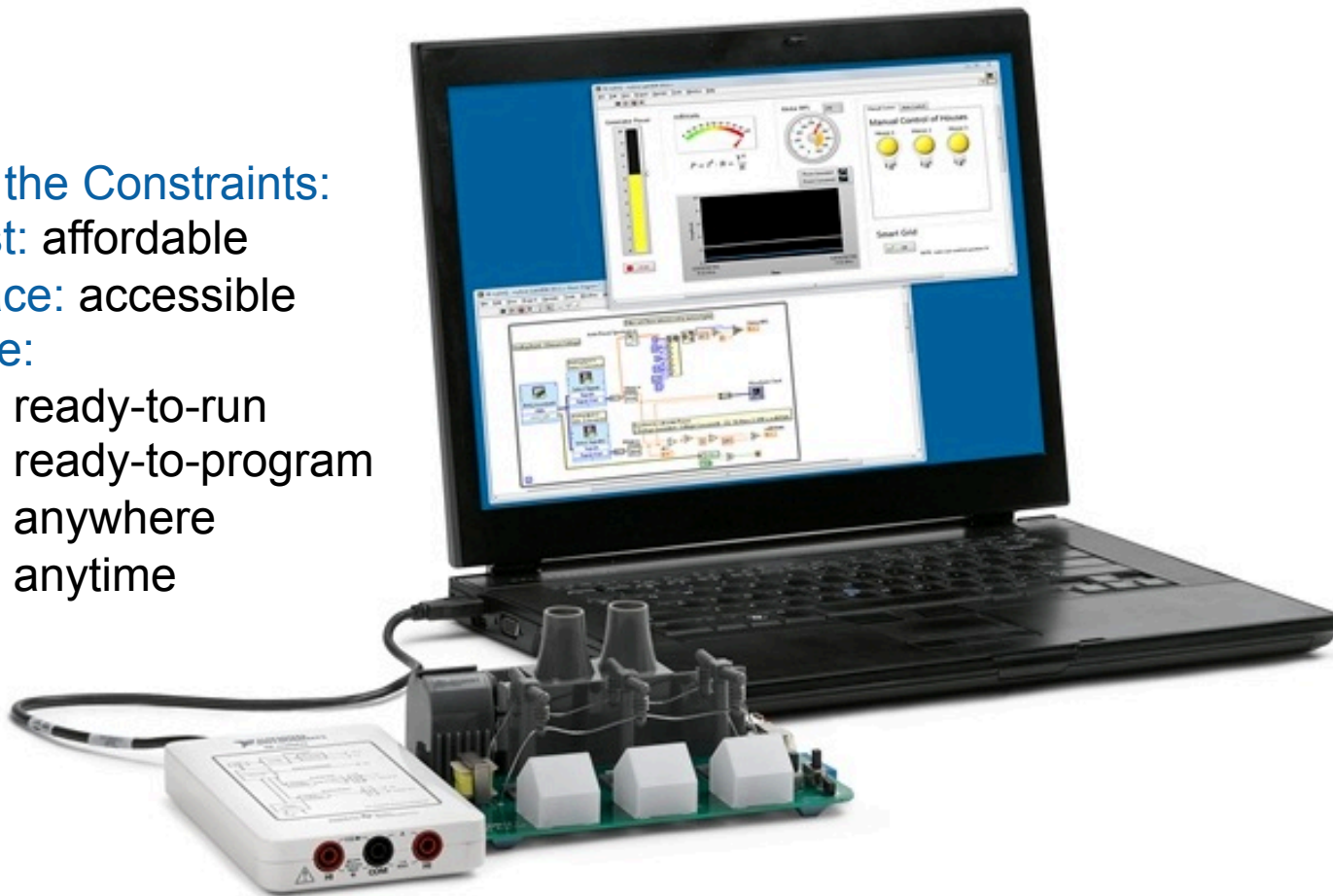
the key  
to solutions  
is in **instant  
relevance**



# Introducing: NI miniSystems

## Within the Constraints:

- **Cost:** affordable
- **Space:** accessible
- **Time:**
  - ready-to-run
  - ready-to-program
  - anywhere
  - anytime



***Instant relevance in science and engineering education***

# The Anatomy of an NI miniSystem

Hardware:

Measurements & I/O

Analog Input

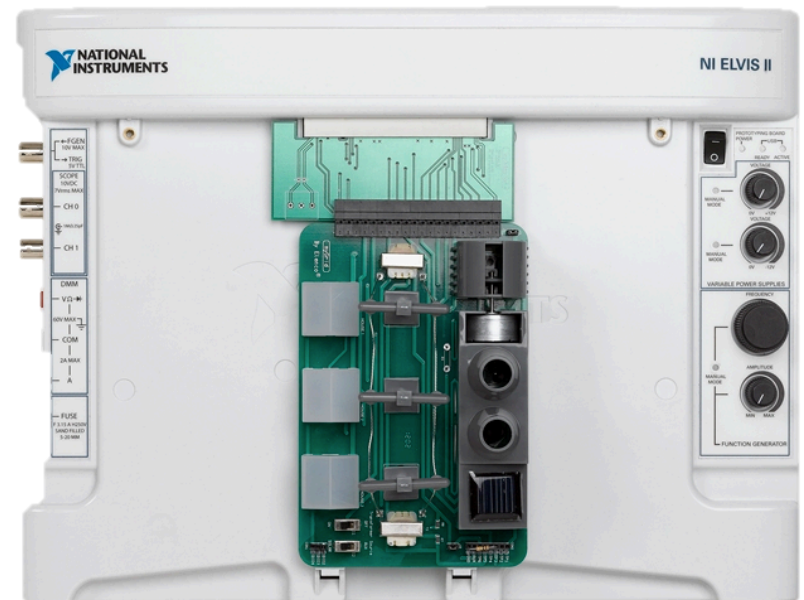
Analog Output

Digital I/O

Counters

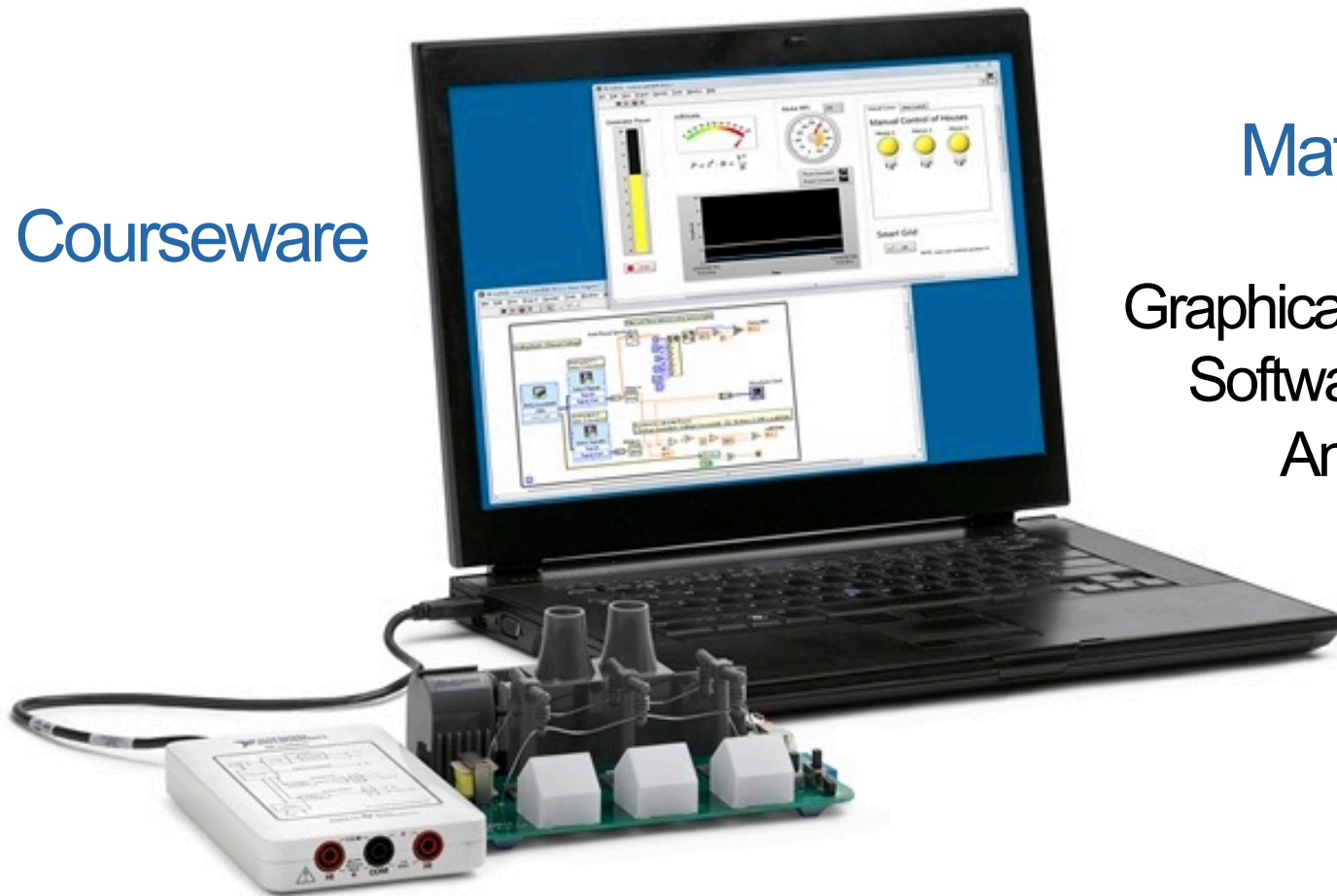
DMM

Student-Proof



# The Anatomy of an NI miniSystem

Courseware

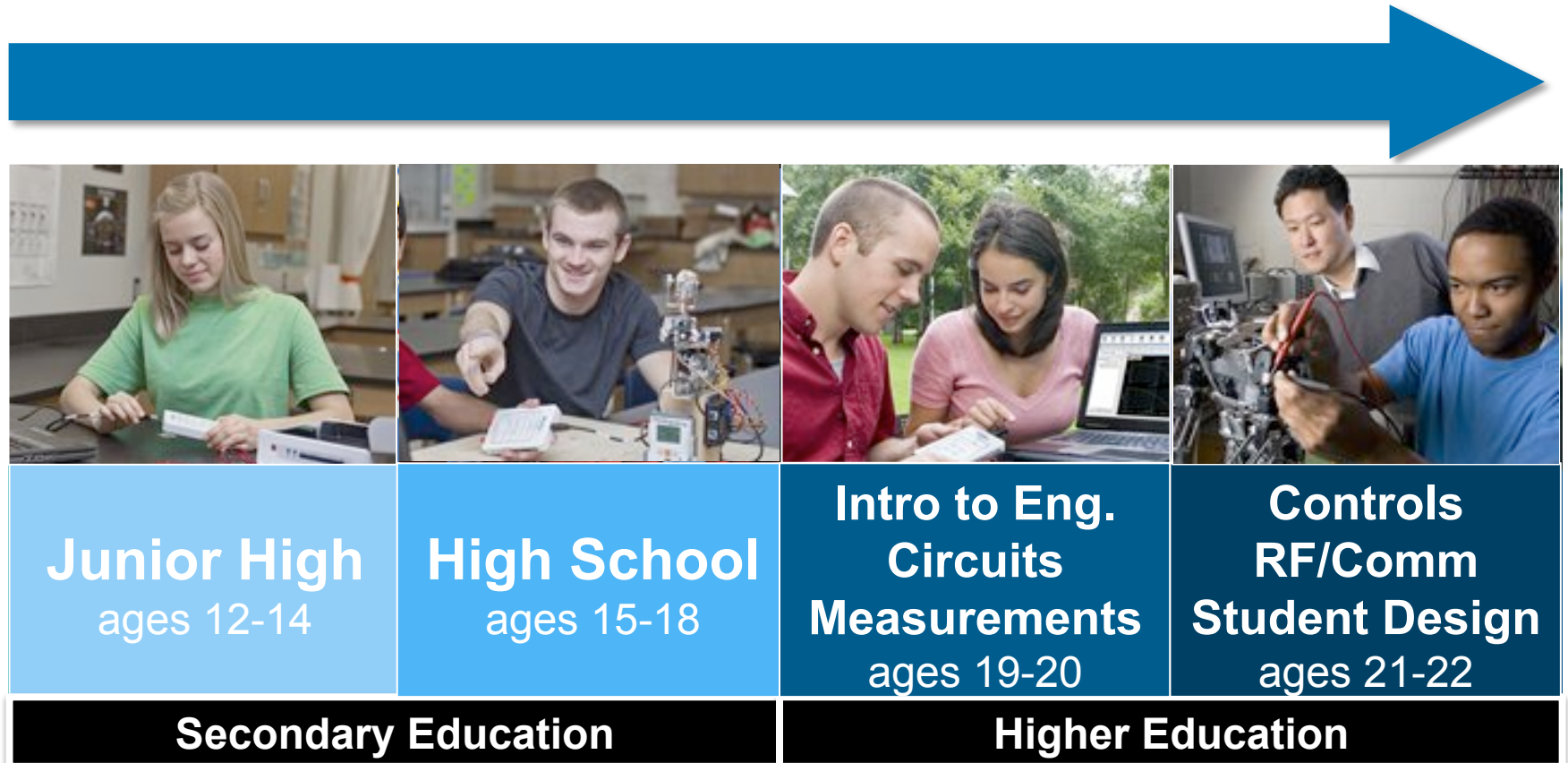


Software:  
Math & Analysis

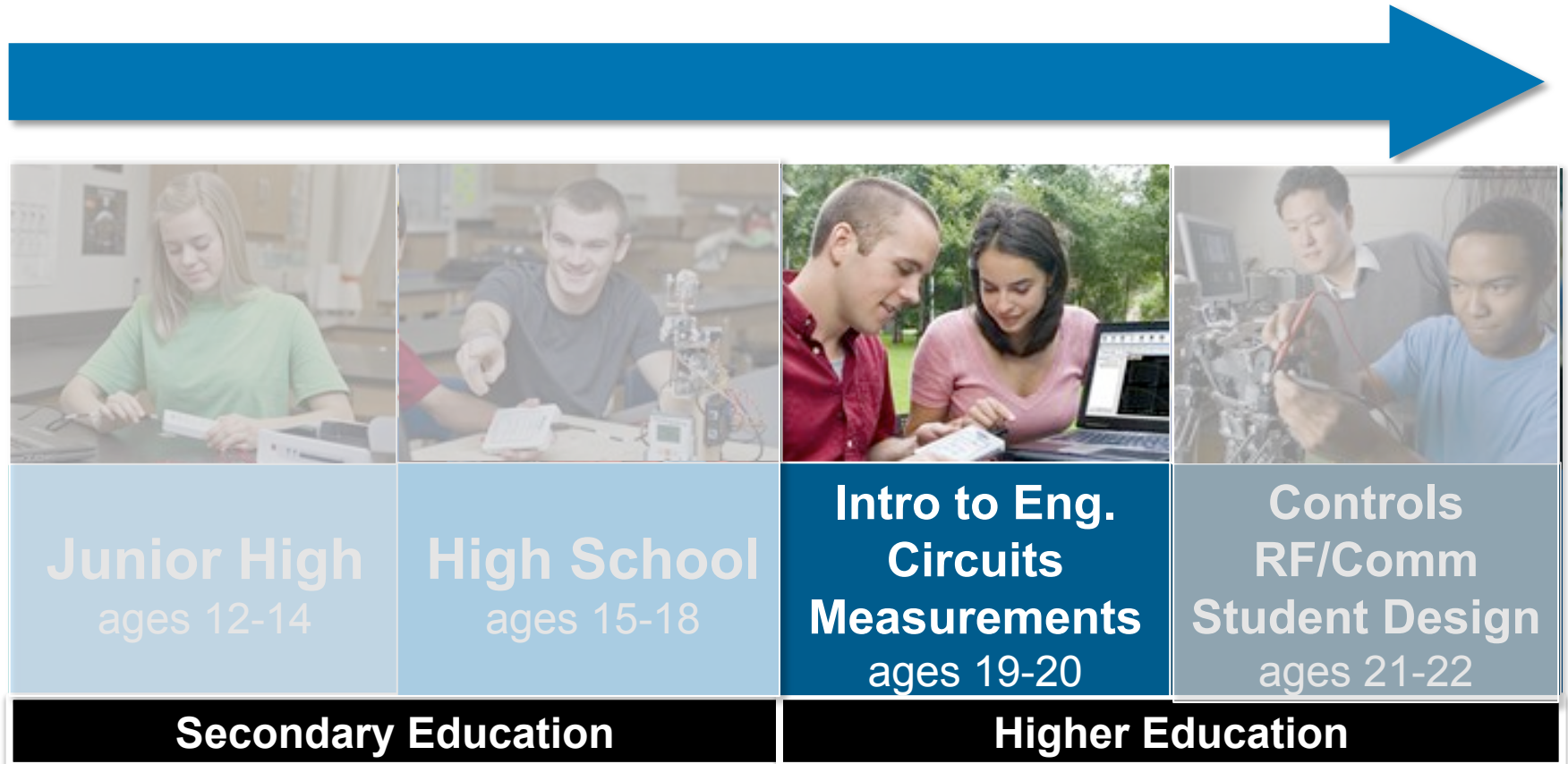
Activity Guides  
Graphical Programming  
Software Instruments  
Analysis Libraries  
Circuit Design

Application

# The NI Education Pipeline: Industry-Ready Students



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# What Makes a Building Strong?

*Learning through an earthquake-on-demand*



# What Makes a Building Strong?

*Learning through an earthquake-on-demand*

## Concepts We Just Covered:

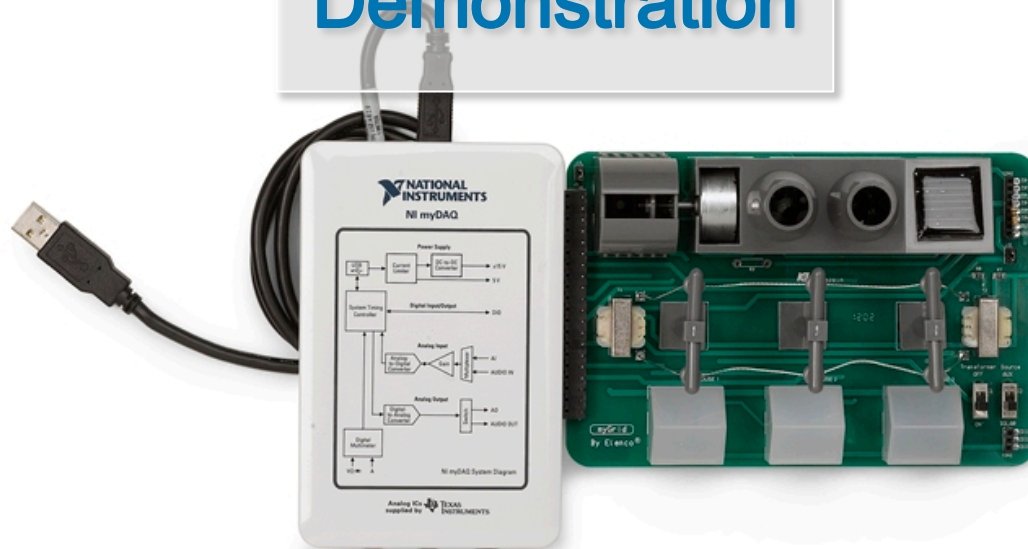
- Sine wave effect
- Sine wave sweep effect
- Effect of different materials on a building's earthquake resistance
- What type of bridge supports more weight during an earthquake?
- Is the pyramid the strongest 3D geometric structure?
- Effect of height on stability of building
- Damping ability of different dampers, effect on stability

# How Much Power Runs a City Block?

## *Learning through the smart grid*



## Demonstration



# How Much Power Runs a City Block?

*Learning through the smart grid*

## Concepts We Just Covered:

- Fossil fuel voltage and frequency
- Solar cell characterization
- Maximum power point tracking
- Effect of light frequency on power
- Transmission losses
- Step-up and step-down transformers
- Power consumption as a function of load
- Total power consumed, reducing power usage
- Power profile emulation (early morning, mid-day, evening, night)

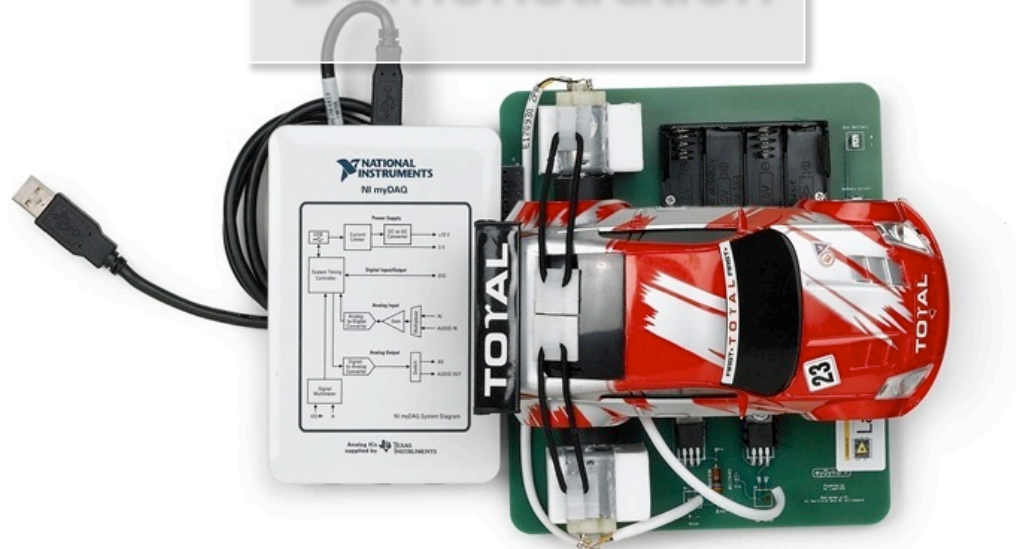


# What Makes a Vehicle Efficient?

*Learning through power on a dynamometer*



## Demonstration





# What Makes a Vehicle Efficient?

*Learning through power on a dynamometer*

## Concepts We Just Covered:

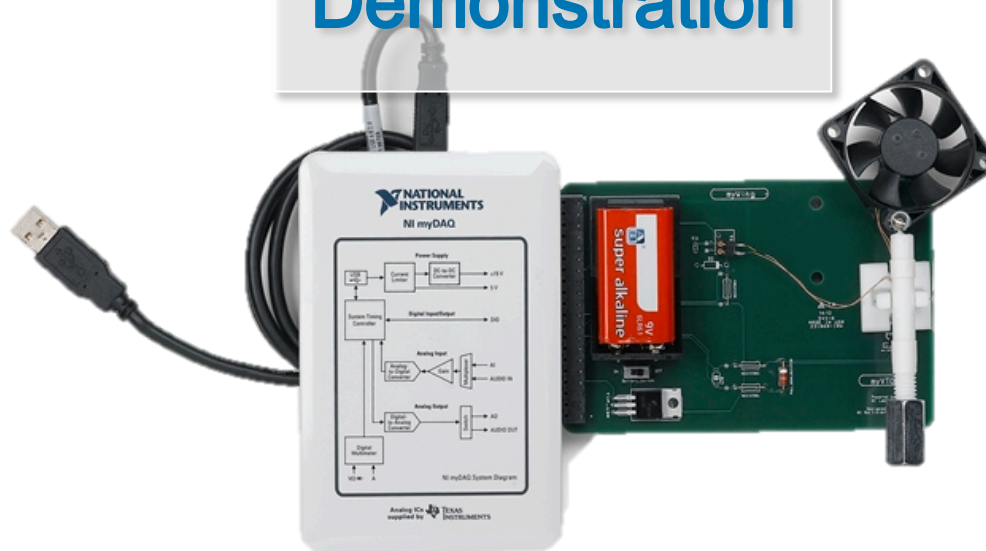
- PID control
  - Differences between P, PI, PID, PD controllers
  - State space models
- Power dissipation
  - One type of battery at different power levels
  - Different types of batteries at one power level
- Power vs. torque
- Loading effects (uphill/downhill)
- Load profiles of popular roads

# What Makes an Aircraft Stable?

*Learning through vertical take-off and landing (VTOL)*



Demonstration



# What Makes an Aircraft Stable?

*Learning through vertical take-off and landing (VTOL)*

## Concepts We Just Covered:

- Motion control
- Flight dynamics
- Model validation
- PID control
- Kinematics
- Dealing with actuator dynamics
- Identifying parameters experimentally
- Cascade control

# Instant Relevance Creates Instant Results





# The NI myDAQ Ecosystem

## *Intro-to-Engineering in a Box*

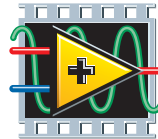


mySolarTracker  
Solar Tracker

myGrid  
Smart Grid



myWing  
Wind Tunnel/Air Foil System



myFarm  
PV Drip Irrigation



myTurbine  
Wind Turbine



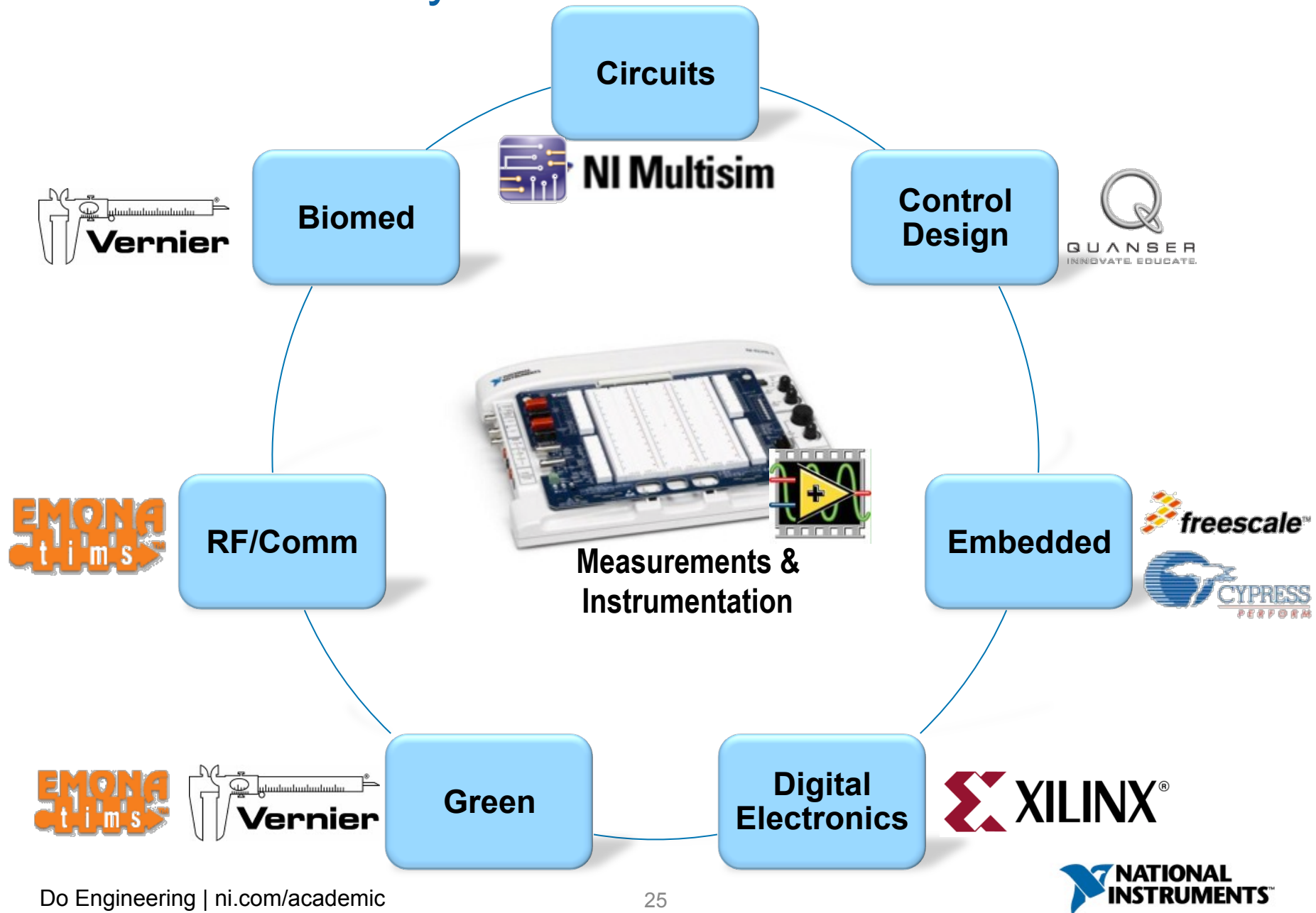
myDyno  
Dynamometer System



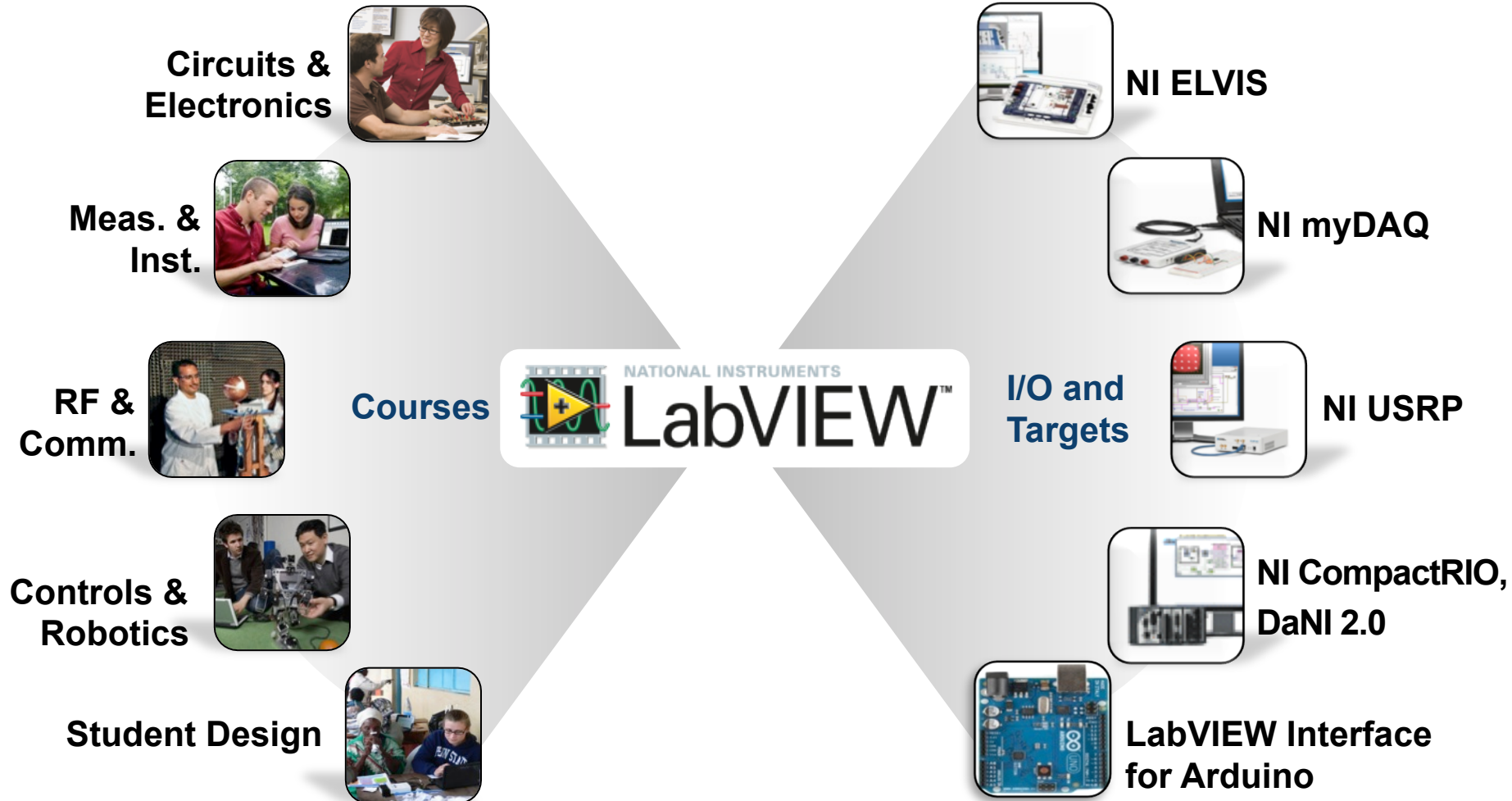
myHeli  
Vertical Take-off & Landing System



# The NI ELVIS Ecosystem



# The NI Education Platform



# The National Instruments Ecosystem

Test



Monitor



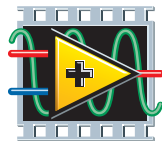
Embedded



Control



Cyber Physical



NATIONAL INSTRUMENTS  
**LabVIEW**<sup>™</sup>



Desktops and  
PC-Based DAQ



PXI and Modular  
Instruments



RIO and Custom  
Designs

**GPB**  
IEEE-488



Open Connectivity  
with 3<sup>rd</sup> Party I/O



# Do Engineering