



Research and Teaching platforms for embedded control and design

An Overview of the National Instruments Solution

Systems are Everywhere



Tesla Motors



Red Bull Stratos



Space X



Insulin Pump
ni.com/academic



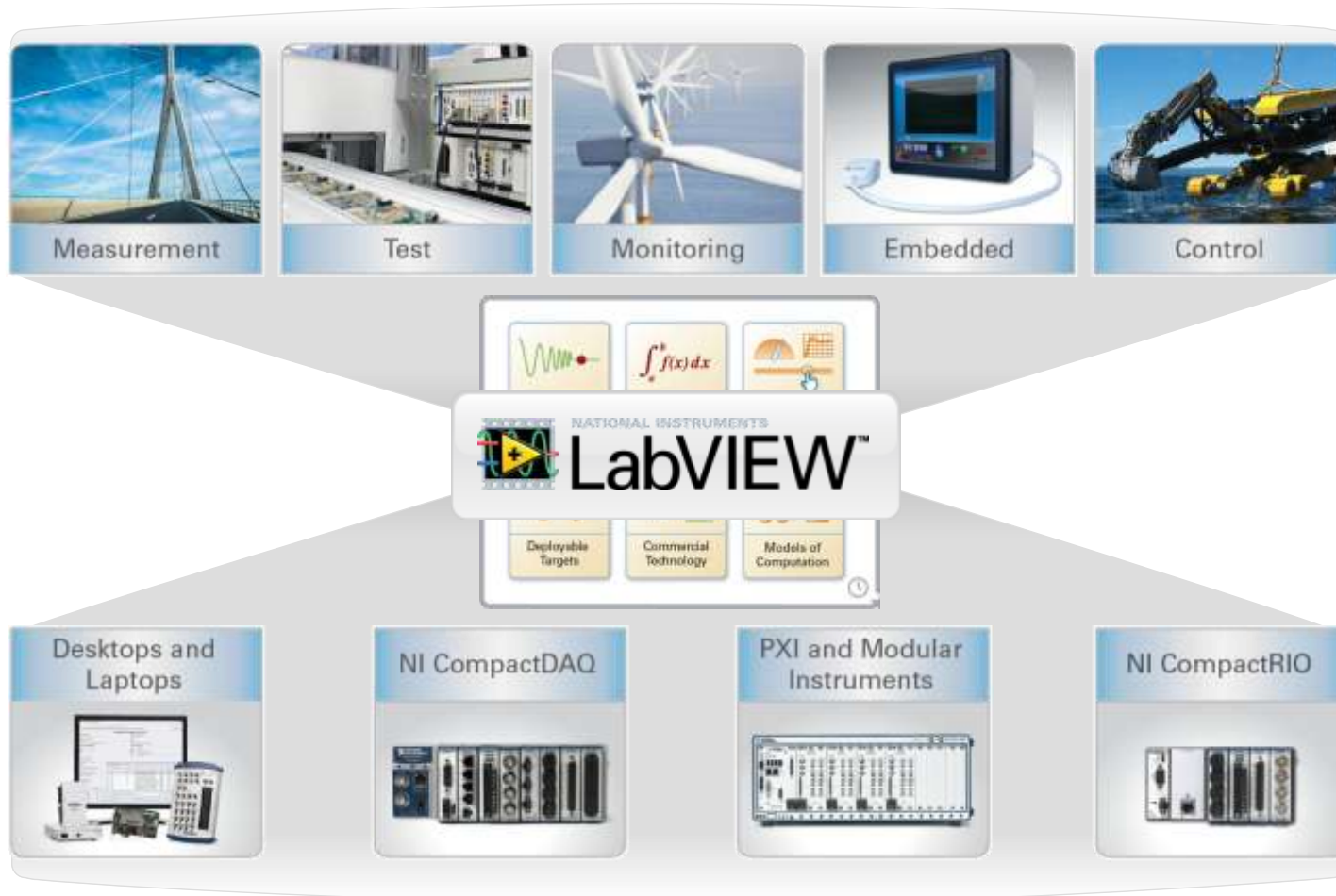
Elevators



Smartphone
**NATIONAL
INSTRUMENTS**

Graphical System Design

A platform-based approach for measurement and control




2012 Graphical System Design Achievement Awards Overall Winner

Andy Clegg & Petros Savidis

Industrial Systems & Control (ISC) Ltd.

Controlling a Motion Compensated Gangway to Access Offshore Turbines





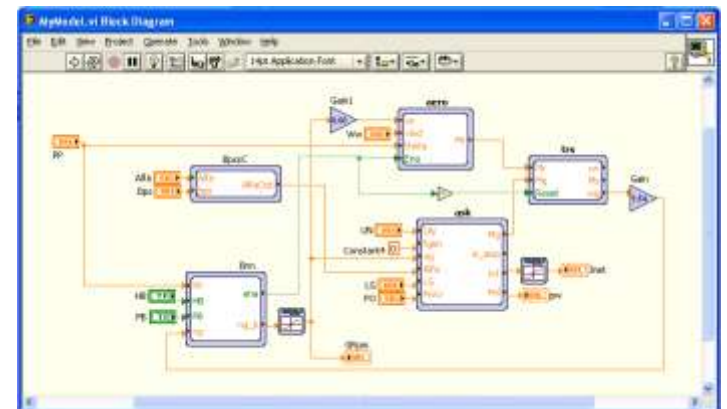
"The combination of NI LabVIEW and NI CompactRIO was ideal for this application, combining the computational power to handle the low level control and inverse kinematic calculations while running the operational logic and monitoring function at the same time. The small and low power nature of the cRIO and touch panel computers is perfectly suited to the marine environment."

Andrew Clegg,
Industrial Systems and Control Ltd

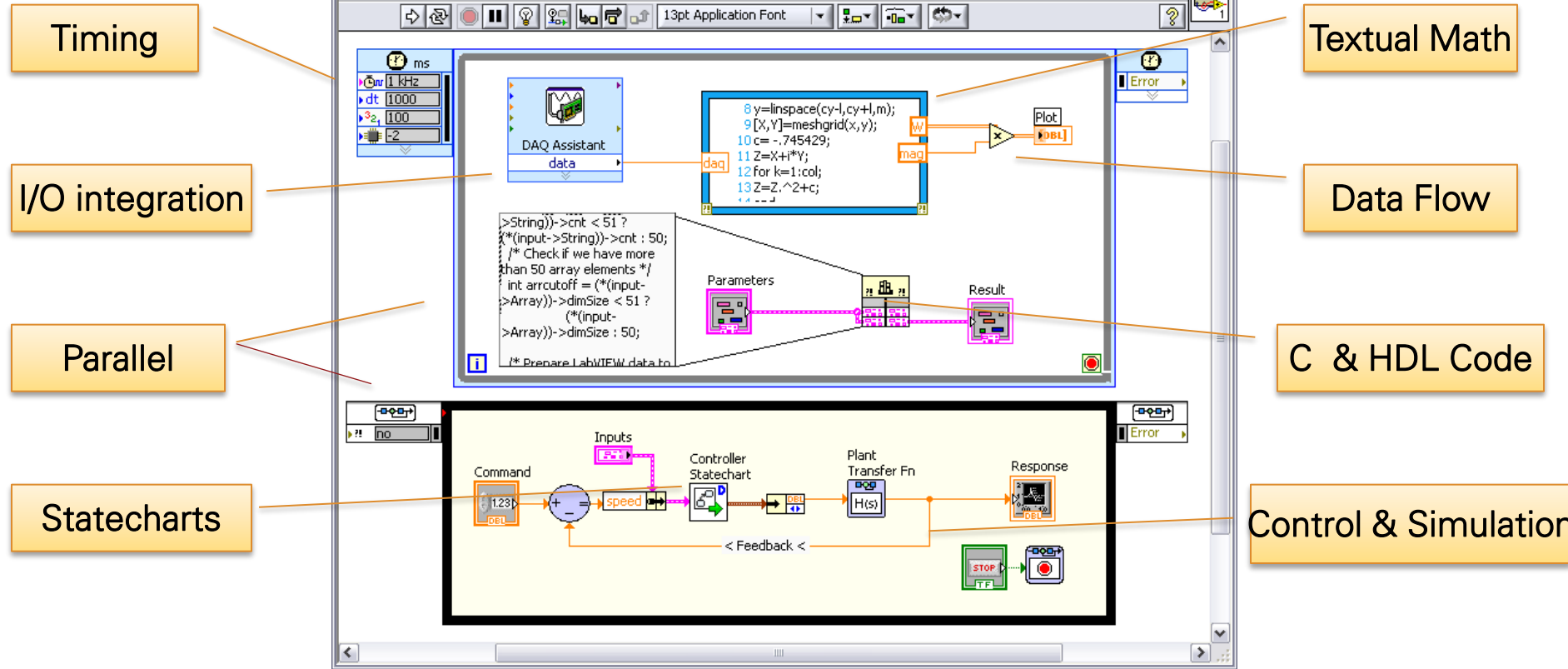
SIEMENS
Siemens Wind Power
Denmark

- **Control Design and Simulation**
- **Real Time**
- **FPGA**

- Real Time OS
- Multicore
- Analog I/O
- Serial



Graphical System Design



NI Platform for Control

LabVIEW Development Environment

Control Design & Simulation Module

System ID Toolkit

Statechart Module

DFD Toolkit

Simulation Interface Toolkit

NI Motion Control

LabVIEW Real-Time

LabVIEW FPGA

LabVIEW Microprocessor

Targets



PXI

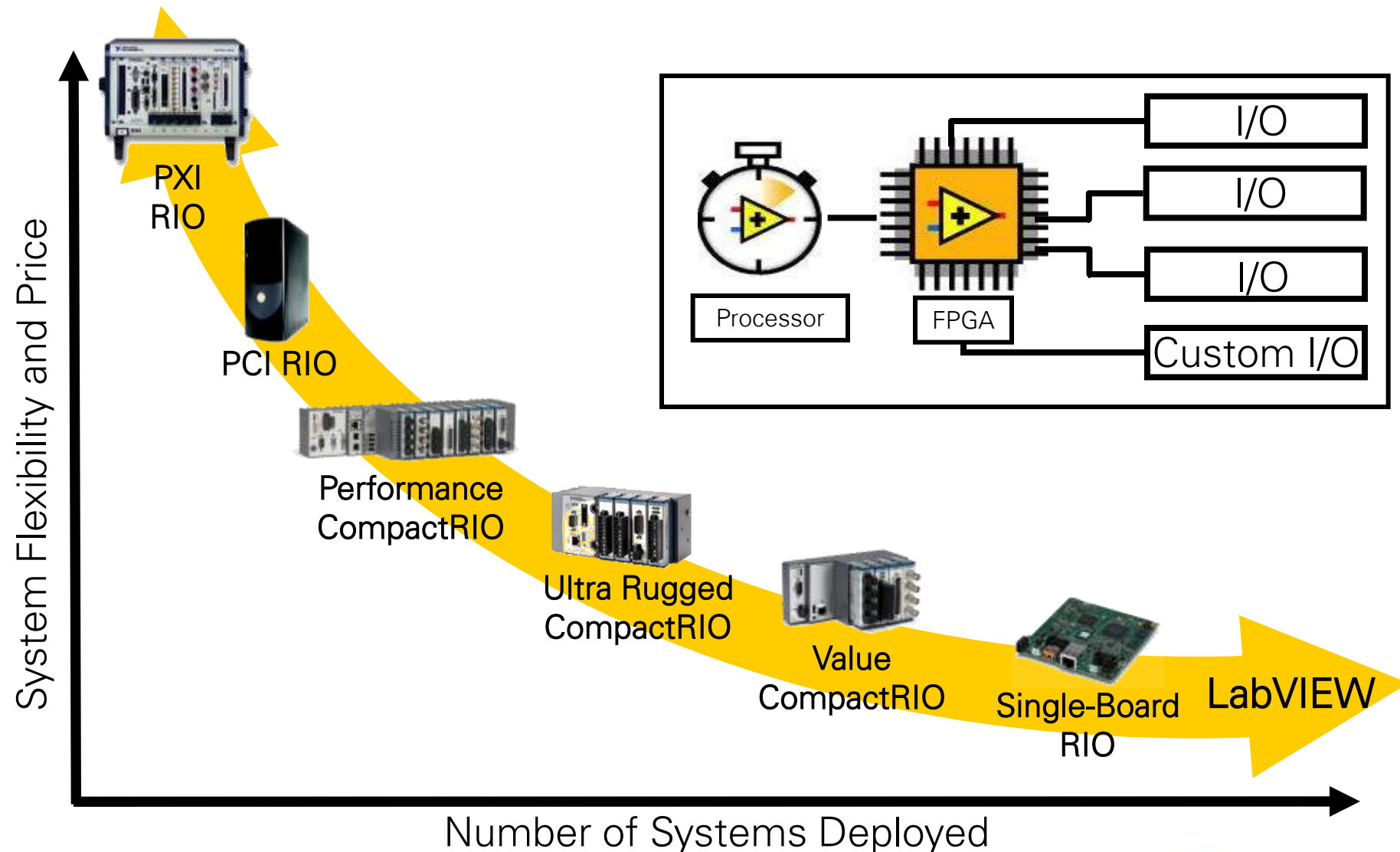


cRIO, sbRIO



Desktops & SBC's 32-bit μ p

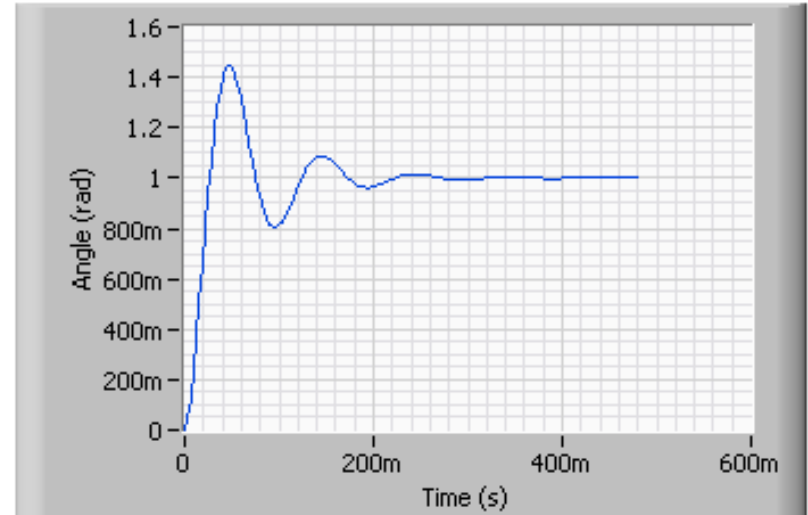
The NI RIO Deployment Curve



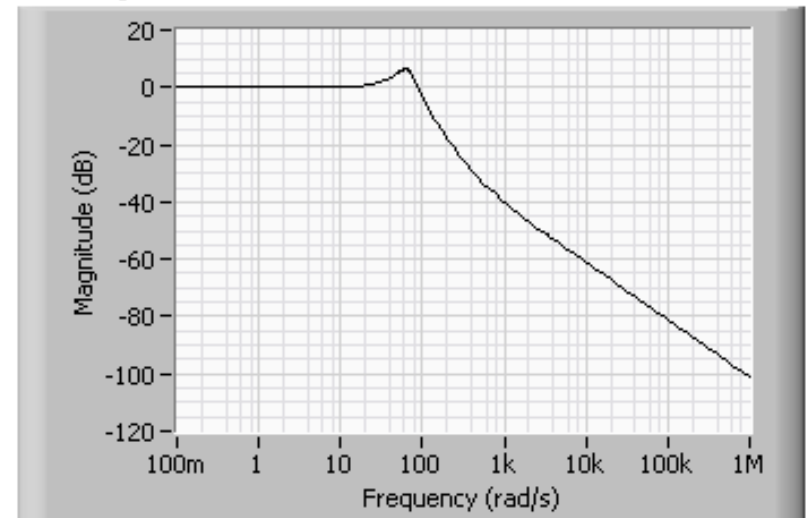
LabVIEW Control Design & Simulation

- Construct and analyze system models
- Design basic and advanced control algorithms
- Simulate response of controller designs
- Analyze control efficiency and stability interactively
- Implement systems with built-in real-time I/O

Step Response Graph

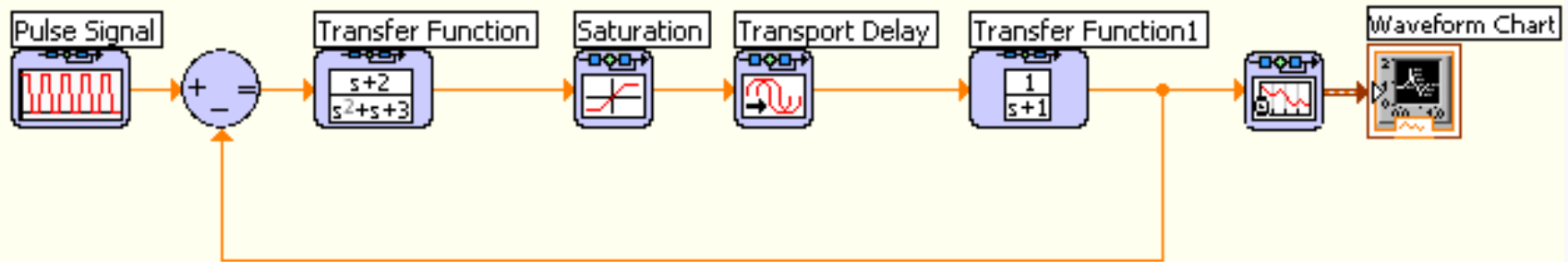


Bode Magnitude

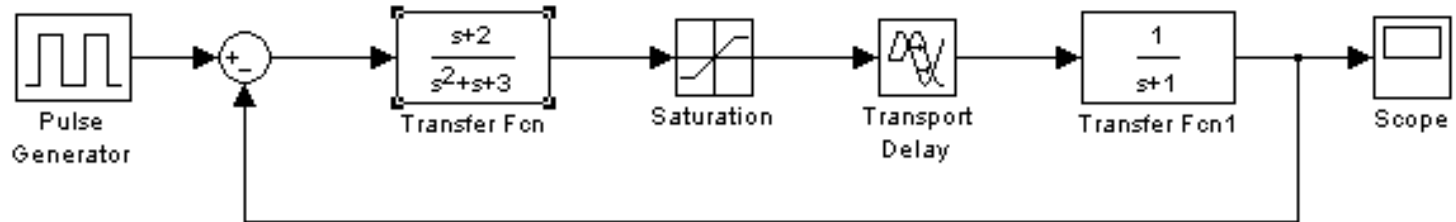


Standard Notation Reduces Learning Curve

LabVIEW Control Design & Simulation Module

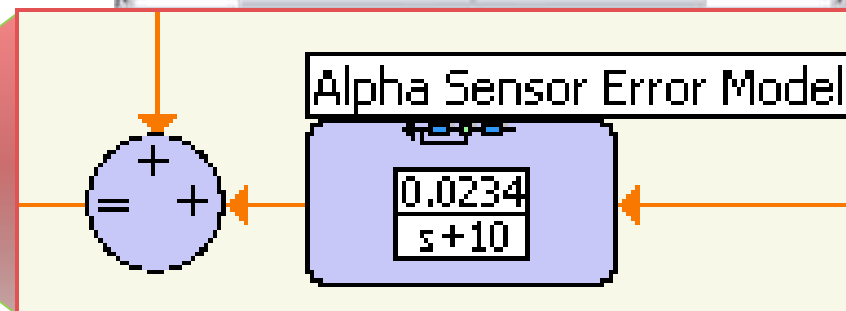
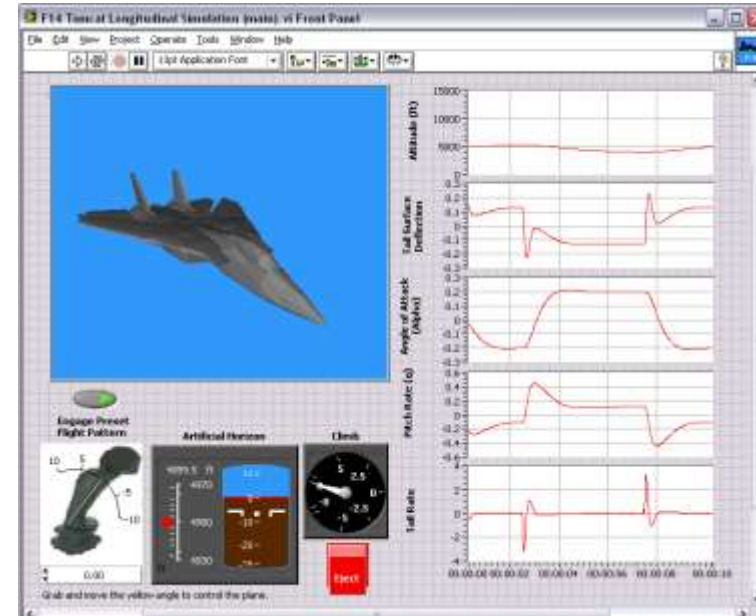
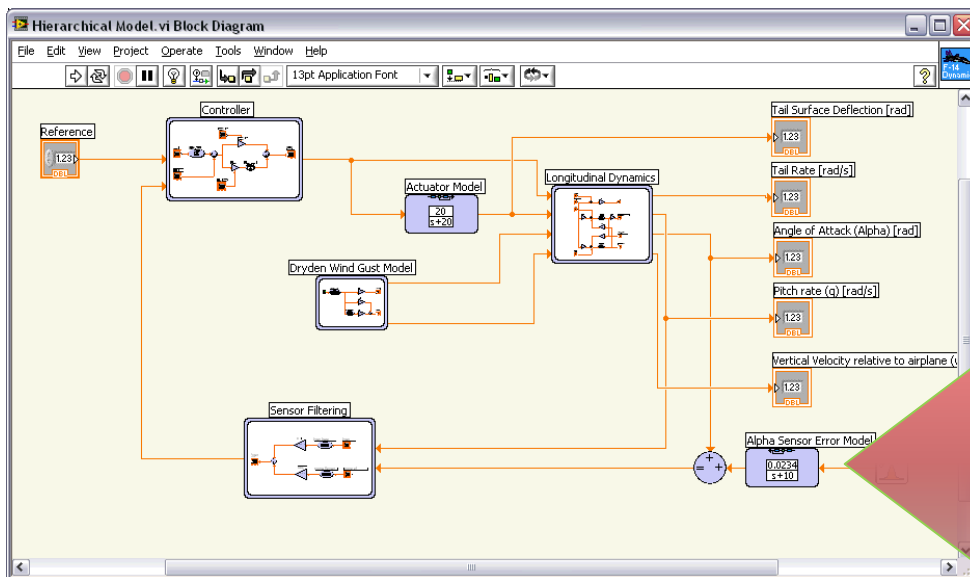


The Simulink® Software Environment



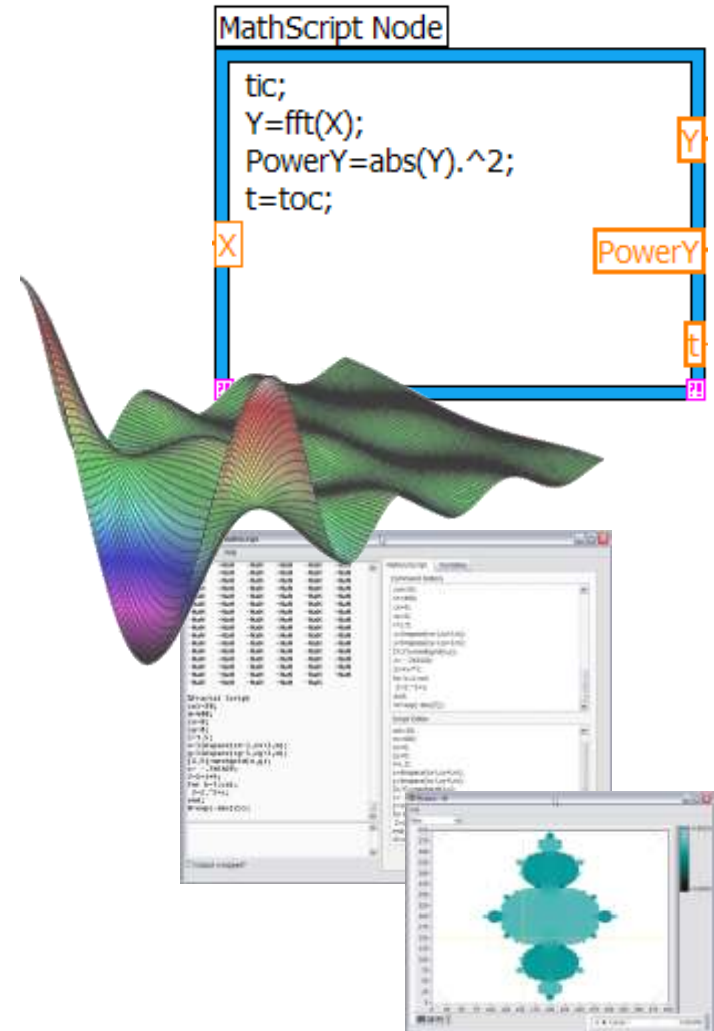
Dynamic System Simulation & Control

- Single environment for:
 - Simulation of dynamic systems
 - Real-time implementation for rapid control prototyping or hardware-in-the-loop simulation



LabVIEW MathScript RT

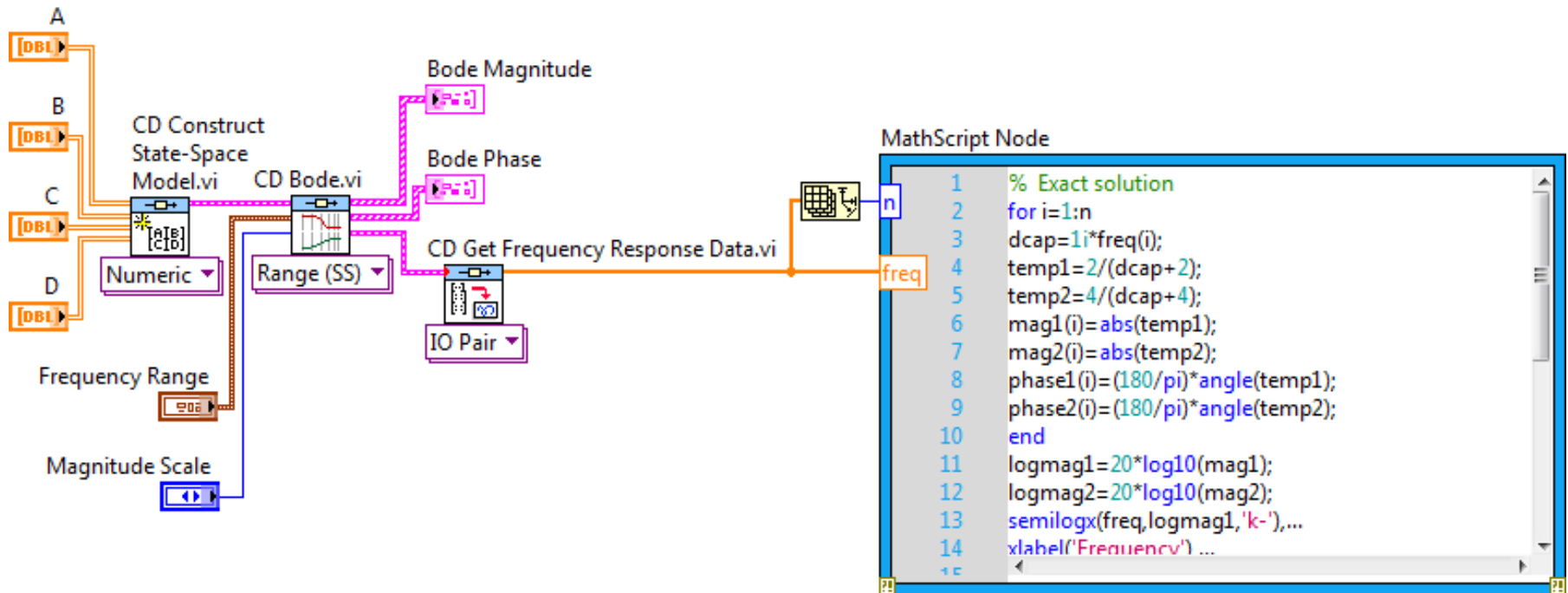
- **Powerful textual programming for Control Design, Signal Processing, and Math**
 - Hundreds of built-in functions
 - Reuse many of your m-file scripts created with The MathWorks, Inc.'s MATLAB® software and others
- **A native LabVIEW solution**
 - Interactive and programmatic interfaces
 - Does not require 3rd party software



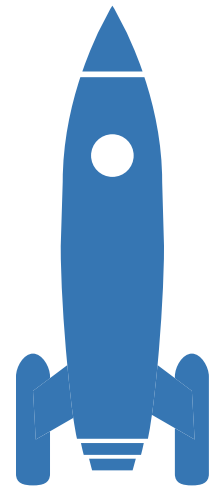
MATLAB® is a registered trademark of The MathWorks, Inc.

Combined Graphical /Textual Programming

A Hybrid Approach



How Does a Student Become a Controls Engineer?



A diagram of a circle with a vertical diameter. The diameter is represented by a line segment with arrows at both ends pointing to the circle's circumference. The label 'b' is placed in the middle of this line segment.

$$y = \ln x + 6$$

$$= \sqrt{a^2 + b^2}$$

$$d = 2a/x$$

für $b=16$:

360

$$= 2 \cdot 6.2 - 4.8$$

$$p = \sqrt{c^2 - a^2} (400y^2 + 5x)$$

$$\gamma = \frac{d}{Z}$$

$$b = \frac{u}{(z-a)}$$

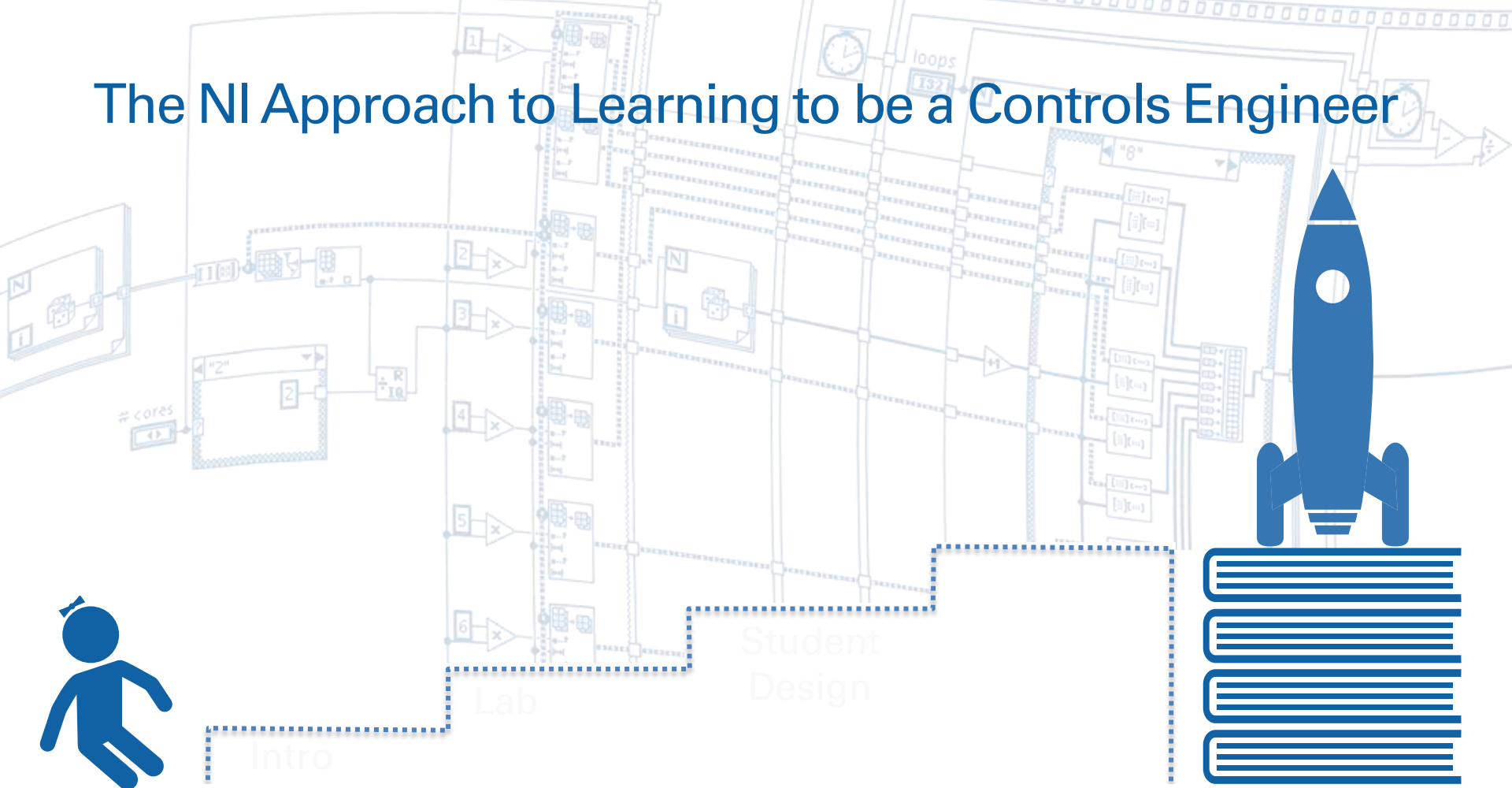
$$C = 100$$

$$(x6)$$

71
7.3
16.8
0.008

$$V =$$

The NI Approach to Learning to be a Controls Engineer



DO ENGINEERING – FROM K TO ROCKET SCIENCE

The NI Approach to Learning to be a Controls Engineer

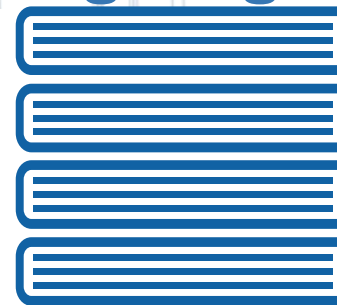
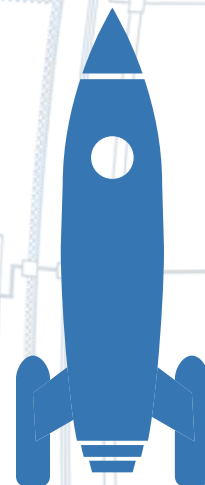


Intro

Lab



Student
Design



DO ENGINEERING – FROM K TO ROCKET SCIENCE

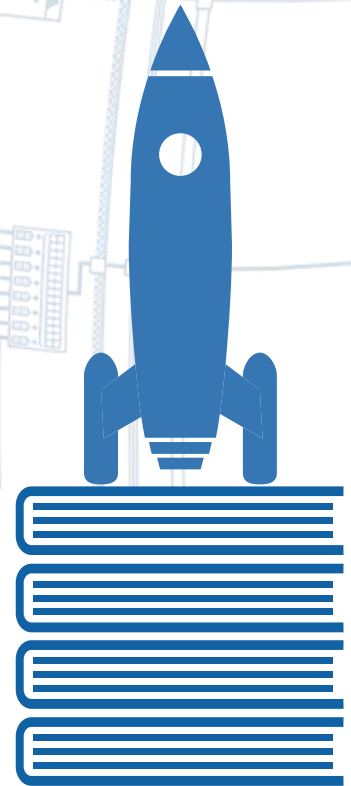
The NI Approach to Learning to be a Controls Engineer



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NI ELVIS – Multidisciplinary Platform

Platform for teaching different introductory classes across disciplines

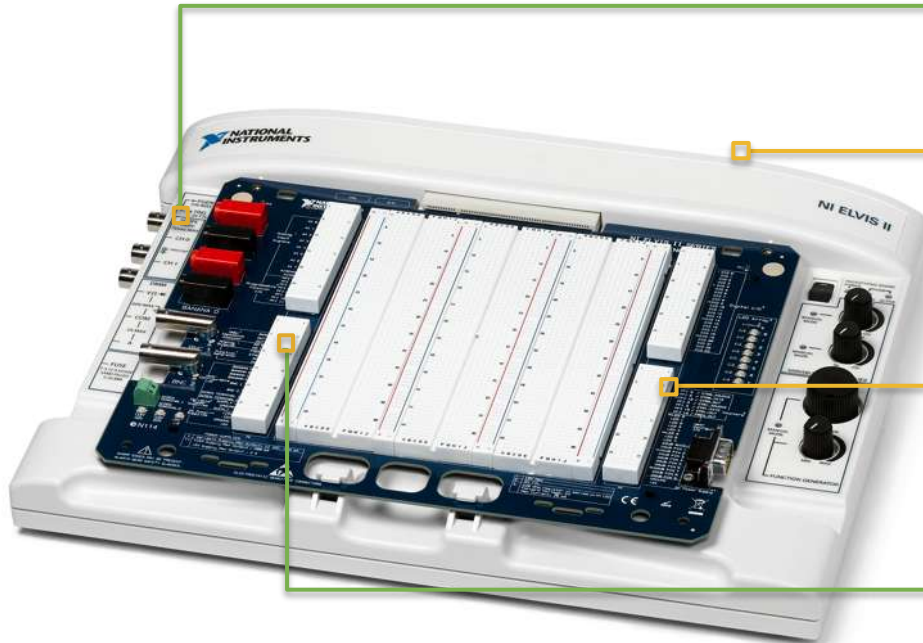
- Controls
- Circuits
- Telecommunications
- Measurements

2 Channel Scope, 100 MS/s
Function Generator, 5 MHz

USB connection
to Host PC

24 lines of Digital I/O

8 Analog Inputs
2 Analog Outputs



Quanser QNETs

HVAC



Rotary Inverted
Pendulum



VTOL



Mechatronics
Sensors



DC Motor

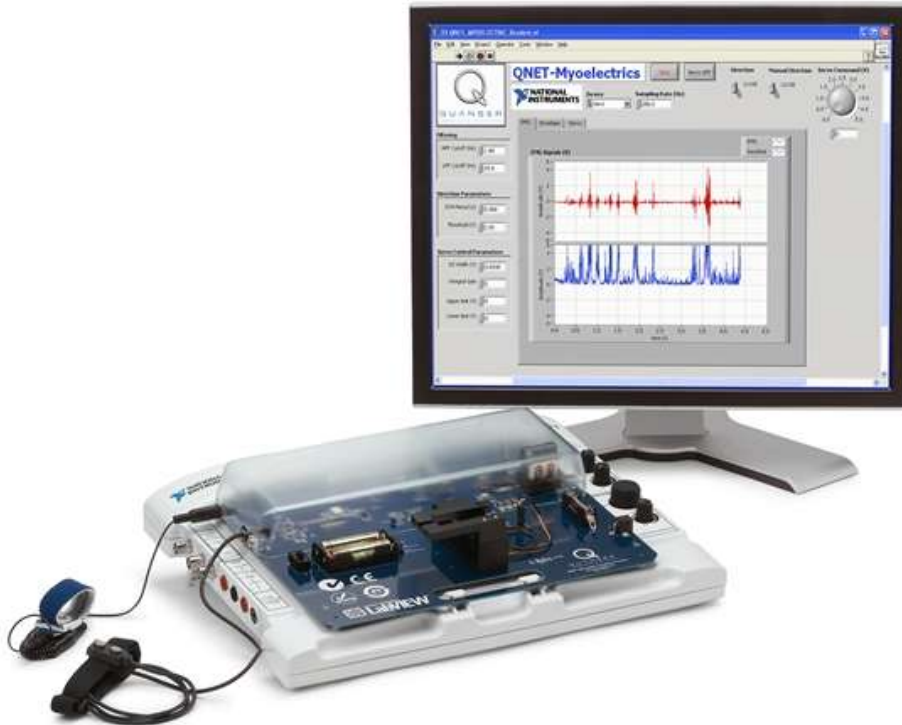


Myoelectric



NI ELVIS Controls Teaching Solution

- Courseware
- Ready to run VIs
- Setup Instructions
- Expandability of NI ELVIS to other courses

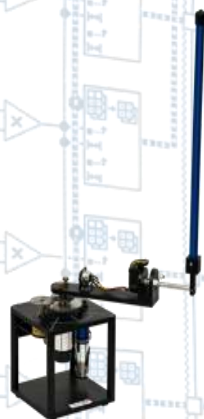


The NI Approach to Learning to be a Controls Engineer

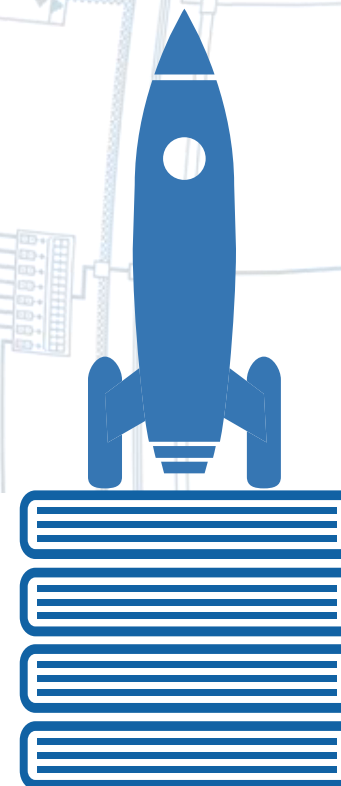


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Quanser Partnership



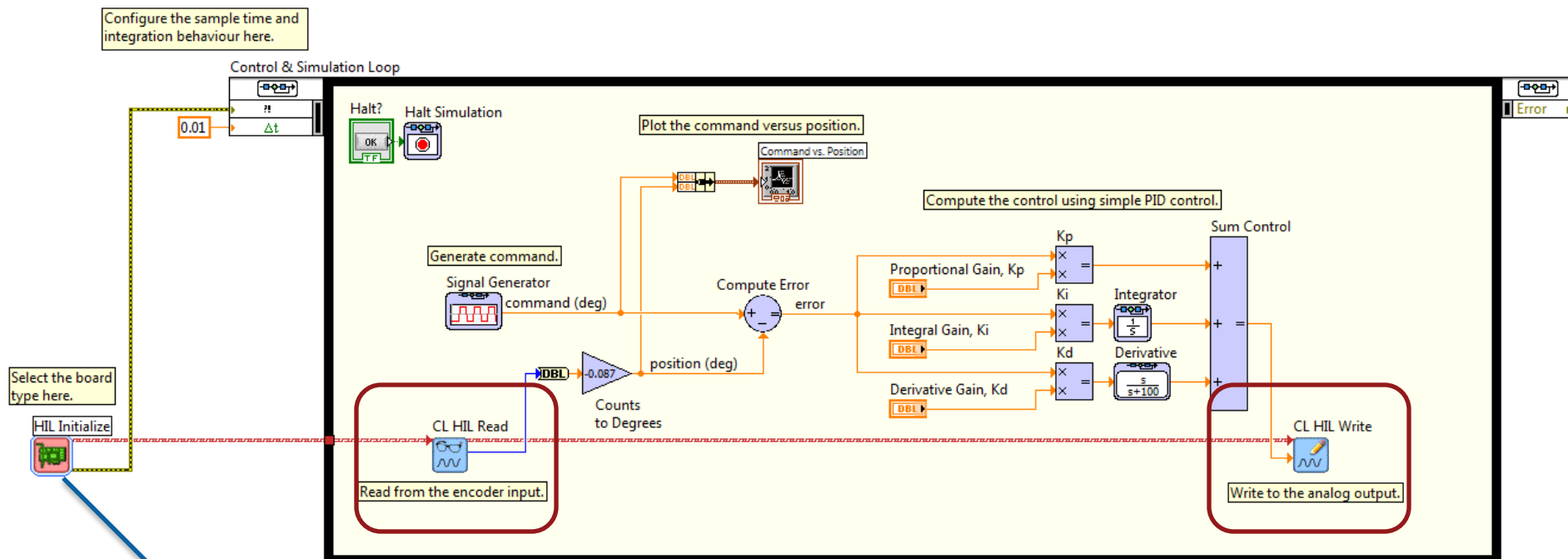
NI CompactRIO - Rugged, Laboratory Solution

- Controls Centric DAQ Module for cRIO
 - 1 AO (16 bit, 80 kS/s)
 - 1 AI (16 bit, 250 kS/s)
 - 2 Encoder inputs (24b, 20MHz)
- Provides ease of connectivity to Quanser Plants

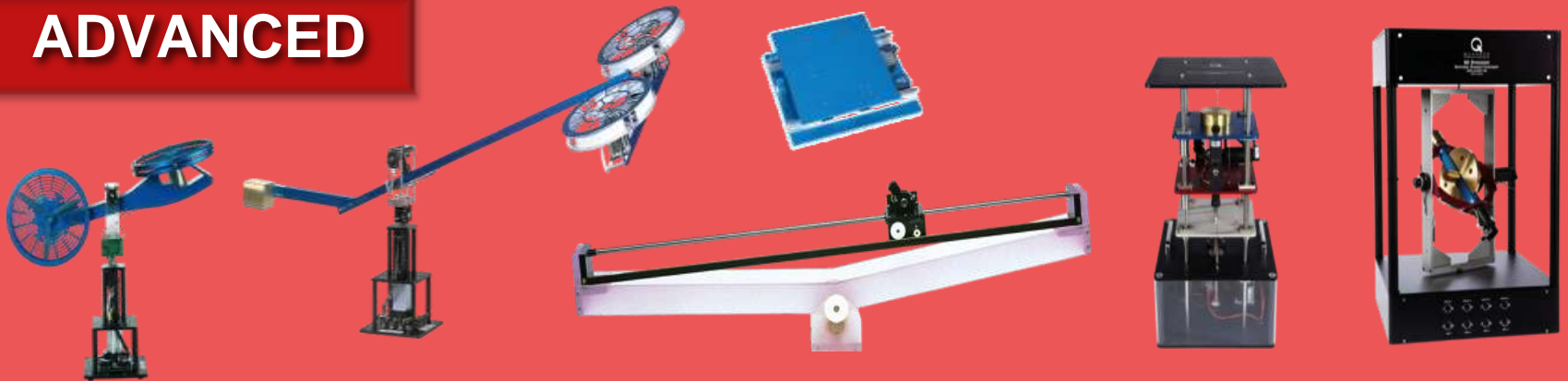
Quanser Q1-cRIO Module



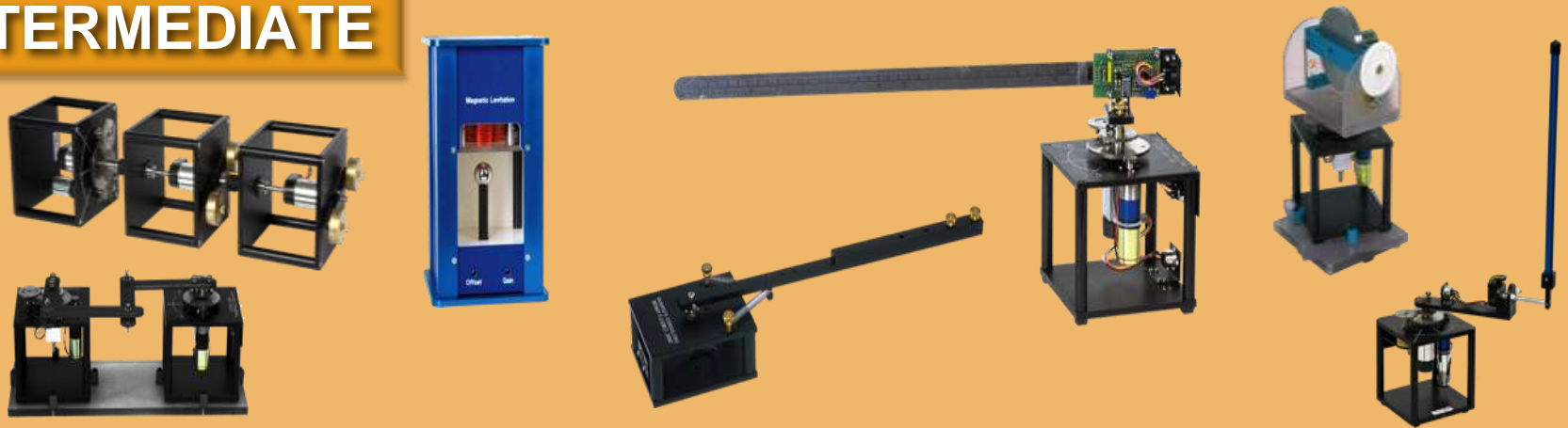
Simple RCP Closed Loop Example



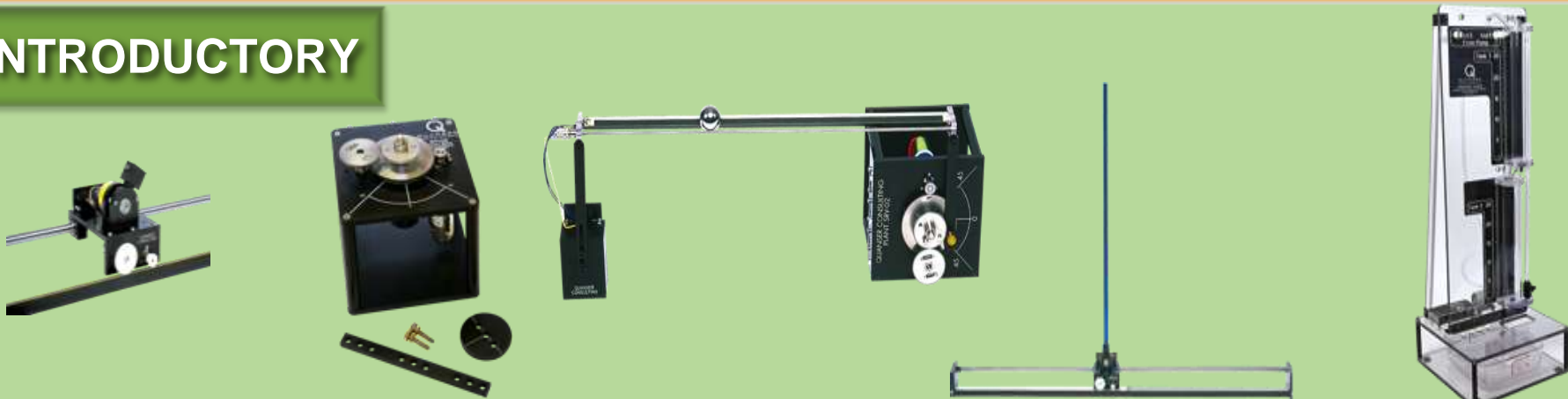
ADVANCED



INTERMEDIATE



INTRODUCTORY

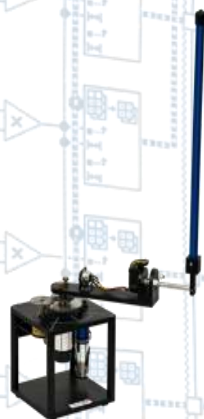


The NI Approach to Learning to be a Controls Engineer

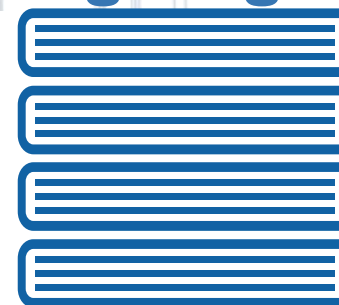
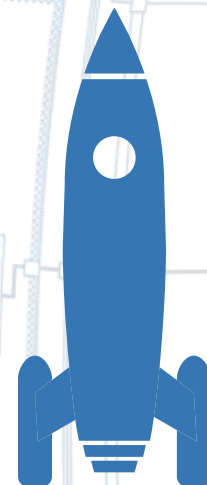


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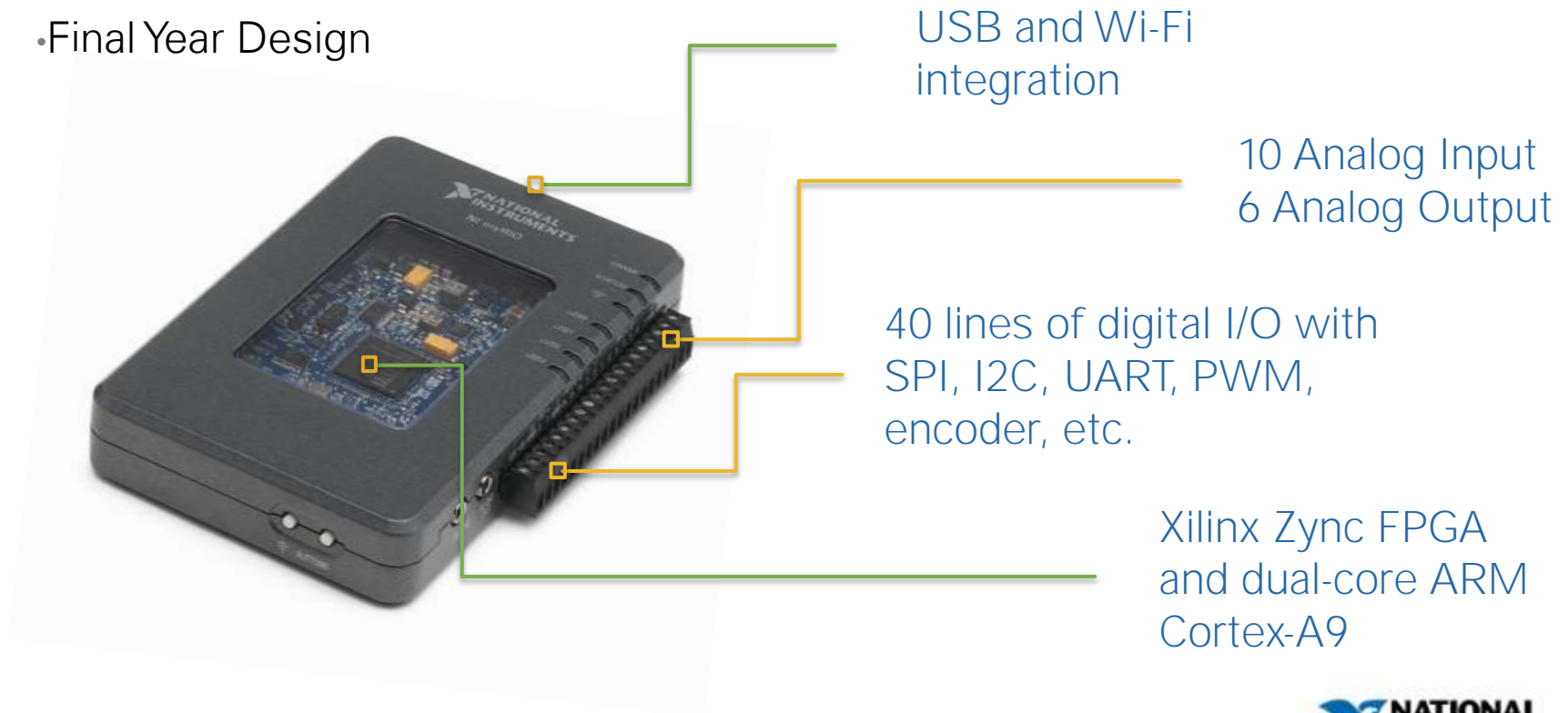


DO ENGINEERING – FROM K TO ROCKET SCIENCE

NI myRIO - Portable Student Design Device

Device for student design inside and outside of the lab

- Controls
- Robotics
- Mechatronics
- Embedded
- Final Year Design



NI myRIO Kits | ni.com/myrio



Starter

- LEDs & switches
- 7-segment display
- Potentiometer
- Thermistor
- Photo resistor
- Hall effect
- Microphone/Speaker
- Battery holder
- DC motor



Mechatronics

- DC gear motors/encoders
- H-bridge driver
- Accelerometer
- Triple-axis gyro
- Infrared proximity sensor
- Ambient light sensor
- Ultrasonic range finder
- Compass
- Hobby servo motors



Embedded

- RFID reader kit
- Numeric keypad
- LED matrix
- Digital potentiometer
- Character LCD
- Digital temp sensor
- EEPROM

NI myRIO

All programmable SoC

Express VIs for ease-of-use

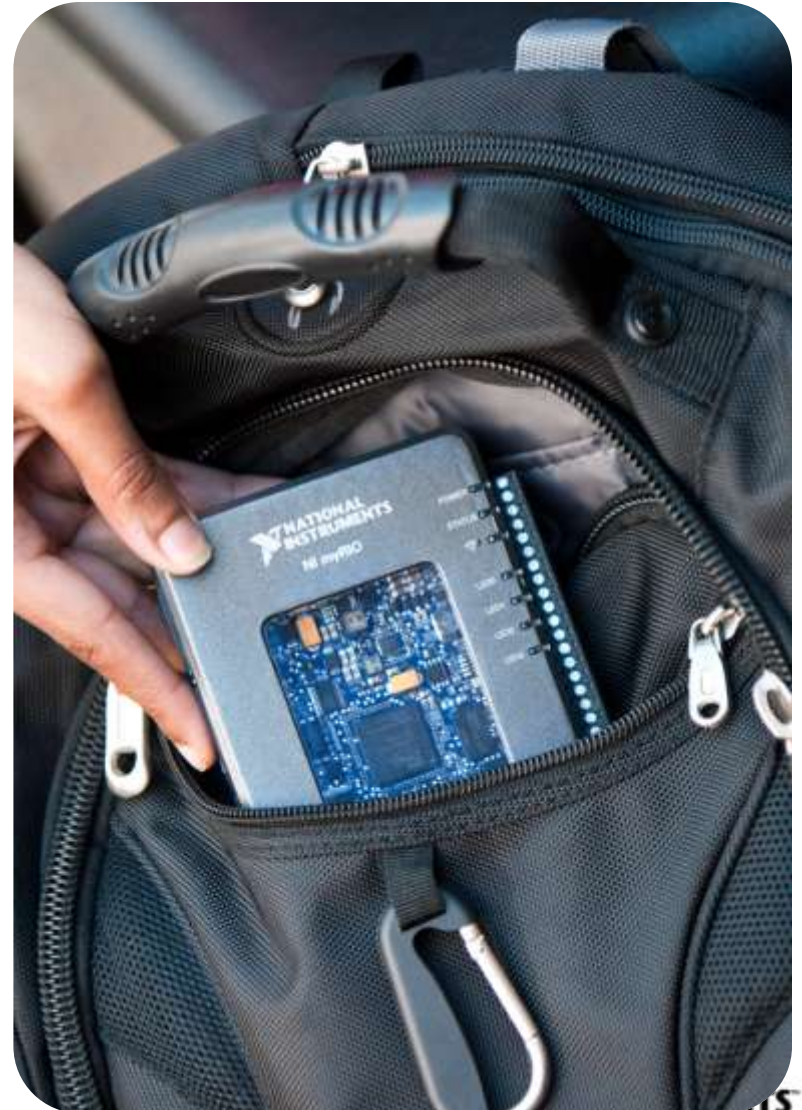
Rich, Known I/O

Extensive Ecosystem

WiFi & Tablet Ready

LabVIEW unleashed

C/C++ Programmable

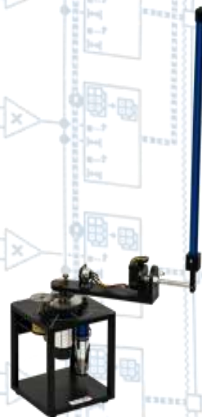


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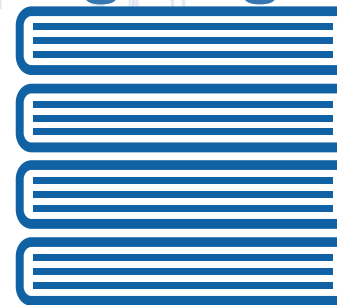
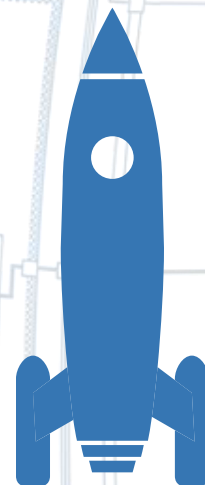


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Do Engineering