Science and Mechatronics Aided Research for Teachers (SMART): A Research Experience for Teachers Site in Mechatronics

NSF Grant # EEC 0227479

Polytechnic University
Brooklyn, NY
PI: Vikram Kapila

URL: http://mechatronics.poly.edu/SMART/

2003 SMART Workshop

Overall Mission/Objective: Provide pre-college teachers hands-on learning opportunities to develop science projects by integrating mechanisms, sensors, actuators, electronics, and microcontrollers thereby enhancing their STEM experience and enabling them to stimulate their students' interest in STEM disciplines.

Start Date	July 14, 2003 (Monday)
End Date	August 8, 2003 (Friday)
Period	4 weeks (Monday–Friday)
Time	8:30am–5pm
Lunch Time	12:30pm–1:30pm
Location	RH514B

Workshop Schedule

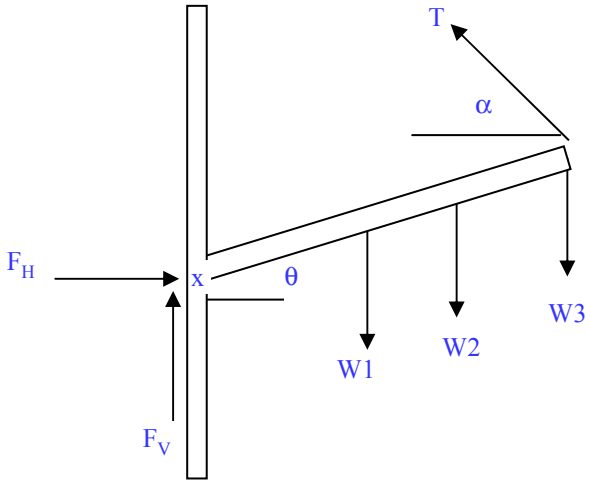
	Mon	Tue	Wed	Thu	Fri
1st	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul
	Registration & Opening	Lecture, Lab, and discussion			
	Orientation	Lecture, Lab, and discussion			
2nd	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul
	Lecture, Lab, and discussion				
	Lecture, Lab, and discussion				Brain storming for project
3rd	28-Jul	29-Jul	30-Jul	31-Jul	1-Aug
	Building the project, report preparation, and presentation slides				
4th	4-Aug	5-Aug	6-Aug	7-Aug	8-Aug
	Building the project, report preparation, and presentation slides				Presentation

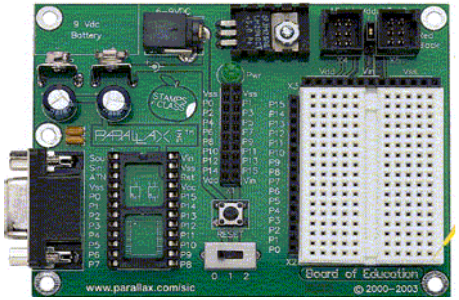
Lecture and Structured Experiment Topics

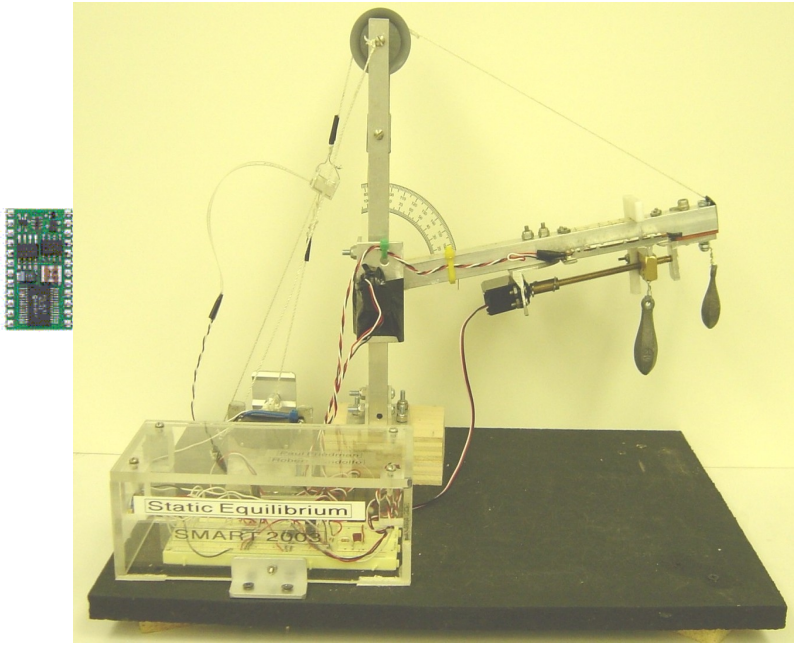
	Topics		Topics
Lecture 1	Resistor	Lecture 10	Thermal sensors
Lecture 2	Mechatronics	Lecture 11	Robotics
Lecture 3	LED	Lecture 12	Infrared sensor
Lecture 4	Button	Lecture 13	Transistor
Lecture 5	Capacitor	Lecture 14	Relay
Lecture 6	Optoelectronics	Lecture 15	H-Bridge
Lecture 7	ADC	Lecture 16	DC motor
Lecture 8	Servomotor	Lecture 17	RC filter
Lecture 9	555 timer	Lecture 18	Op amp

Static Equilibrium

Teachers: Robert Gandolfo & Paul Friedman

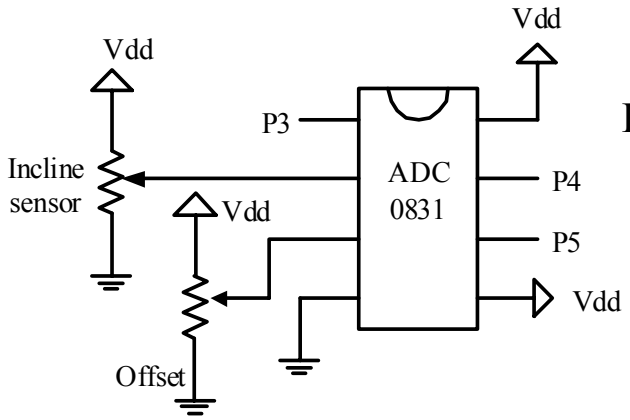






Σ FORCES = 0

Σ TORQUE = 0



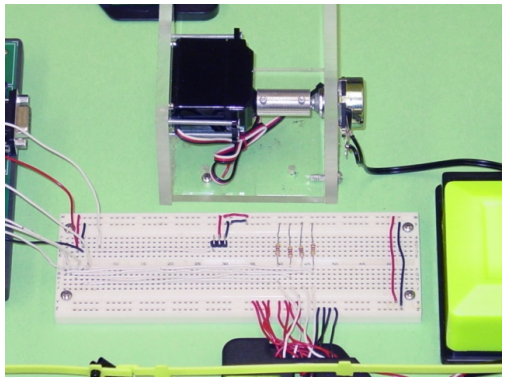
KEY PARTS: TWO SERVOMOTORS
ROTARY POTENTIOMETER
SLIDE POTENTIOMETER
LOAD CELL
LEAD SCREW

The Smart Road

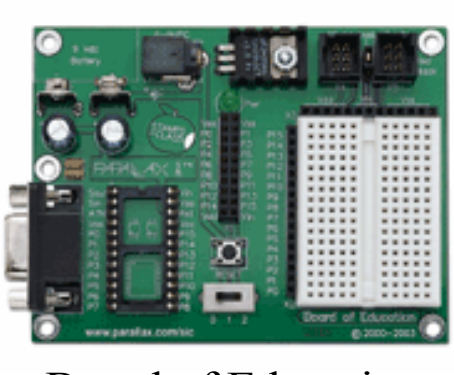
Physics Core Correlation: Kinematics

Teachers: Clay Davis & Richard Balsamel

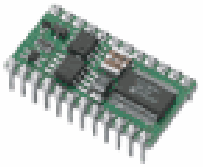
A Mechatronics Demonstration Project

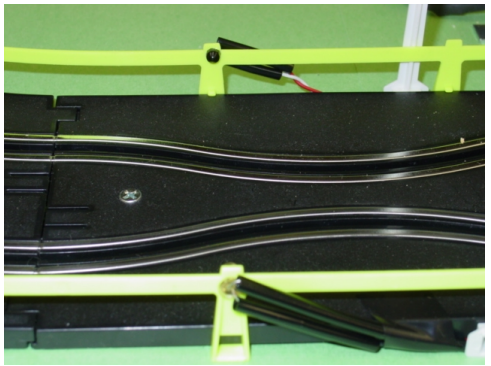


Servomotor Assembly



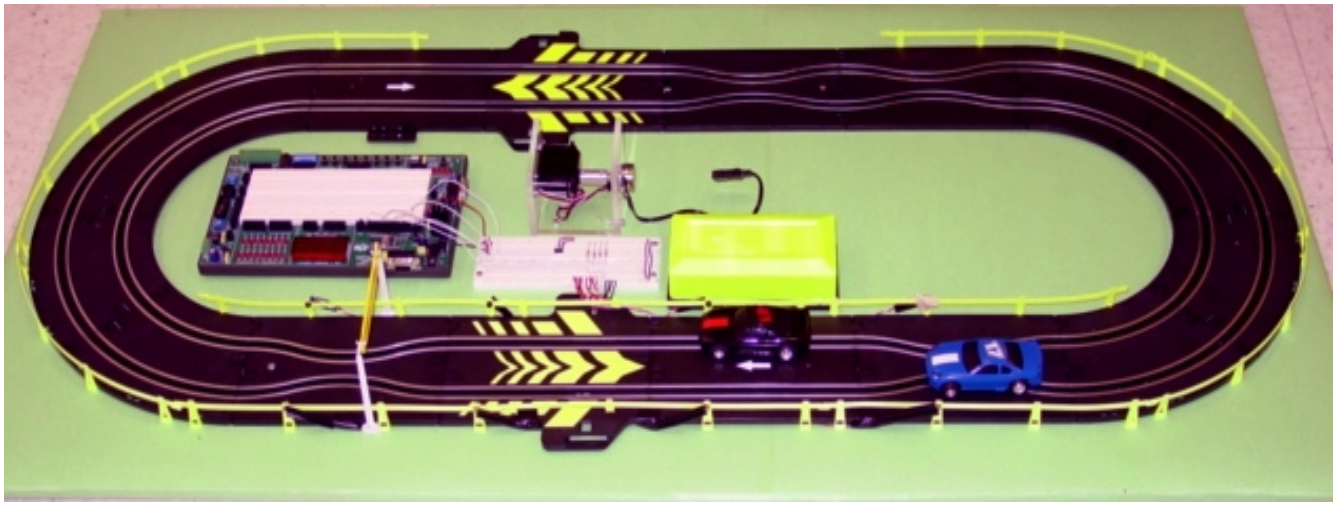
Board of Education and Basic Stamp 2





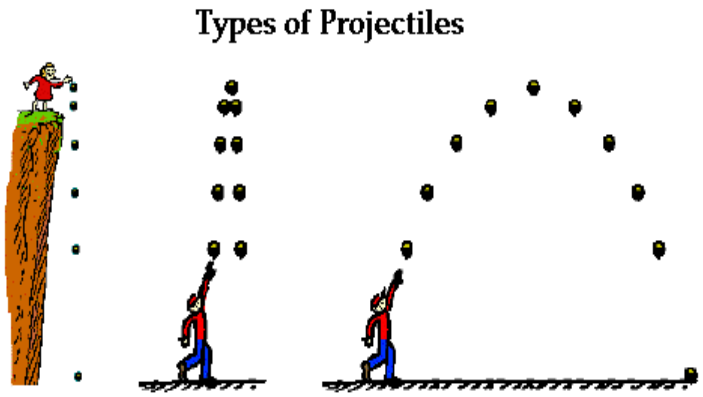
Photogate

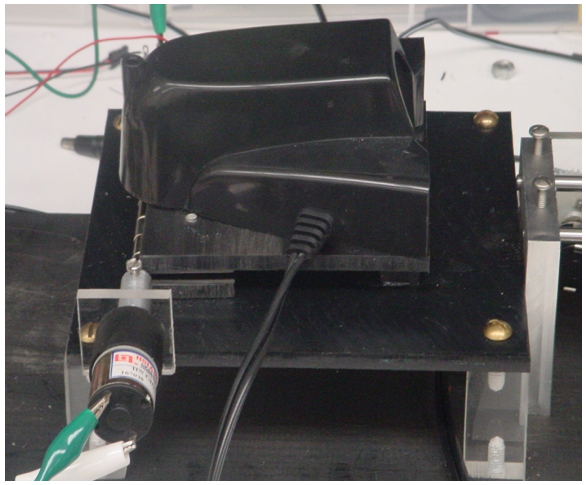
KEY PARTS: SERVOMOTOR
ROTARY POTENTIOMETER
LEDS
PHOTOTRANSISTORS

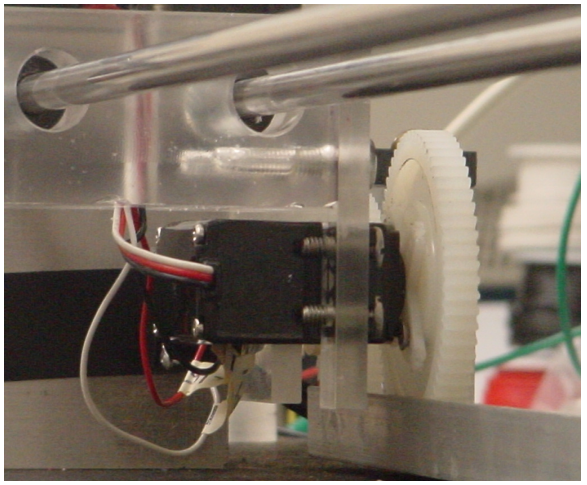


Catch Me If You Can

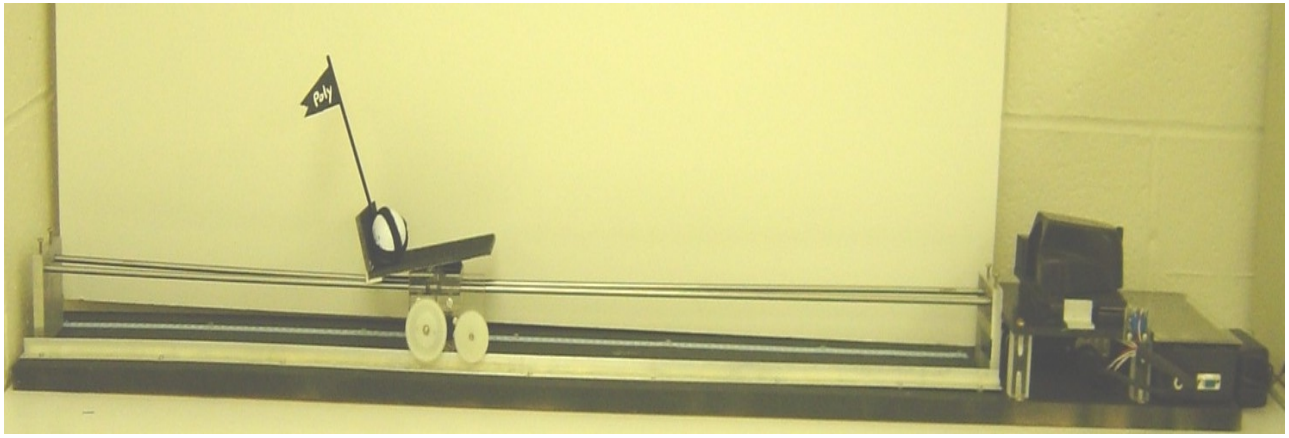
Teachers: John Luvera & Michael McDonnell







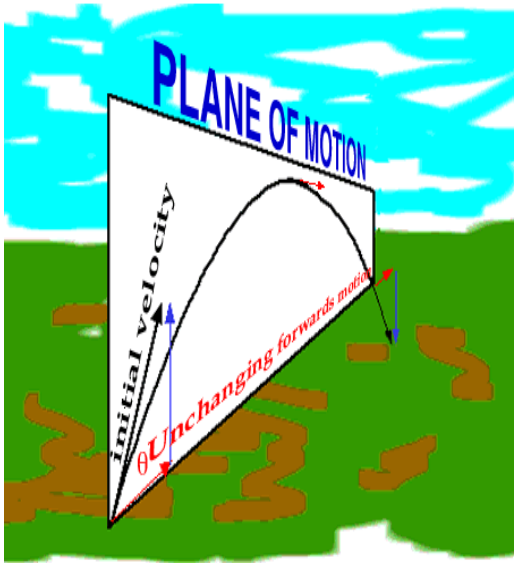
$$x = V_o x t = \frac{V_o \cos\theta \left(2V_o \sin\theta\right)}{g}$$

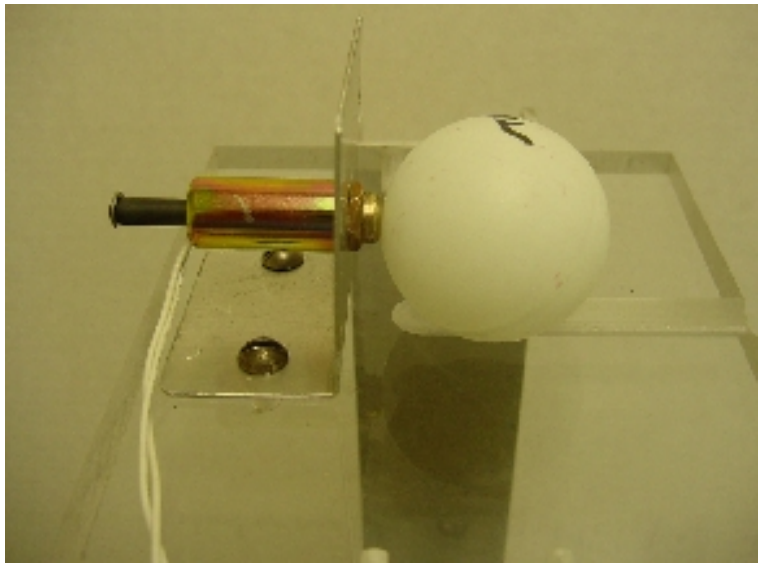


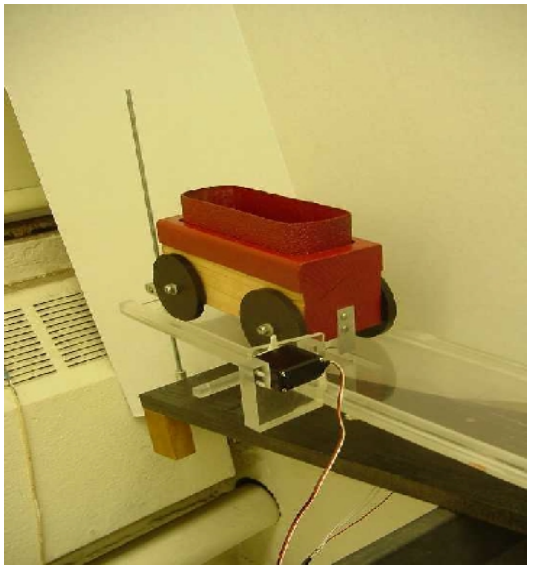
KEY PARTS: SERVOMOTOR
DC MOTOR
ROTARY POTENTIOMETERS
LAUNCHER
H-BRIDGE
SOLID STATE RELAY
ANALOG DIGITAL CONVERTER

The Physics of Projectile Motion

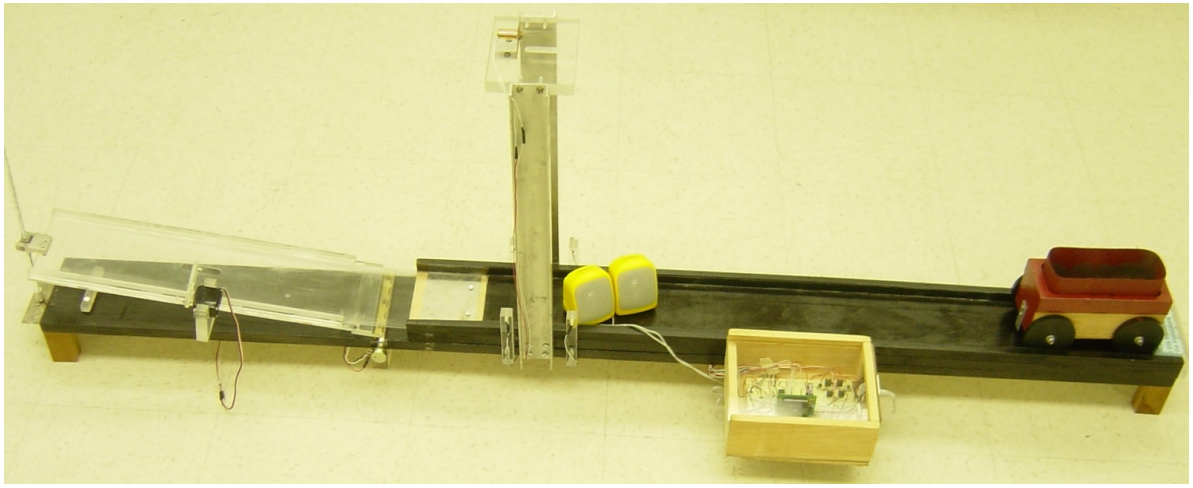
Teachers: William Leacock & Marlene McGarrity





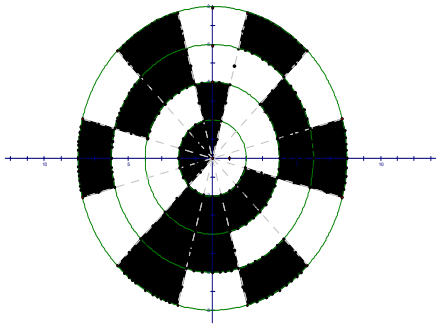


KEY PARTS: SERVOMOTOR
DC MOTOR
ROTARY POTENTIOMETERS
PUSH SOLENOID
H-BRIDGE
INFRARED EMITTERS
PHOTOTRANSISTORS
ANALOG DIGITAL CONVERTER
SOUND PLAYBACK MODULE



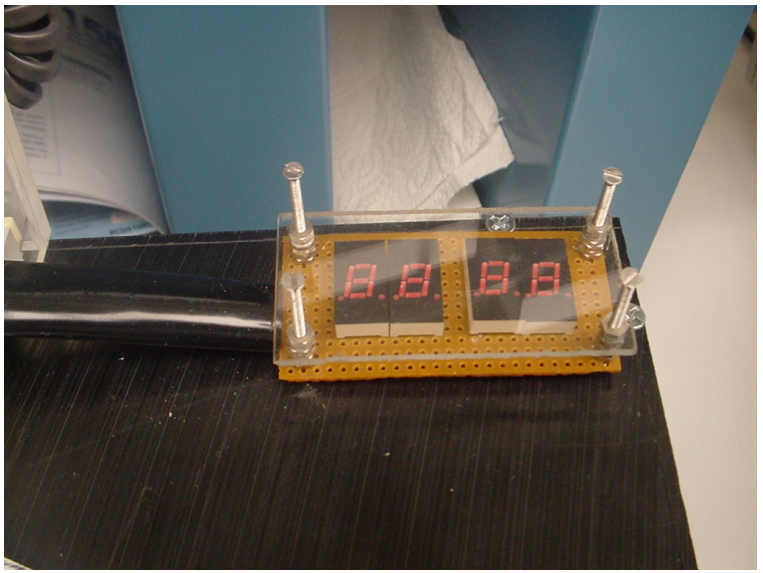
The Ro-Boe-Clock

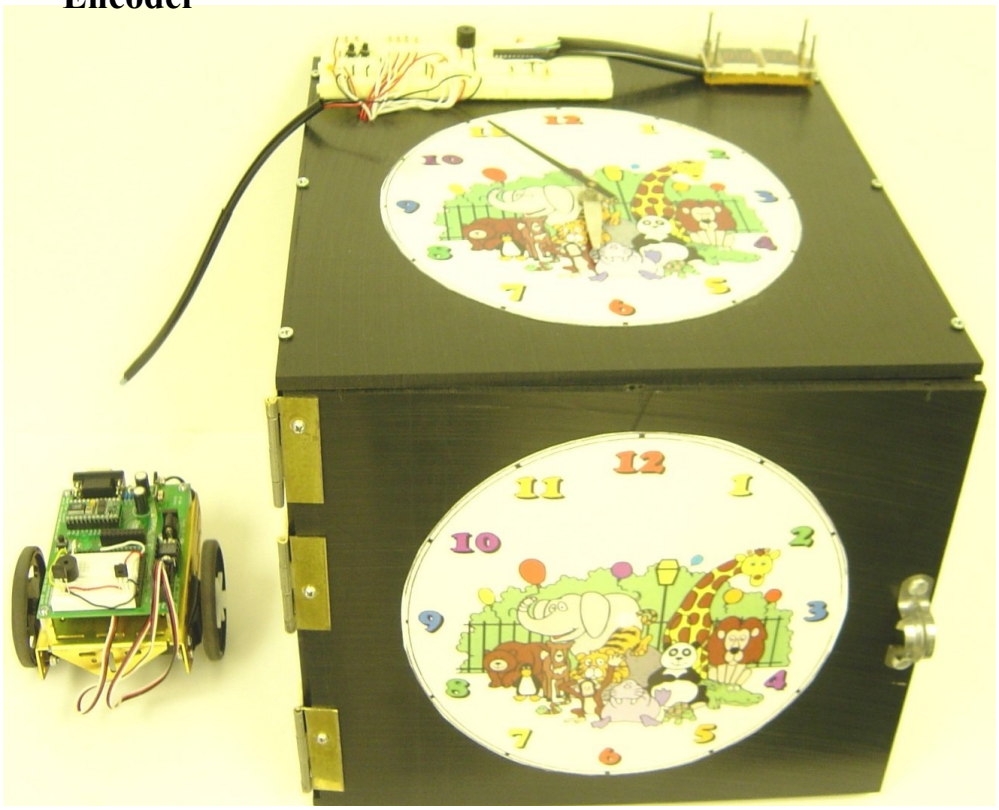
Teachers: Michelle Carpenter-Smith & David Deutsch



Encoder

To teach children ages 4-7 how to tell time

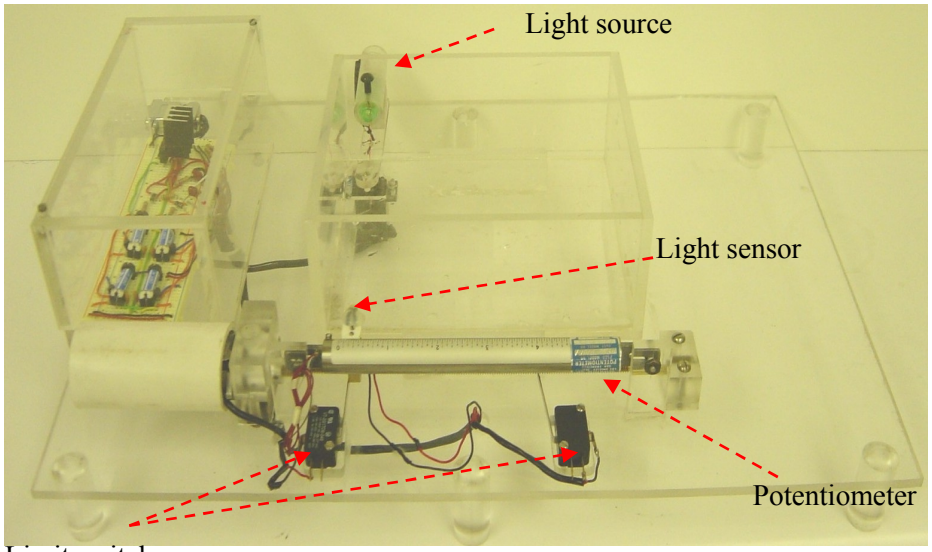




KEY PARTS: BINARY ENCODER
PHOTORESISTORS
ROTARY POTENTIOMETER
SERVOMOTORS
INFRARED EMITTER
INFRARED DETECTOR
MOBILE ROBOT

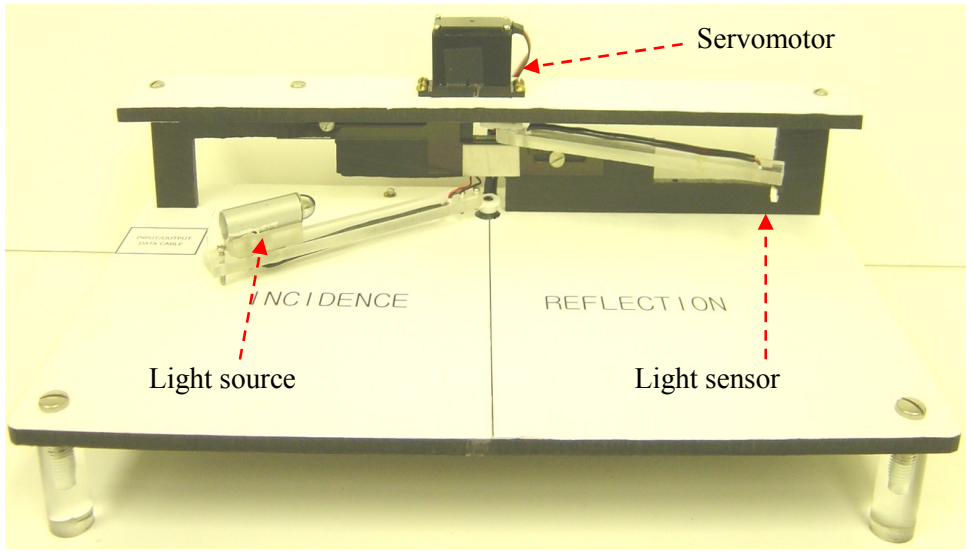
Light Refraction & Reflection

Mechatronics/Process Control Laboratory



The refraction experiment test-bed is used to measure the index of refraction for various media.

KEY PARTS: SERVOMOTOR
DC MOTOR
PHOTORESISTOR
LINEAR POTENTIOMETER
LASER POINTER
H-BRIDGE
LIMIT SWITCH



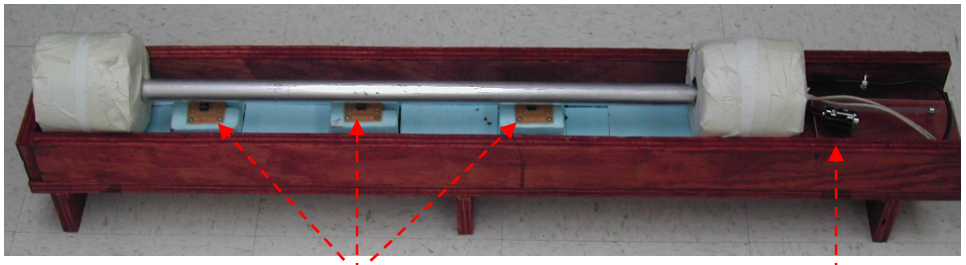
The reflection experiment test-bed is used for both light reflection and absorption experiments.

A common laser pointer is used as the light source. A photoresistor is used as the light sensor.

KEY PARTS: SERVOMOTORS
PHOTORESISTOR
LASER POINTER

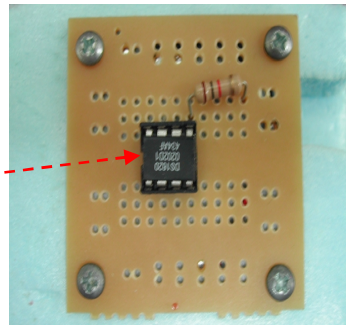
Heat Conduction & Periodic Motion

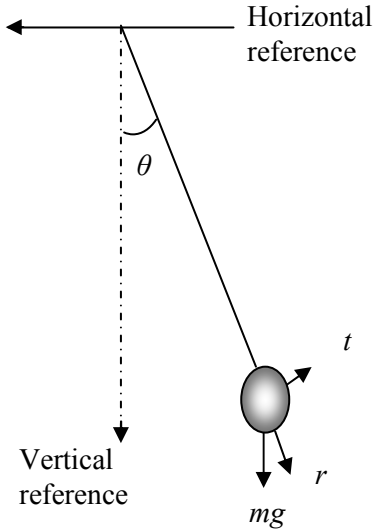
Mechatronics/Process Control Laboratory

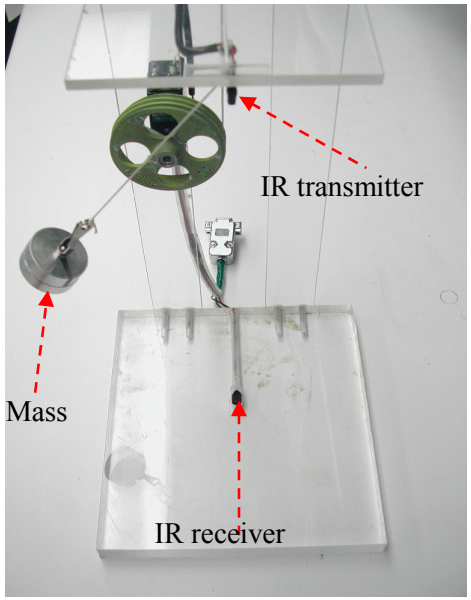


The conduction experiment test-bed is used to measure heat conductivity through the rod. A hole has been bored into one end of each rod for the heating element to be inserted. The other end of the rod is placed into an ice water bath.

KEY PARTS: THERMAL SENSOR
HEATER
ALUMINIUM ROD
ICE BATH
SOLID STATE RELAY







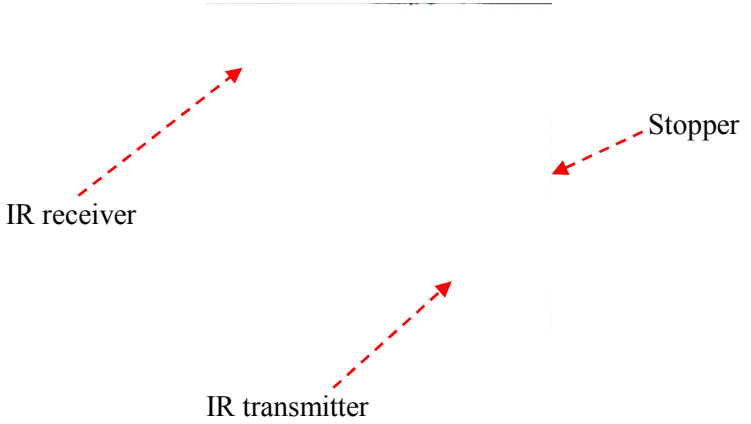
The pendulum experiment test-bed is used to measure the periodicity of a simple pendulum. The length of the pendulum is adjusted by the servomotor through a pulley.

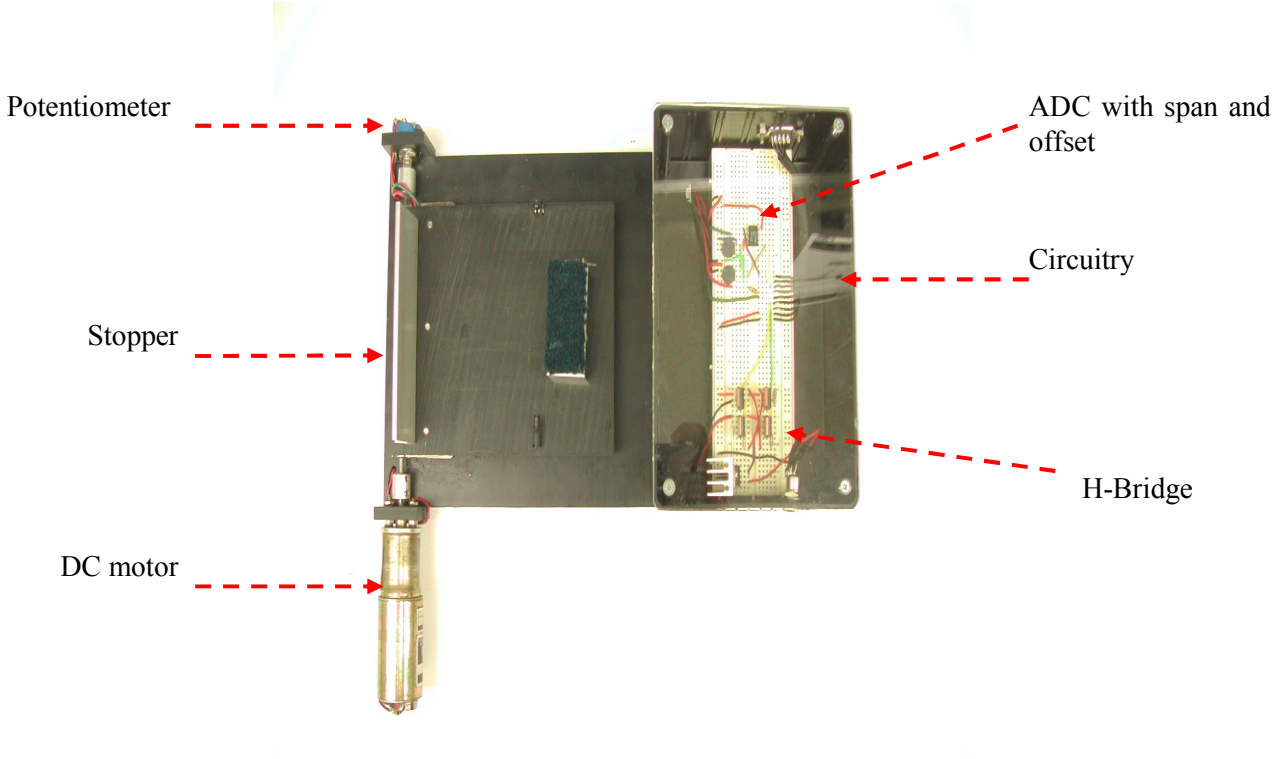
KEY PARTS: SERVOMOTOR
INFRARED EMITTER
INFRARED DETECTOR
MASS

Static Friction

Mechatronics/Process Control Laboratory

The static friction coefficient test-bed is used to experimentally determine the coefficient of static friction between various surfaces. It consists of a horizontal base and a plate that can be rotated from a level plane to the vertical position.



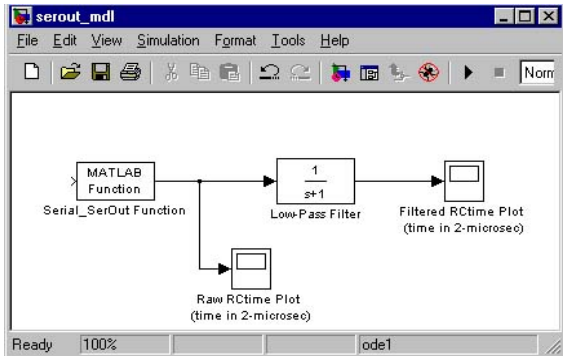


KEY PARTS:
DC MOTOR
ROTARY POTENTIOMETER
ANALOG DIGITAL CONVERTER
INFRARED EMITTER
INFRARED DETECTOR

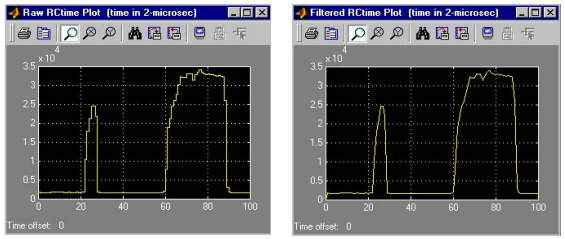
Matlab-Based Graphical User Interface Development for Basic Stamp 2 Microcontroller Projects

Yang-Fang Li, Saul Harari, Hong Wong, and Vikram Kapila
Department of Mechanical, Aerospace, and Manufacturing Engineering
Polytechnic University, Brooklyn, NY 11201

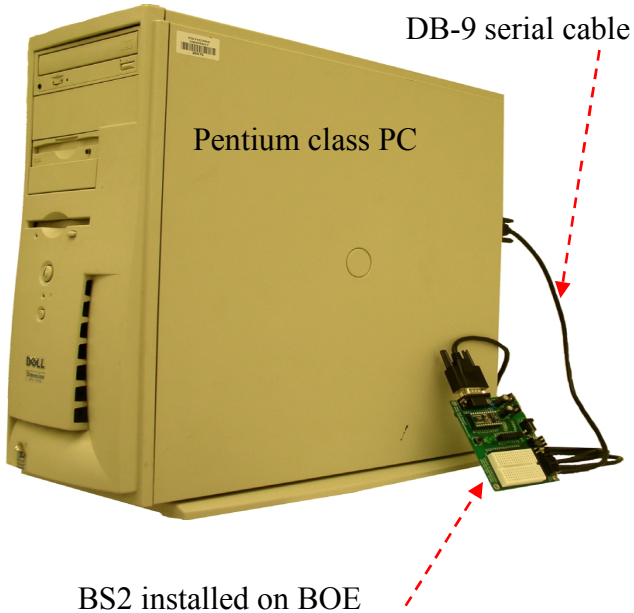
This paper presents an approach to endow the BS2 microcontroller with GUI capabilities by interfacing it with Matlab and by exploiting Matlab's abundant GUI tools. The proposed Matlab-based GUI environment for BS2 relies on the use of serial communication between the BS2 and a personal computer.



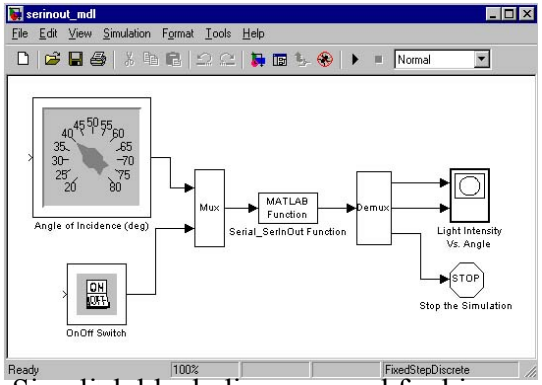
Simulink block diagram used for BS2 to PC serial communication



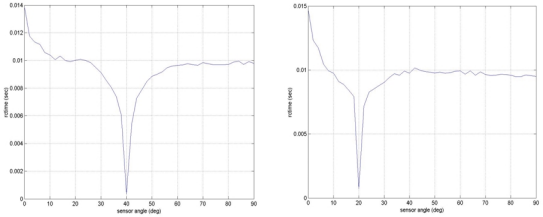
Unfiltered and Filtered plot of rctime



BS2 installed on BOE development platform



Simulink block diagram used for bi-directional serial communication between BS2 and PC



Plot of rctime vs. angle of light sensor

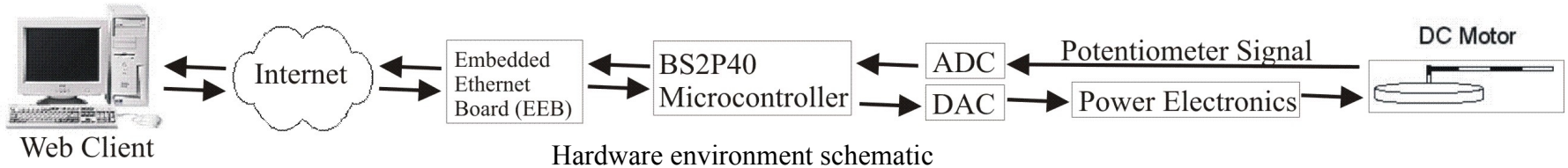
Internet-Based Remote Control using a Microcontroller and an Embedded Ethernet Board

Imran Ahmed, Hong Wong, and Vikram Kapila

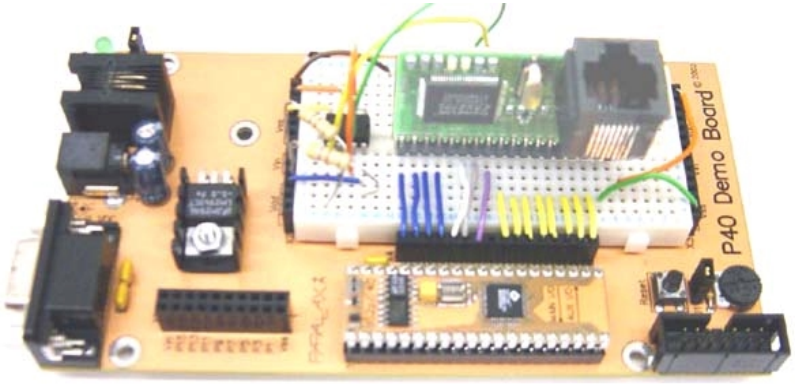
Department of Mechanical, Aerospace, and Manufacturing Engineering

Polytechnic University, Brooklyn, NY 11201

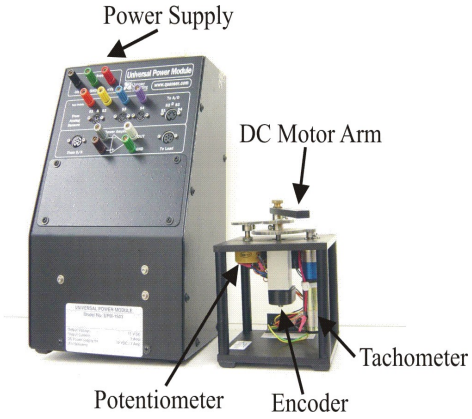
This paper presents a recently developed DC motor position control experimental setup that can be accessed via the Internet. The experiment consists of two primary elements communicating with each other: i) a server consisting of a low-cost microcontroller, Parallax's 40-pin Basic Stamp 2 (BS2P40), interfaced with an embedded ethernet IC, Crystal's CS8900A-CQ, and ii) a client computer.



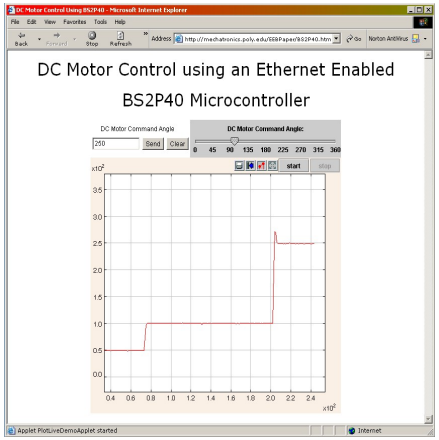
Hardware environment schematic



Ethernet Enabled BS2P40



DC motor test-bed



Java applet GUI screen capture

Outcomes

People: PI, 3 graduate students, and 3 undergraduates partnered with 10 New York city metropolitan area pre-college STEM educators for 4 weeks in summer 2003 to develop projects demonstrating concepts of projectile motion, speed, time, static balance, mobile robotics, etc.

Idea: Introduce teachers to *mechatronics*—synergistic integration of mechanical engineering, control theory, computer science, and electronics to manage complexity, uncertainty, and communication in engineered systems—to allow them to become technology proficient and help them integrate project-based learning in their classrooms.

Tools: Integrated Matlab with Basic Stamp 2 (BS2) microcontrollers and integrated BS2 with an Embedded Ethernet Board for Internet-based control.

Dissemination

Polytechnic University Community

Mechatronics/Process Control Remote Laboratory

Center for Youth in Engineering and Science

David Packard Center for Technology and Educational Alliances

For Inspiration and Recognition of Science and Technology

Pre-college Community

Teachers Name		School Name
Richard	Balsamel	Science High School
Clay	Davis	Manhattan Comprehensive Night and Day High School
John	Luvera	Montville Township High School
Michael	McDonnell	Midwood High School
Paul	Friedman	Seward Park High School
Robert	Gandolfo	Plainedge High School
Michelle	Carpenter-Smith	Packer Collegiate Institute
David	Deutsch	Manhattan Center for Science and Mathematics
William	Leacock	W. C. Mepham High School
Marlene	McGarrity	Chrita McAuliffe Intermediate School

SMART DAY at Poly September 13, 2003 (Saturday), 33 attendees

General Public: NY1 and WABC

Matlab-Based Graphical User Interface Development for Basic Stamp 2 Microcontroller Projects
Y.-F. Li, S. Harari, H. Wong, and V. Kapila
Internet-Based Remote Control using a Microcontroller and an Embedded Ethernet Board
I. Ahmed, H. Wong, and V. Kapila

Teachers Use High-Tech Methods To Help Students Pursue Engineering, Electronics Careers

JULY 21ST, 2003

Some New York City teachers are hoping to bring all sorts of high-tech concepts into their classrooms next school year to inspire more students to pursue careers in engineering and electronics. As NY1 Tech Beat reporter Adam Balkin explains in the following story, students won't just be hearing about those concepts, they'll be building them too.

Classrooms have certainly come a long way since the abacus and the quill. How far? Polytechnic University in Brooklyn is running a new program this summer, educating area high school teachers on how to bring mechatronics into the classroom. It's a program funded by the National Science Foundation called SMART.

"SMART stands for 'science and mechatronics aided research for teachers,'" says Vikram Kapila of Polytechnic University. "Mechatronics is marriage of mechanical engineering, electrical engineering, electronics, computer science and computer engineering to make smart products."

These projects aren't just designed to look neat or be like high-tech erector sets - they're built to actually do something eventually in the real world. A hexapod, for example, could be used for disaster recovery. After a building collapse it could be sent in to look for possible survivors.

"These could be robots, smart jet engines, automotive hybrid systems, rockets, missiles, or what have you," says Kapila.

"This is like a simulator for a jet pilot, and what they'd do before they actually become jet pilots, but most of it has to do with the fact that I'm controlling the helicopter basically by using sensors," says Clay Davis of Manhattan Comprehensive Day/Night High School.

The teachers all agree, students are more eager to learn when they can use concepts and equations to actually make something they can touch and use.

"It's tangible," says Paul Friedman of Seward Park High School. "You look at a differential equation and it's a differential equation. It just sits there, and this is real. It's live, and it has applications."

Michelle Carpenter-Smith of Packer Collegiate Institute says, "I think this is a way for me to bring projects back that will interest females as well as male students so that hopefully more female students will go into engineering, go into math and science professions, and they'll bring their way of viewing engineering from a creative perspective, from an artistic perspective, so that there can be more representation from both genders."

The program runs for four-weeks. After it's over, each teacher is given supplies to build some of these projects back at their high schools.
For more information on the program, including a list of which high schools are participating, visit mechatronics.poly.edu/smart.

- Adam Balkin