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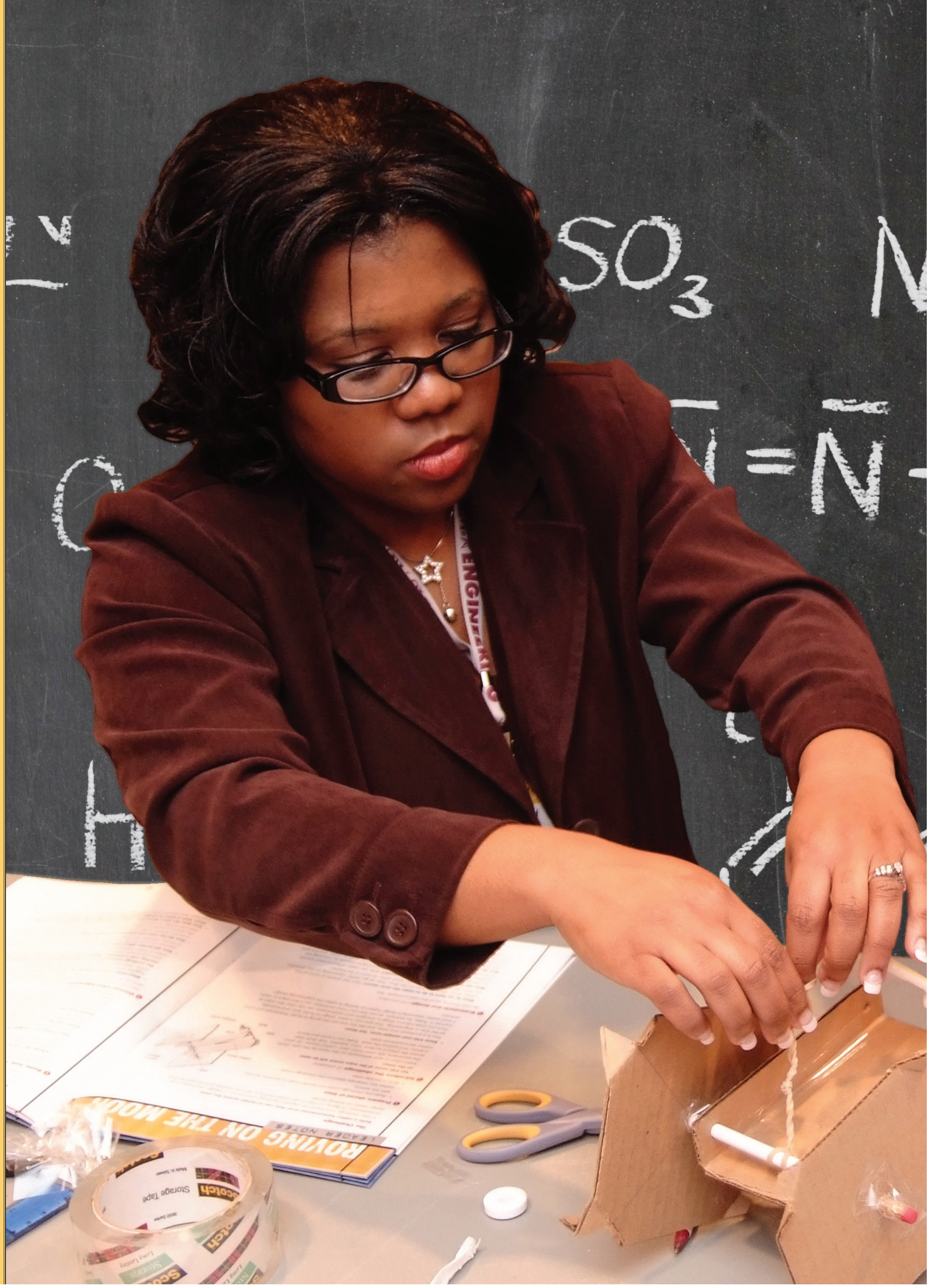
Teacher Summit 2012

Focus on STEM
science and engineering
in the classroom



January 27, 2012
College Station, Texas
Hilton Hotel and Conference Center

Presented by
The College of Science and
The Dwight Look College of Engineering
at Texas A&M University

Teacher Summit 2012 Evaluation Form

We hope you enjoyed the summit and it provided you with valuable information. Please take a moment to tell us how we did and provide us with any suggestions for improving this event in the future.

Part I: Teacher Summit Program

1) Please rate the overall relevance of this year's ***Teacher Summit – Focus on STEM*** for use in your classroom. (Please circle.)

1 Poor   2 Fair   3 Good   4 Very Good   5 Excellent

Comments ____

2) Please rate the ***presentation on research by Dr. James Moore*** (Please circle)

1 Poor   2 Fair   3 Good   4 Very Good   5 Excellent

Comments ____

3) Please rate the ***resource material*** available at the resource tables (Please circle)

1 Poor   2 Fair   3 Good   4 Very Good   5 Excellent

Comments ____

4) If you attended the ***workshop sessions on Math, Physics, and Engineering Design,*** please provide your feedback below. Otherwise, please move to question #5.

A. ***Workshop Session Name: What Makes Learning Physics Enjoyable***

- Please rate the "***What Makes Learning Physics Enjoyable***?" session (Please circle.)

  1 Poor   2 Fair   3 Good   4 Very Good   5 Excellent

- If you plan to use this information in your classroom, please let us know the class subject:

Comments ____

- Please provide additional comments for the physics workshop session below:

____

B. ***Workshop Session Name: Get Ideas to Excite Students about Math***

- Please rate the "***Get Ideas to Excite Students about Math***" session (Please circle.)

  1 Poor 2 Fair 3 Good 4 Very Good 5 Excellent

- If you plan to use this information in your classroom, please let us know the class subject:

Comments ____

- Please provide additional comments for this workshop session below:

____

C. ***Workshop Session Name: Real World Engineering in the Science Classroom***

- Please rate the "***Real World Engineering in the Science Classroom***" session (Please circle.)

  1 Poor 2 Fair 3 Good 4 Very Good 5 Excellent

- If you plan to use this information in your classroom, please let us know the class subject:

Comments ____

- Please provide additional comments for this workshop session below:

____

5) ***Workshop Session Name: Robotics I, II, III***

If you attended the three Robotics sessions please provide your feedback below. (Please circle.). Otherwise, please move to question #6..

5.1 Please rate the "***Robotics Session I - Software***?" session (Please circle.)

1 Poor 2 Fair 3 Good 4 Very Good 5 Excellent

- If you plan to use this information in your classroom, please let us know the class subject:

Comments ____

- Please provide additional comments for this workshop session below:

____

5.2 Please rate the "***Robotics Session II - Hardware***?" session (Please circle.)

1 Poor 2 Fair 3 Good 4 Very Good 5 Excellent

- If you plan to use this information in your classroom, please let us know the class subject:

Comments ____

- Please provide additional comments for this workshop session below:

____

5.3 Please rate the "***Robotics Session III – Engineering Design***?" session (Please circle.)

1 Poor 2 Fair 3 Good 4 Very Good 5 Excellent

- If you plan to use this information in your classroom, please let us know the class subject:

Comments ____

- Please provide additional comments for this workshop session below:

____

6) Did you find the session “How to Best Prepare High School Students for STEM Majors” useful?

Yes_____ No______

Comments____

7) Did you find the Texas A&M student presentations useful?

Yes______ No______

Comments____

8) Please rate the presentation by Astronaut Richard Linnehan (Please circle)

1 Poor 2 Fair 3 Good 4 Very Good 5 Excellent

9) How did the Teacher Summit affect your impression of STEM majors at Texas A&M University? (Check one.)

Improved ______ Did not affect ______ Lowered ______

Please explain. ____

10) How did the Teacher Summit affect your impression of Texas A&M University? (Check one.)

Improved ______ Did not affect ______ Lowered ______

Please explain. ____

11) Will you recommend Texas A&M University to your students? (Circle one)

Yes No Not sure

Comments ____

Part II: Facilities/Registration

Please rank the facilities and registration below (1 being the lowest and 5 being the highest):

1) Ease of online registration process

1 2 3 4 5 Suggestions: ____

2) Quality of lodging, conference facility and food

1 2 3 4 5 Suggestions: ____

3) Value of door prizes

1 2 3 4 5 Suggestions: ____

Part III: Please tell us about yourself

4) Identify your expertise area. (Circle all that apply.)

a) Astronomy
b) Biology
c) Chemistry
d) Engineering
e) Math
f) Physics
g) Other ____________________
____

5) Identify the grade levels you currently teach (Circle all that apply.)

a) 7th grade
b) 8th grade
c) 9th grade
d) 10th grade
e) 11 grade
f) 12th grade
g) Other _____________________

6) Identify the subject matters you currently teach. (Check all the apply.)

1. Algebra I ______ Algebra II______
2. Geometry______ Pre- Calculus______ Calculus______
3. Physics Pre AP_____ Physics AP (non-calculus–based) _____ Physics AP (calculus-based) ______
4. Chemistry Pre-AP______ Chemistry AP______
5. Biology Pre AP______ Biology AP______ Anatomy_______
6. Engineering______ Environmental ______ IPC________
7. Other (please specify) ____

7) What is the size of your student population at your school (all grades included)? _____________

8) How did you receive your invitation? (Circle all that apply.)

a) Dwight Look College of Engineering
b) College of Science
c) Participated in the Research Experience for Teachers
d) Selected by principal or other school administrator
e) Other ___________________
____

Part IV: 2013 Teacher Summit

1) Each Teacher Summit event is fully supported by sponsor funds but recent economic challenges have had an impact on the ability of our sponsors to support us as generously as before. As we start planning the 2013 Teacher Summit, we would like to know if you would be able to attend the event if it required a small fee. Please provide your input below to assist us in the planning:

- If there was a fee of $50 / participant with no hotel room accommodations, please check one:
  - Yes, I would be able to participate ___________________________
  - No, I would not be able to participate _________________________

- If there was a fee of $100 / participant with hotel room accommodations, please check one:
  - Yes, I would be able to participate ___________________________
  - No, I would not be able to participate _________________________

2) Please provide suggestions for future speakers and topics:

____

____

Thank you!

Speakers

Teacher Summit 2012

M. Katherine Banks, Ph.D., P.E.

Vice Chancellor for Engineering, The Texas A&M University System
Dean and Harold J. Haynes Dean's Chair, Dwight Look College of Engineering, Texas A&M University

Dr. M. Katherine Banks is vice chancellor for engineering for The Texas A&M University System and dean of the Dwight Look College of Engineering at Texas A&M University.

As vice chancellor, Dr. Banks oversees coordination and collaboration among the engineering, academic and research programs at universities throughout the A&M System, as well as three state agencies.

As dean of the Look College and holder of the Harold J. Haynes Dean's Chair in Engineering, Dr. Banks leads one of the largest engineering schools in the country, with more than 11,000 students and nearly 400 faculty.

Dr. Banks was previously the Bowen Engineering Head for the School of Civil Engineering at Purdue University and the Jack and Kay Hockema Professor at Purdue. She received her B.S.E. from the University of Florida, M.S.E. from the University of North Carolina, and Ph.D. in civil and environmental engineering from Duke University.

Dr. Banks is a Fellow of the American Society of Civil Engineers (ASCE) and is a licensed professional civil engineer in Indiana and Kansas. She has received numerous awards, including the ASCE Petersen Outstanding Woman of the Year Award, ASCE Rudolph Hering Medal, Purdue Faculty Scholar Award, Sloan Foundation Mentoring Fellowship and the American Association of University Women Fellowship. She is the author or co-author of more than 150 journal articles, proceedings papers and book chapters, and has made more than 200 scholarly or technical presentations before professional and related groups. Dr. Banks has served as editor-in-chief for the *ASCE Journal of Environmental Engineering* and associate editor of the *International Journal of Phytoremediation*.

Karan L. Watson, Ph.D., P.E.

Provost and Executive Vice President for Academic Affairs, Texas A&M University

Dr. Karan L. Watson, is provost and executive vice president for academic affairs at Texas A&M University. She was previously vice provost at Texas A&M from December 2008 to July 2009 and dean of faculties and associate provost from February 2002 to December 2008. She was interim vice president and associate provost for diversity from November 2005 to September 2006, a role that she again held from December 2008 until July 2009.

She joined the Texas A&M faculty in 1983 and is currently a Regents Professor in the Department of Electrical and Computer Engineering and the Department of Computer Science and Engineering. She has served the Dwight Look College of Engineering as associate dean for graduate studies, associate dean for academic affairs and as a member of the Faculty Senate. She has chaired the graduate committees of 34 doctoral students and more than 60 master's degree students.

Dr. Watson is a fellow of the Institute of Electrical and Electronic Engineers (IEEE) and the American Society for Engineering Education. Her awards and recognitions include the U.S. President's Award for Mentoring Minorities and Women in Science and Technology, the American Association for the Advancement of Science mentoring award, the IEEE International Undergraduate Teaching Award, the College of Engineering Crawford Teaching Award, and two University-level Distinguished Achievement Awards from The Texas A&M University Association of Former Students in Student Relations and in Administration. She is currently president–elect of ABET Inc., which accredits more than 3,000 applied science, computing, engineering and technology programs worldwide to ensure quality education and standards.

Dr. Tatiana Erukhimova

Senior Lecturer, Department of Physics and Astronomy, Texas A&M University

Dr. Erukhimova received her Ph.D. in physics from the Institute of Applied Physics at the Russian Academy of Sciences in 1999, and is now a senior lecturer in the Department of Physics and Astronomy at Texas A&M. She has been teaching introductory physics classes since 2006 and a summer physics preparatory class for the Dwight Look College of Engineering since 2008. From 2008 to 2011 Dr. Erukhimova received four teaching awards. In 2009, together with Professor Gerald North, she published a textbook, *Atmospheric Thermodynamics* (Cambridge University Press).

Dr. Erukhimova is outreach coordinator in the Department of Physics and Astronomy. She has coordinated and organized six successful Physics Festivals, which were highly appreciated by the community. She is in charge of the Physics Show.

Magdalini Z. Lagoudas

Program Director, Engineering Student Services and Academic Programs, Dwight Look College of Engineering, Texas A&M University

Magda Lagoudas is director of the Engineering Student Services and Academic Programs (ESSAP) Office in the Dwight Look College of Engineering at Texas A&M University. She manages all outreach, recruiting, retention, college-level scholarships and enrichment programs for the college. She works closely with the Engineering Development Office and pursues state and federal opportunities to secure funds for the support of programs.

In outreach, she is responsible for the E12 targeted recruitment program, which involves working closely with 12 high schools across Texas to increase the number of qualified and diverse students that enroll in engineering at Texas A&M. She regularly collaborates with others on efforts that promote STEM awareness in high schools.

She oversees retention programs such as programs offered at the Engineering Living Learning Community, which houses about 600 freshman engineering students. She has extensive experience with multidisciplinary activities for undergraduates as director of the Space Engineering Institute (SEI) and is currently supporting college efforts to promote multidisciplinary opportunities for undergraduates with industry support.

She has been with Texas A&M University for 19 years. Before joining ESSAP in 2010, she served as SEI director and associate director of the Spacecraft Technology Center at Texas A&M. In addition, she taught in the Department of Mechanical Engineering and the Department of Engineering Technology and Industrial Distribution.

Before coming to Texas A&M in 1992, she worked for Dynamic Systems Inc. and the Office of General Services for the State of New York. Lagoudas holds a diploma in mechanical engineering from Aristotle University (Greece) and a master's degree in mechanical engineering from Lehigh University. She is the advisor for the Society of Women Engineers at Texas A&M and also serves on the Advisory Board of Texas Alliance for Minorities in Engineering.

Richard Linnehan, D.V.M., M.P.A.

Director, Space Science, Policy and Education, The Texas A&M University System

Astronaut Rick Linnehan, who has logged more than 58 days in space, is currently director for space science, policy and education for The Texas A&M University System.

Dr. Linnehan is working to develop space science initiatives targeting research in aerospace engineering, physics and biomedical performance-enhancing countermeasures associated with human spaceflight and exploration. A veterinarian trained in comparative pathophysiology, Dr. Linnehan works with Texas A&M researchers to test and evaluate adaptive biological solutions in animal models to support advanced imaging, pharmacokinetics and the development of novel space flight countermeasures and associated technologies.

He is also working to develop and implement space science curricula, including creating a space policy section at Texas A&M's George Bush School of Government and Public Service and a space science lecture and visiting scholar series focused on the scientific research necessary to implement NASA's strategic vision.

After graduating from The Ohio State University College of Veterinary Medicine in 1985, Dr. Linnehan entered private veterinary practice and was later accepted to a two-year joint internship in zoo animal medicine and comparative pathology at the Baltimore Zoo and The Johns Hopkins University. He was later commissioned as a captain in the U.S. Army Veterinary Corps, where he became chief clinical veterinarian for the U.S. Navy's Marine Mammal Program.

He joined NASA in 1992 and flew his first mission in 1996. A veteran of four space flights aboard space shuttles Columbia and Endeavour, Dr. Linnehan's mission experience also includes six spacewalks totaling 42 hours and 11 minutes.

James E. Moore, Jr., Ph.D.

Lohman Professor, Department of Biomedical Engineering, Texas A&M University

Dr. Moore received his Bachelor of Mechanical Engineering in 1987, his Master of Science in mechanical engineering in 1988 and his Ph.D. in 1991, all from Georgia Institute of Technology. He had postdoctoral training at the Swiss Institute of Technology at Lausanne from 1991 to 1994. From 1994 to 2003 Dr. Moore served as a professor of mechanical and biomedical engineering at Florida International University. He joined Texas A&M in July 2003.

Dr. Moore's specialty is cardiovascular biomechanics, implantable devices and the lymphatic system. His research is concerned with the role of biomechanics (flow patterns and wall stresses) in the formation and treatment of diseases in arterial, venous and lymphatic vessels. He has more than 60 publications in scholarly journals. Along with his funding from the National Institutes of Health and the National Science Foundation, Dr. Moore has received five patents and co-founded two startup companies. He has established new courses in biofluid mechanics and entrepreneurial issues for biomedical engineers at Texas A&M.

Carlos Montalvo

Innovation Academy of Engineering, Environmental, and Marine Science at Foy H. Moody High School

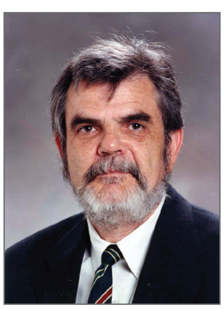
Carlos Montalvo is the science department chair; teaches chemistry and biotechnical engineering; and is one of the robotics coaches for the Innovation Academy of Engineering, Environmental, and Marine Science at Foy H. Moody High School in Corpus Christi, Texas. He is a past participant in Texas A&M University's Enrichment Experiences in Engineering (E3) Program. Carlos earned his B.S. degree in chemistry from Florida State University in 2005 and is in his sixth year teaching at Moody High School.

Dr. Joseph A. Morgan

Professor, Electronics and Telecommunications Program, Department of Engineering Technology and Industrial Distribution, Texas A&M University

Dr. Joseph A. Morgan is a full professor in the Electronics and Telecommunications Program at Texas A&M University. He is a registered professional engineer in the state of Texas. His major areas of interest include wireless networking and embedded microcontroller-based data acquisition, instrumentation and control systems. Dr. Morgan has also served as director of engineering and as a senior consultant to the private sector where he has been involved in several design, development and system integration projects sponsored by the Federal Aviation Administration, U.S. Air Force, and major airport authorities. As a Texas A&M faculty member, he established the Mobile Integrated Solutions Laboratory, a joint university-industry partnership focusing on the design and development of hardware and software products.

Dr. Morgan served 22 years in the Air Force, including a tour of duty on faculty with the electrical engineering department at the U.S. Air Force Academy.



Dr. H. Joseph Newton

Dean, College of Science, Texas A&M University

Dr. H. Joseph Newton, who joined the Texas A&M faculty in 1978, has served as dean of the College of Science and holder of the Richard H. Harrison III/External Advisory and Development Council Endowed Dean's Chair in Science since July 2002. Prior to that appointment, he spent two years as interim dean, two years as executive associate dean, and eight years as head of the Department of Statistics. A native of Syracuse, N.Y., Newton holds a doctorate in statistical sciences and a master of arts in statistics from the State University of New York in Buffalo. He earned his bachelor of science in mathematics from Niagara University. He is the author of numerous research articles and two books in the areas of time series analysis, computational statistics, and technology-mediated instruction. Elected a Fellow of the American Statistical Association in 1995, he currently serves as American co-editor of *Computational Statistics* and as editor of *The Stata Journal*.

Sandra Nite

Senior Lecturer, Department of Mathematics, Texas A&M University

Sandra Nite is a senior lecturer in the Department of Mathematics, director of AP Summer Institutes in Mathematics, and associate director for the Center for Technology Mediated Learning in Mathematics. Sandra has taught high school mathematics and science, community college mathematics and music, and university mathematics for the past 33 years, and has been involved in curriculum development and providing professional development for teachers for 15 years. She also serves as an associate editor for a K-12 newsletter for mathematics teachers published online through the mathematics department. She has co-authored a high school mathematical modeling textbook and is currently working with the publisher to develop teacher materials.

Dr. Jay R. Porter

Professor and Director, Electronics and Telecommunications Program, Department of Engineering Technology and Industrial Distribution, Texas A&M University

Dr. Jay R. Porter received his B.S. in electrical engineering in 1987, his M.S. in physics in 1989, and his Ph.D. in electrical engineering in 1993, all from Texas A&M University. He has been on faculty at Texas A&M since 1998 and is responsible for teaching courses in analog circuits and electronics, instrumentation, and applied electromagnetics.

Dr. Porter is currently a professor and the director of the Electronics and Telecommunications Engineering Technology Program. Dr. Porter's research expertise includes the design of application-specific instrumentation solutions in the areas of medical imaging, software defined radio, and device/system testing. Dr. Porter has been working in the area of virtual instrumentation since 1995 and has developed an ongoing collaboration with National Instruments, an industry leader in the development of hardware and software for virtual instrumentation.

Timothy P. Scott

Associate Dean for Undergraduate Programs, College of Science, Texas A&M University

Dr. Timothy P. Scott is associate dean for undergraduate programs in the College of Science at Texas A&M University, where he also is an associate professor of science education policy. Dr. Scott performs research on teaching and learning in science and student success. He also serves as co-director of the Center for Mathematics and Science Education at Texas A&M.

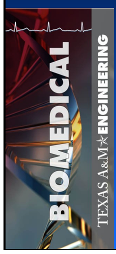
Dr. Scott's work focuses on national and state science standards and policy as it relates to teacher certification. In 2001, he founded the university's aggieTEACH program, which was developed to address the shortage of teachers in the high need areas of mathematics and science. In addition to aggieTEACH, Dr. Scott overseas a number of projects in the center and serves as principal investigator on two NSF-funded projects, the Science Scholars Program and the Texas A&M Robert Noyce Scholarship Program. The projects Dr. Scott has acquired and collaborated on over the past 10 years total $25 million.

Jennifer G. Whitfield

Senior Lecturer, Department of Mathematics, Texas A&M University

Jennifer G. Whitfield is currently a senior lecturer in the Department of Mathematics, the program manager for the Texas A&M University Center for Math and Science Education's aggieTEACH program, the co-director of online homework systems for the Department of Mathematics, and co-director for the Department of Mathematics Personalized Precalculus Program. She has 18 years experience teaching mathematics spanning from 7th grade to university level, has seven years experience delivering professional development to in-service teachers, and has just begun the adventure of working with pre-service teachers. Over the last decade, she has worked on numerous projects that use technology to improve mathematics education and help better prepare students for college. Her latest project is the opening of a STEM Teacher Preparation Academy that aims to improve the quality of Texas A&M secondary STEM pre-service teachers.

The Role of Cardiovascular Biomechanics in Causing and Preventing Heart Attacks



James E. Moore Jr., Ph.D.
Carolyn S. and Tommie
E. Lohman '59 Professor
Department of Biomedical Engineering
jmoorejr@tamu.edu

Texas A&M University

Emerging Technologies Building

For interdisciplinary engineering education, research and service

- $124 million project, opened 2011
- State-of-the art classrooms
- Lecture Halls, study areas
- Wet bench labs
- Large-scale visualization room
- LEED* Silver Sustainable Building

* Leadership in Energy and Environmental Design

Biomedical Engineering Research Areas

- Vascular Biomechanics
- Cardiac, Vascular, and Cellular Mechanics
- Cell Mechanobiology
- Molecular Dynamics
- Nanosensors
- Optical Biosensing
- Tissue Microscopy
- Biomaterials
- Computational Mechanics

BIOMEDICAL ENGINEERING
TEXAS A&M UNIVERSITY

Accredited BS program since 1977
Graduate Degrees: MS, ME, PhD
Student Populations: 400 undergraduates (50% female)
90 graduate students (30% female)
20 faculty
Ranked 18th in USA
$5M in research expenditures last year

biomed.tamu.edu

Introduction: Cardiovascular Diseases – Mortality

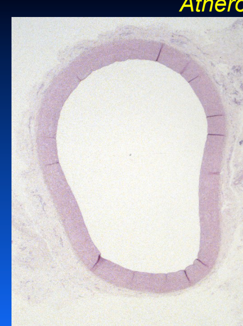
Deaths: 910,614/year

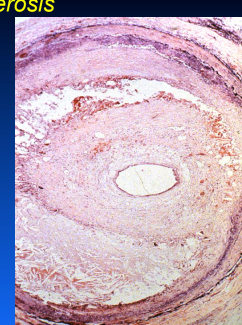
- Since 1900, CVD No. 1 killer
- 2,600 American deaths per day (2/minute or 108/hr)
- CVD claims more lives than the next 7 leading causes of death in the US.
- Males: 426,000+
- Females: 483,000+
- Cost $403.1 billion

AHA Fact Sheet 2007 (www.americanheart.org)

Peripheral Vascular Diseases

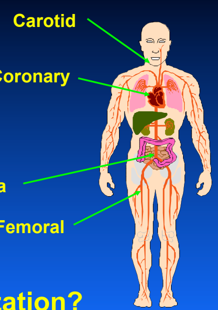
Atherosclerosis





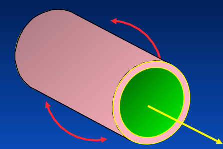
Atherosclerosis

- Highly localized
- Traditional risk factors are diffuse



Are mechanical factors responsible for this localization?

Arterial Mechanics: Fluids and Solids



Fluid shear stress from flow of blood

Tensile hoop (circumferential) stress due to pressurization

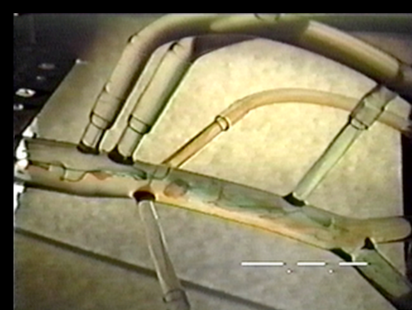
Atherosclerosis development is affected by both

In motu igitur sanguinis explicando easdem offendimus insuperabiles dfficultates, quae nos impediunt omnia plane opera Creatoris accuratius perscrutari; ubi perpetuo multo magis summam sapeintiam cum omnipotentia coniunctam admirari ac venerari debemus, cum ne summum quidem ingeniun humanum vel levissimae vibrillae veram structuram percipere atque explicare valeat.

Leonhard Euler, 1775

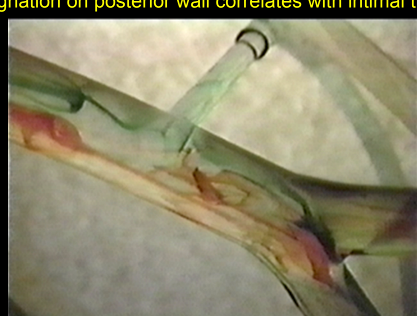
Loosely translated:
If God wanted us to understand flow in the arteries, He would not have made the equations so difficult.

Flow visualization in the abdominal aorta: resting conditions



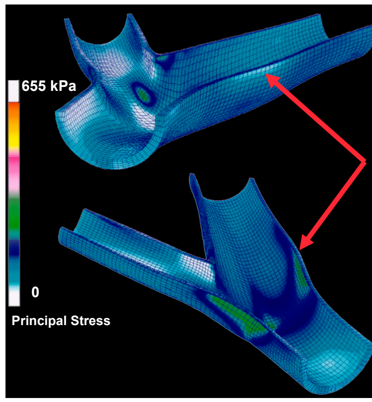
Moore, Ku, Zarins, Glagov. J Biomech Eng 114, 1992

Flow stagnation on posterior wall correlates with intimal thickening



Moore, Ku, Zarins, Glagov. J Biomech Eng 114, 1992

Artery Wall Stress



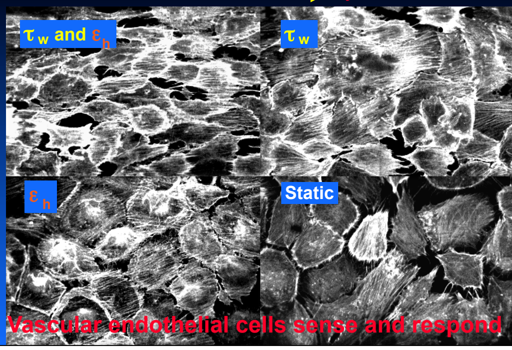
Internal carotid inner wall stress concentration correlates with disease development

Mechanobiology

FLOW

Wall shear stress = 8 ± 4 dynes/cm^2

Cyclic stretch = 10 %



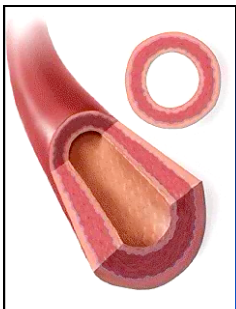
Two methods for treating atherosclerosis

By-pass grafting

Angioplasty & Stents

Similar mode of failure: Restenosis

What is role of biomechanics in restenosis?



Current stent market:

Approx. $5B per year

Angioplasty/Stents are minimally invasive treatment for obstructive atherosclerotic lesions

Two basic designs:

- Balloon expanded
- Self-expanding

Restenosis 20%-30%, depending on design

Bare metal stent design affects restenosis rate

Stent	Restenosis
Guidant Multi-Link	20.0%
Jomed Jostent	25.8%
J&J Palmaz-Schatz	29.0%
PURA-A	30.9%
Inflow Steel	37.3%
NIR	37.8%
Inflow gold	50.3%

All are balloon-expanded stainless steel

From Kastrati et al., 2001

Why?

Clinical studies provide no specific design criteria

Differences may be related to stent-design related changes in flow/stress

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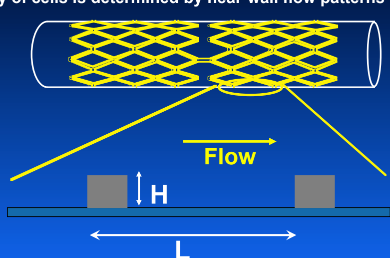
First reactions to stent: Thrombus Formation and Inflammation

Delivery of cells is determined by near-wall flow patterns

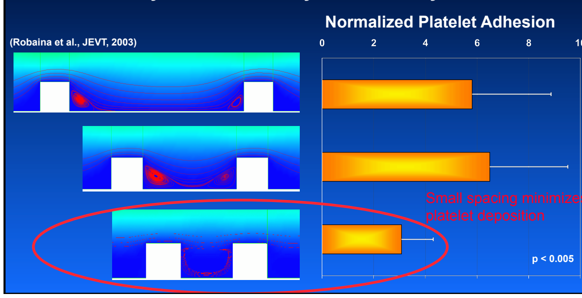


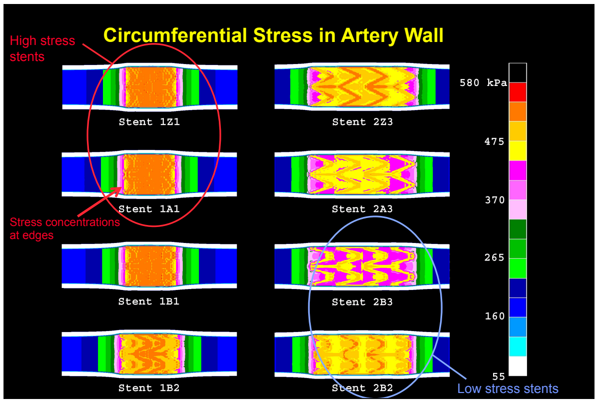
Ratio of L/H varies among designs

Deposition of Platelets on Stents Depends on Stent Design

Delivery of inflammatory cells is likely similar

(Robaina et al., JEVT, 2003)





Conclusions

Atherosclerosis is a serious health problem

Biomechanics plays a role in atherogenesis

Both fluid and solid mechanics

Also important for disease treatment

We should optimize post-implant biomechanics

Have to understand pathogenesis as well as reactions to implants

Student Skill Sets

Biology

Physiology

Chemistry

Physics (electrical, mechanical)

Calculus

Statistics

Computers

"Other"

Communication (written and oral)

Read and absorb

Learn MD language

Creativity

Problem Solving

Cooking

Exercise conditions eliminate atherogenic flow patterns

Lesson for the day: Get some exercise and avoid the stent!

Acknowledgments

Texas A&M
Julian Bedoya
Fred Clubb
Stephen Darrouzet
Danika Hayman
Brandis Kellar
Clark Meyer
Matt Miller
Michael Moreno
Jessica Thibodeaux
Lucas Timmins

Other places
J. Berry
A. Burki
A. Delfino
N. Duraiswamy
S. Glagov
D. Ku
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Funding: NIH, NSF, RSNA

Teacher Summit 2012

KRISYS
Unmanned Systems

STEM
Teachers Summit

PRODUCTS ATM SYSTEMS

Electronics & Telecom

n Look College of Engineering

on learning and applied research

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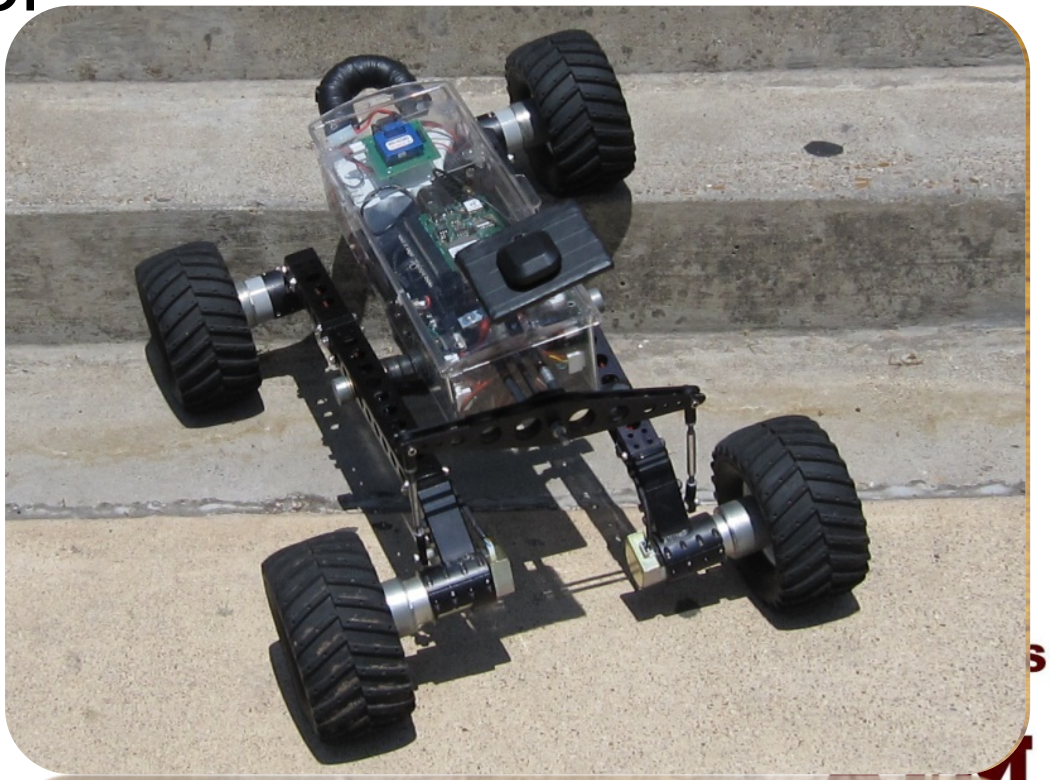
– Develop tools for

– Identify and prom

PRODUCTS SYSTEMS

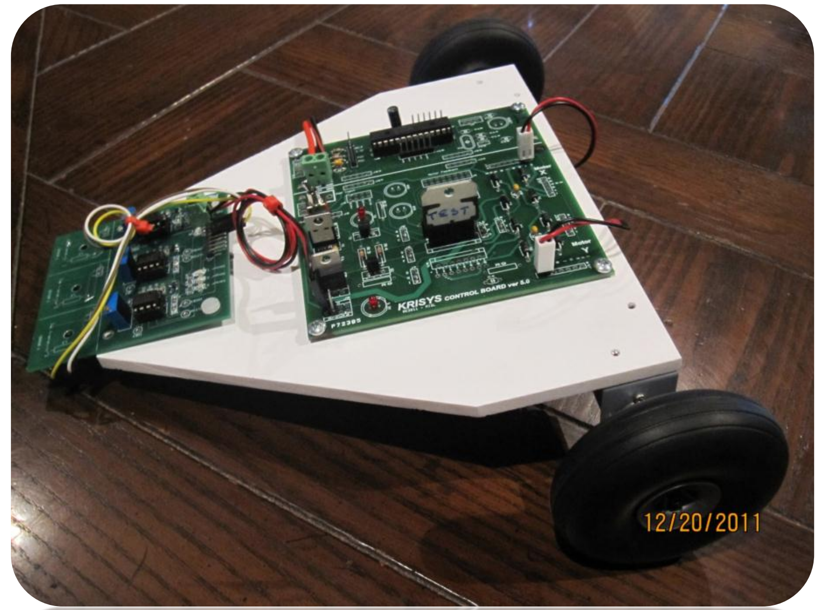
EET Use of Robotics

- Digital Design
- Embedded Control
- Communications
- Capstone



Outreach Objectives

- STEM focus on robotics
- Small teams
- Short time periods
- Mechanical fabrication
- Electronics
- Embedded intelligence
- Sensing and control
- Software development
- Technical communications
- Positive reinforcement through competition



Krisys Requirements

- Low-cost
- Light weight
- Easy construction
- Rugged
- Transportable
- Maneuverable
- Expandable
- Multi-mode operation

PRODUCTS ATM SYSTEMS

PRODUCTS ★ SYSTEMS

TEAM GOAL

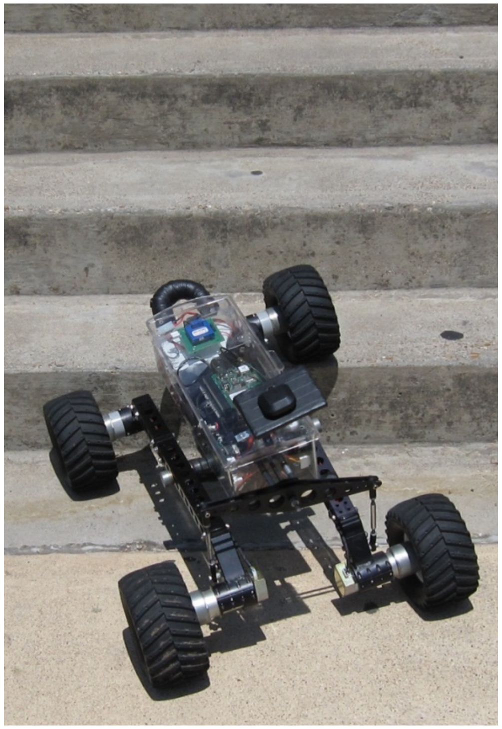
LET'S GET STARTED !!

PRODUCTS ATM SYSTEMS

PRODUCTS SYSTEMS

Seminar Overview

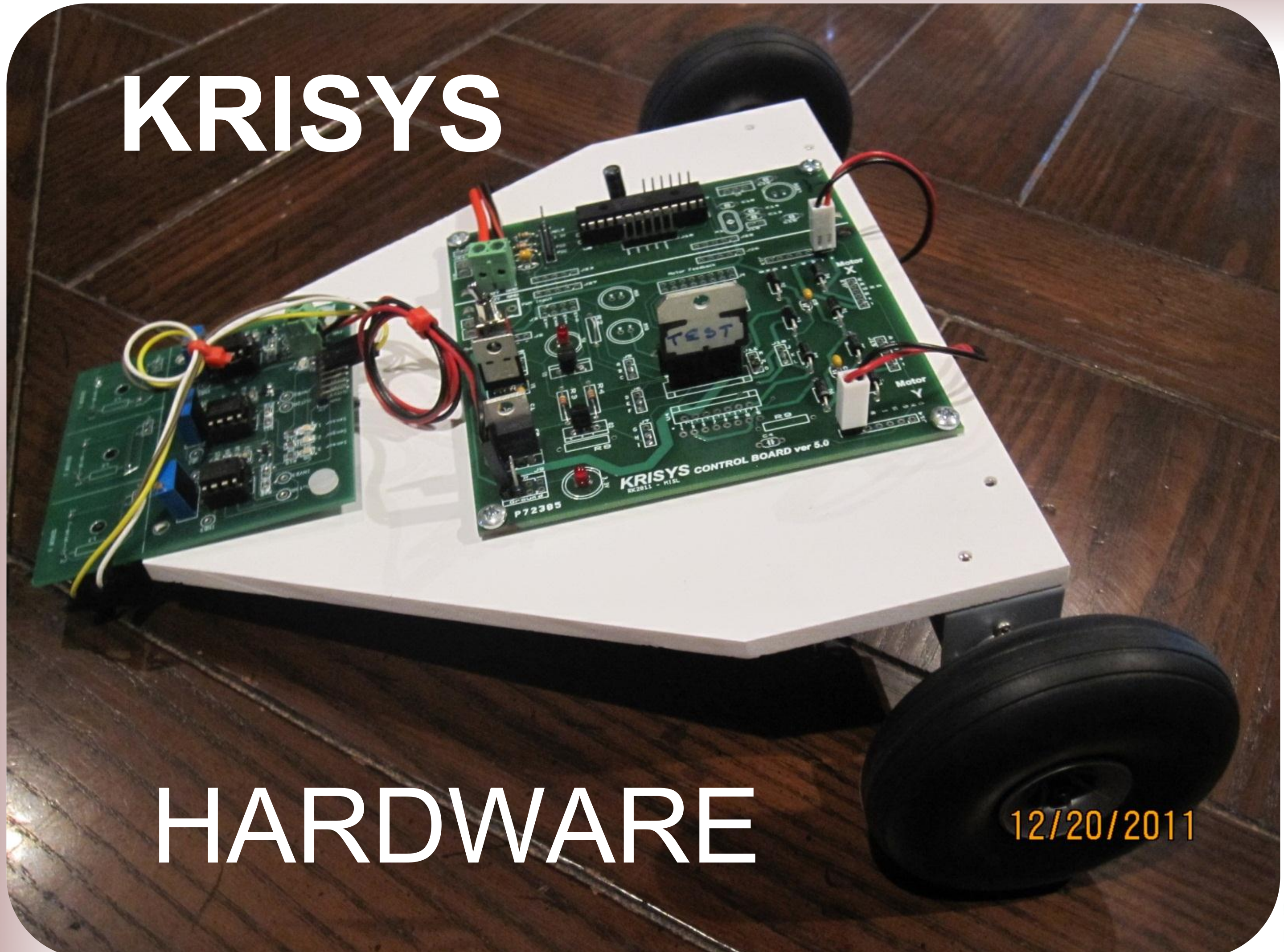
- Hour 1 – Learning
  - Hardware
    - Mechanical
    - Electronics
  - Software
    - Sensing
    - Control
- Hour 2 – Doing
  - Build robot
  - Develop control algorithm
  - Generate software
- Hour 3 – Integration
  - Testing / Optimizing
  - Feedback – survey
- Hour 4 – Krisys Race of Champions
  - Drag Race, Road Race
  - 2012 STEM Teacher Summit Bragging Rights



PRODUCTS ATM SYSTEMS

PRODUCTS ★ SYSTEMS

KRISYS



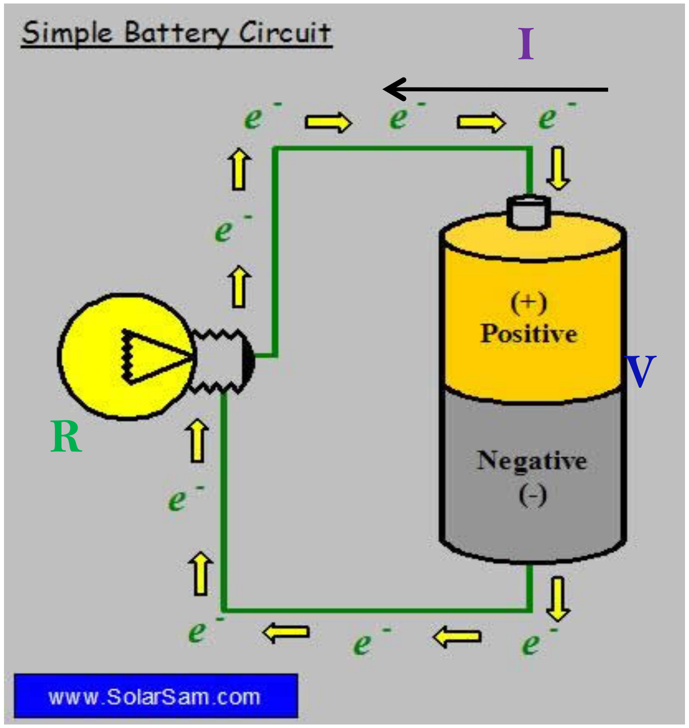
HARDWARE

Hardware

- Mechanical
  - 1 Base – 8”x8”x1/4”
  - 2 DC motors with brackets
  - 2 Wheel hubs
  - 2 Rubber wheels – ¾” width x 3” diameter
  - 1 Ball bearing third wheel
- Power
  - Lithium-Ion battery
  - 7.4V
  - 2200 mAH

Ohm's Law

- Voltage → Pressure
- Current → Flow
- Resistance → Opposition



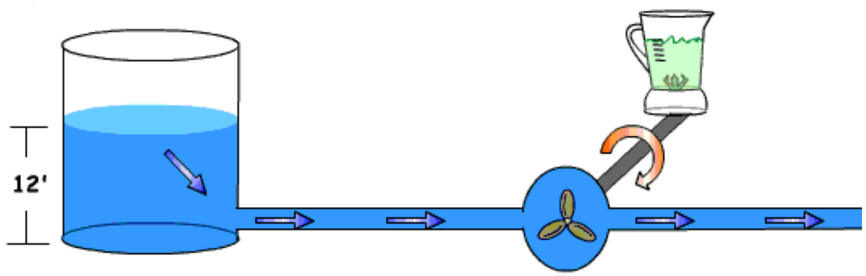
$$V_{(\text{volts})} = I_{(\text{Amps})} \times R_{(\text{Ohms})}$$

Or

$$I = V/R$$

Battery Capacity

- How long will a battery last?



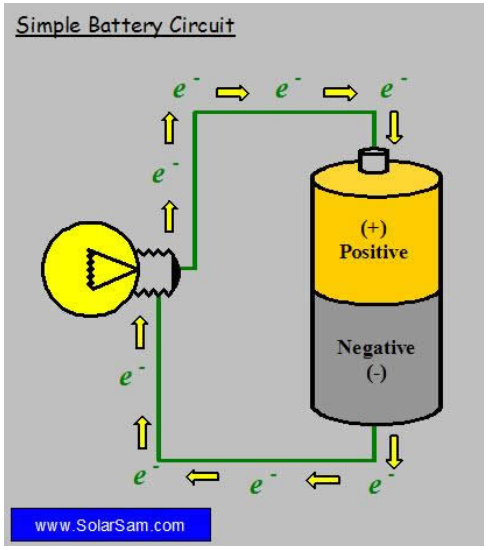
Battery Capacity is measured in Amp-hours

Capacity = Current Supplied x Battery Life

Or

Battery Life = Capacity / Current Supplied

Example: AAA battery has a capacity of 0.65 Amp-hours (or 650 mA-Hrs)



Questions

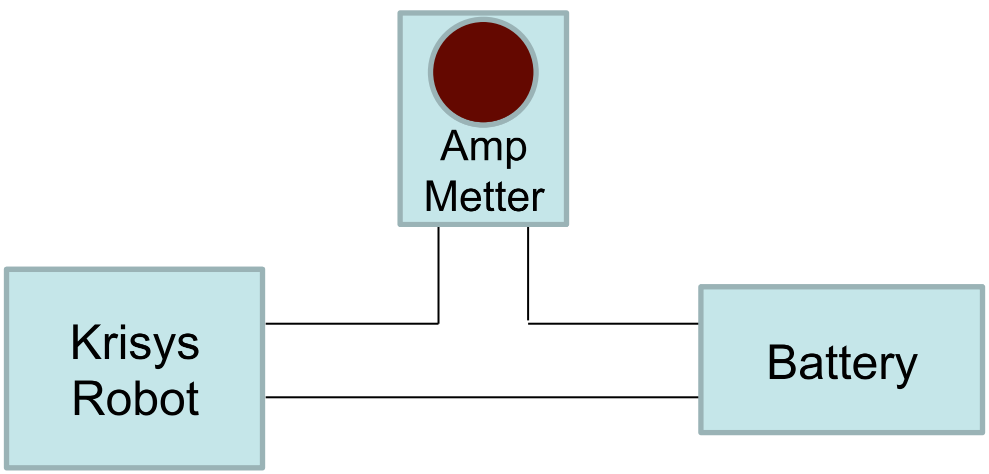
- Empirical data provide the following information for a 7.4 V battery directly connected to two Krisys Robot motors
  - Total resistance is 12 ohms
  - Each motor turns at a rate of 240 Rev/min

- Determine the following
  - Diameter of robot wheel: _______________
  - Speed of robot in MPH: _______________
  - Current draw of robot in mA: _______________
  - Capacity of battery needed for 30 minutes of operation: ____________
  - Distance robot could travel on fully charged battery: ______________

PRODUCTS ★ SYSTEMS

Data Collection/Reduction

- The battery on your platform has a capacity of 2200 mAmp-Hours (mAH).
- Measure the current the platform uses at different speeds by inserting an Amp Meter in series
- Make your measurements for the duty cycles and conditions listed on the table.



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Battery Capacity

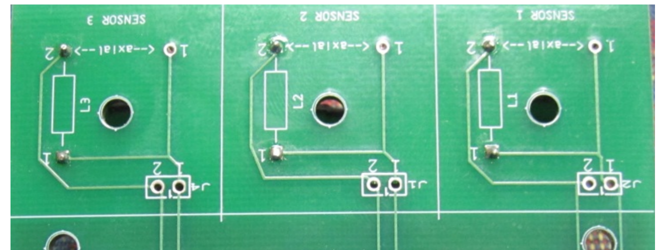
Configuration	Speed MPH	I	Battery Capacity	Time	Dist
60% Duty Cycle					
80% Duty Cycle					
90% Duty Cycle					
100% Duty Cycle					

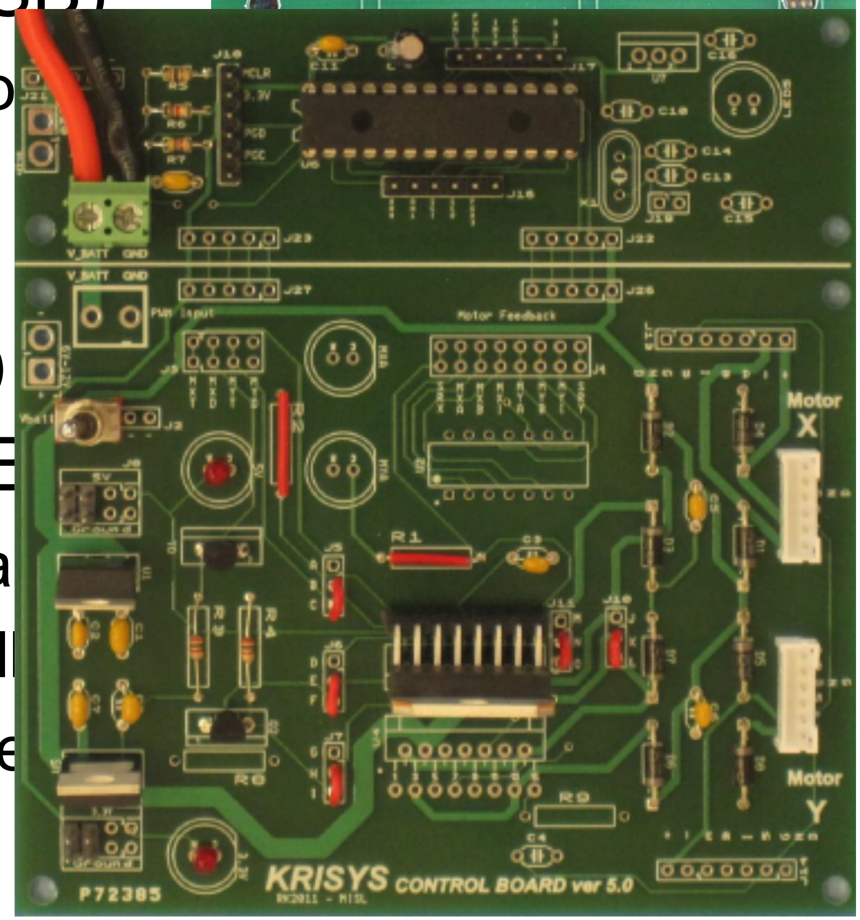
Speed is measured
I is measured
Capacity is given as 2200 mAmp-hours
Time is calculated
Distance is calculated

PRODUCTS ★ SYSTEMS

Hardware

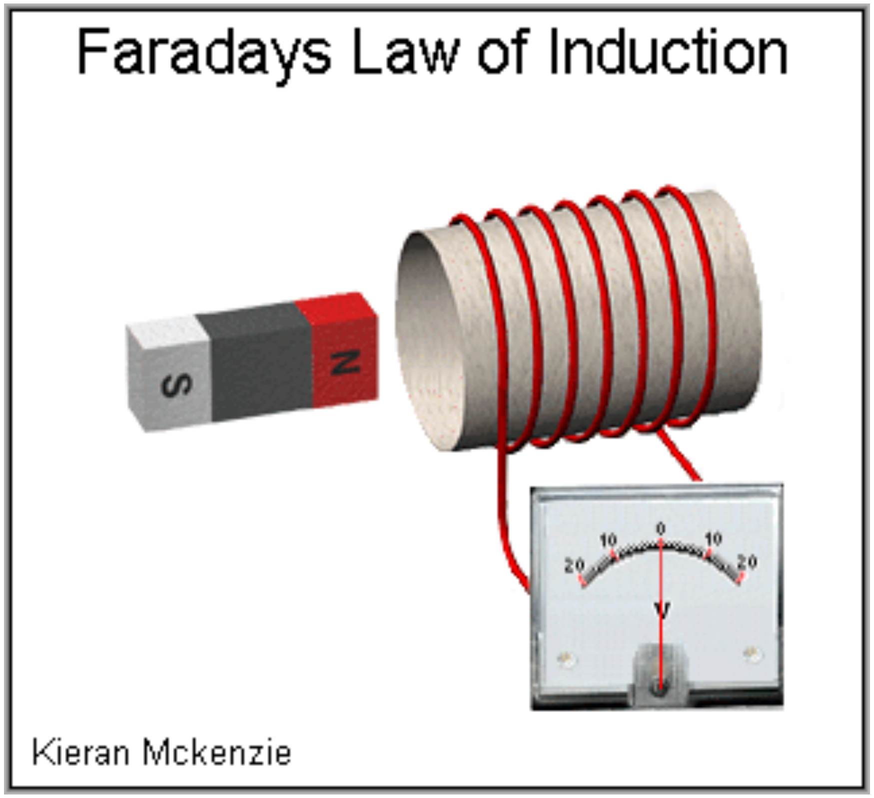
- Electronics
  - Krisys Sensor Board (KSB)
    - Inductive sensors – analo
    - Amplifiers
    - Analog comparators
    - Digital output (active low)
  - Krisys Motor Controller B
    - Voltage regulators 3.3V a
    - dsPIC 33 embedded intell
    - Dual H-Bridge motor drive



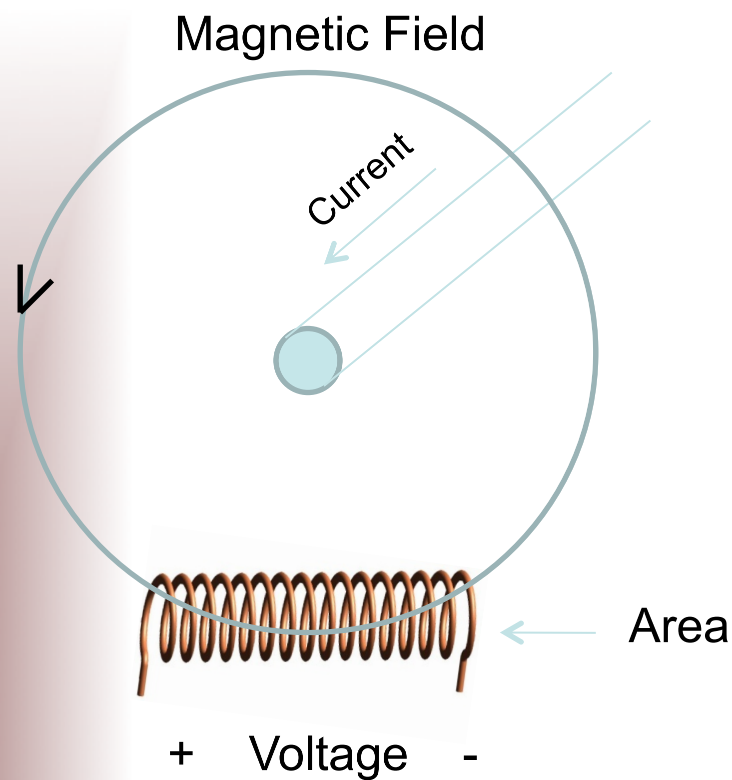


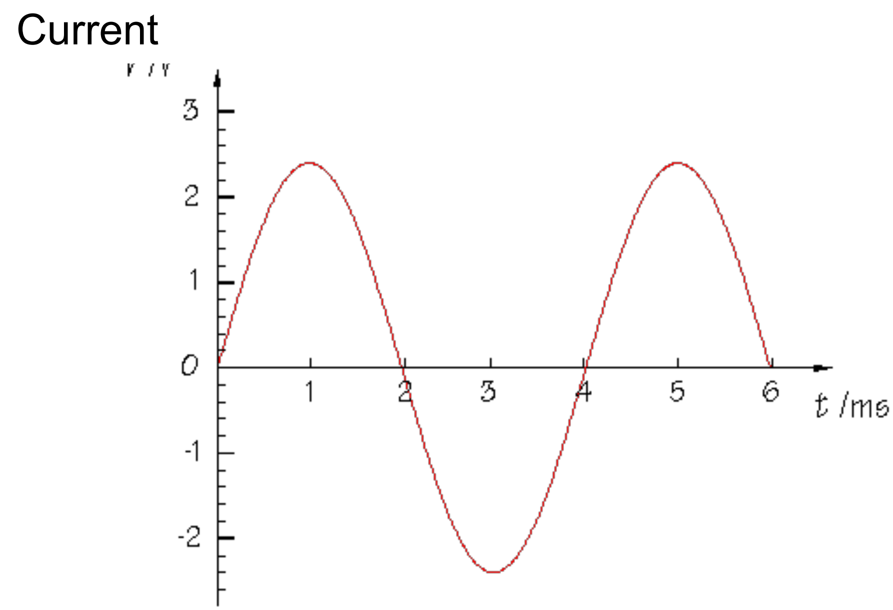
Faraday's Law of Induction

- If a changing magnetic flux flows through a coil of wire, a voltage will be induced in the coil.
- As you pass a bar magnet through a coil, this creates a changing magnetic field.
- How else can we create a changing magnetic field?



Magnetic Sensors





$$Voltage \approx -Turns \quad x \quad Area \quad x \quad \frac{\Delta MagneticField}{\Delta Time}$$

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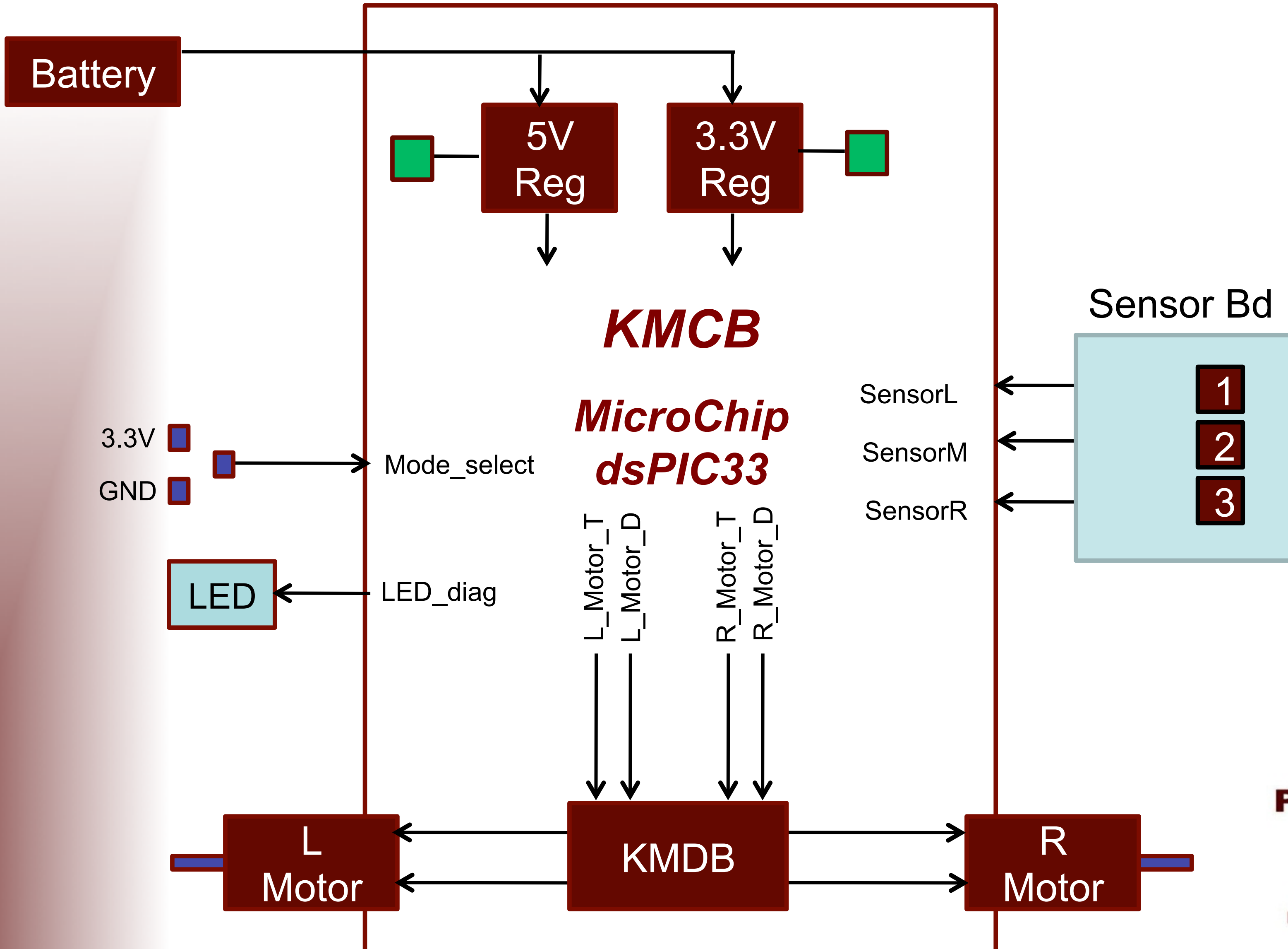
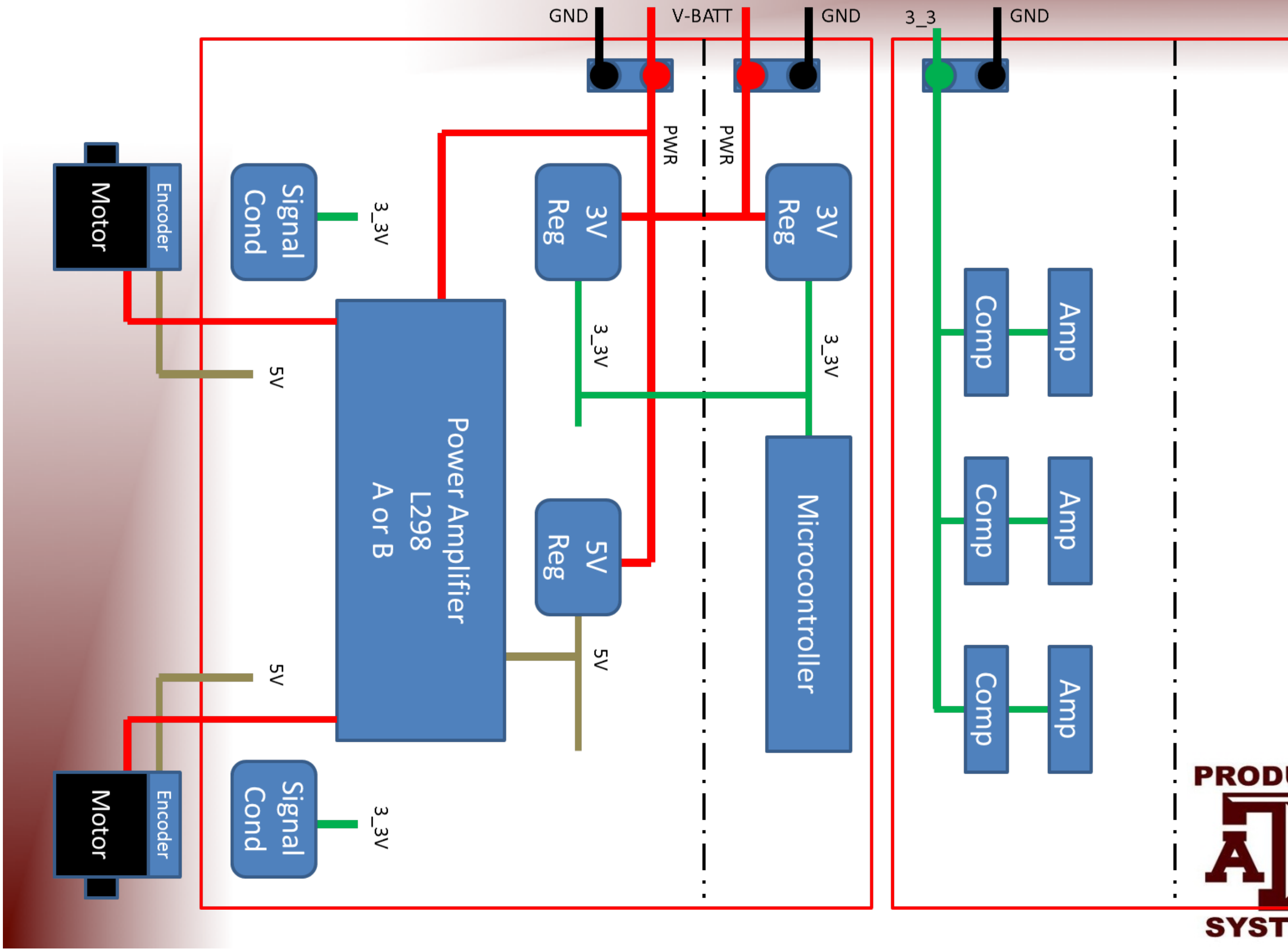
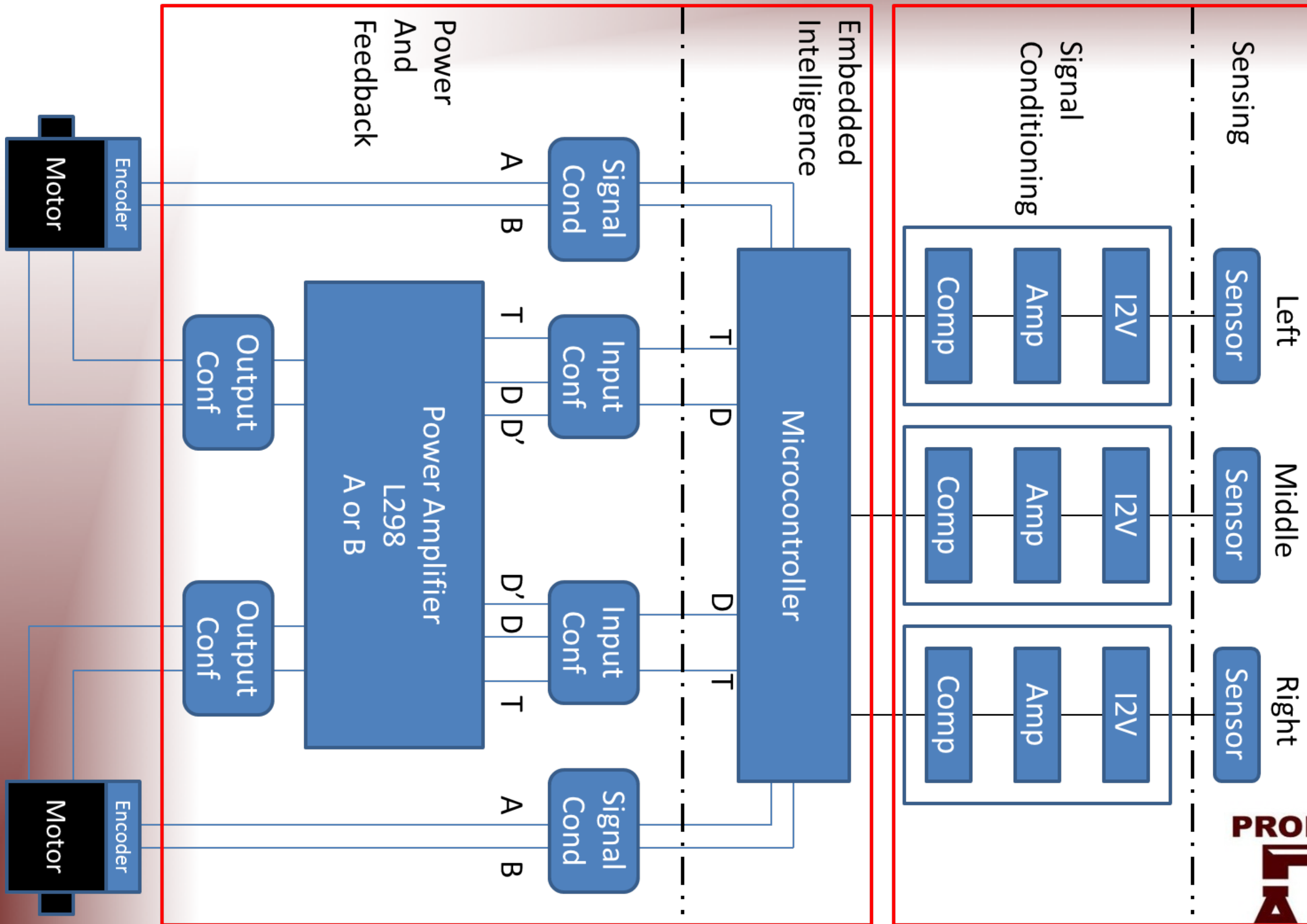
Krisys Functional Block Diagram



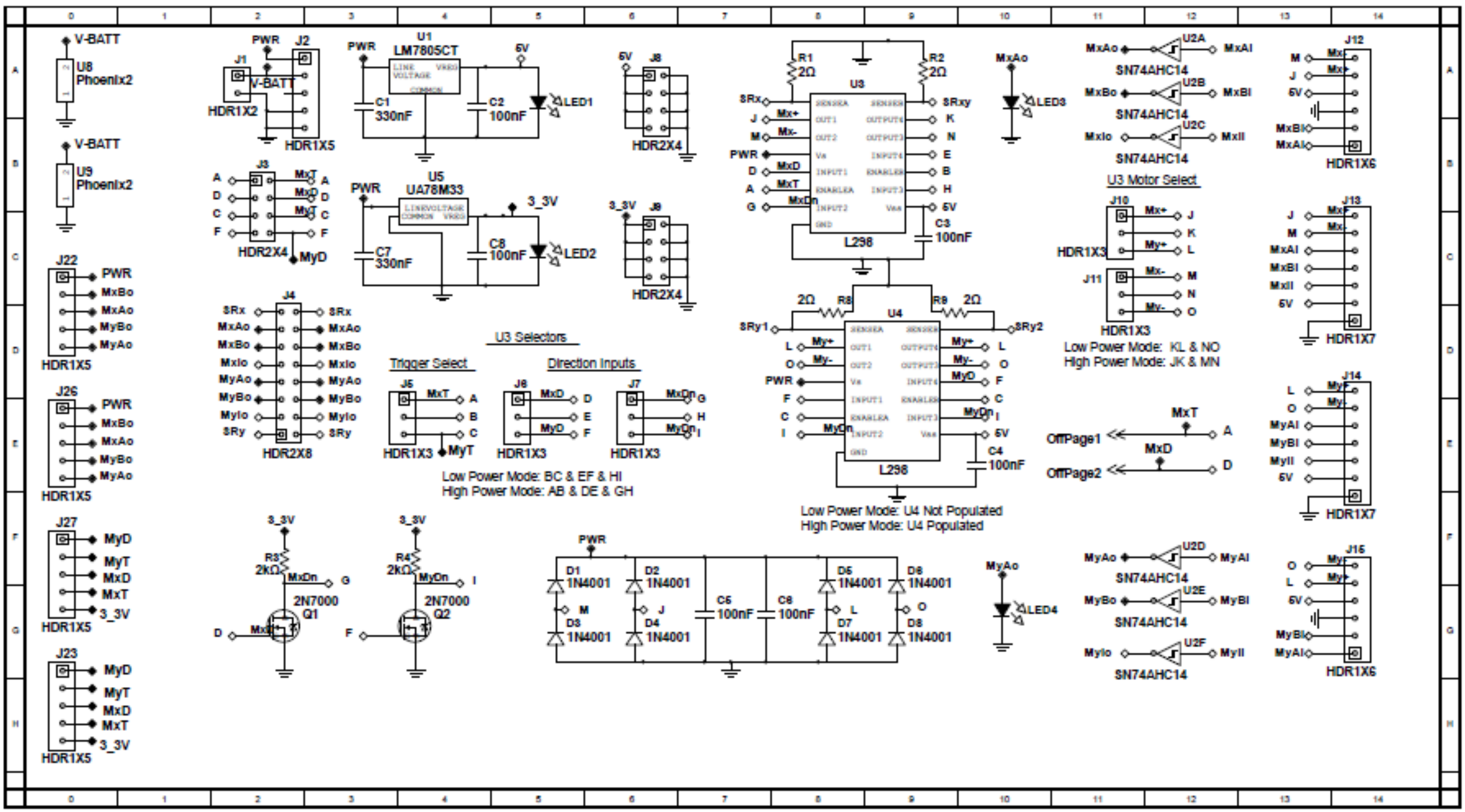
PRODUCTS SYSTEMS




Sensing
Signal Conditioning
Embedded Intelligence
Power And Feedback
Left
Middle
Right
Sensor
12V
Amp
Comp
Microcontroller
T
D
Signal Cond
Input Conf
A
B
T
D D'
Power Amplifier L298 A or B
Output Conf
Encoder
Motor

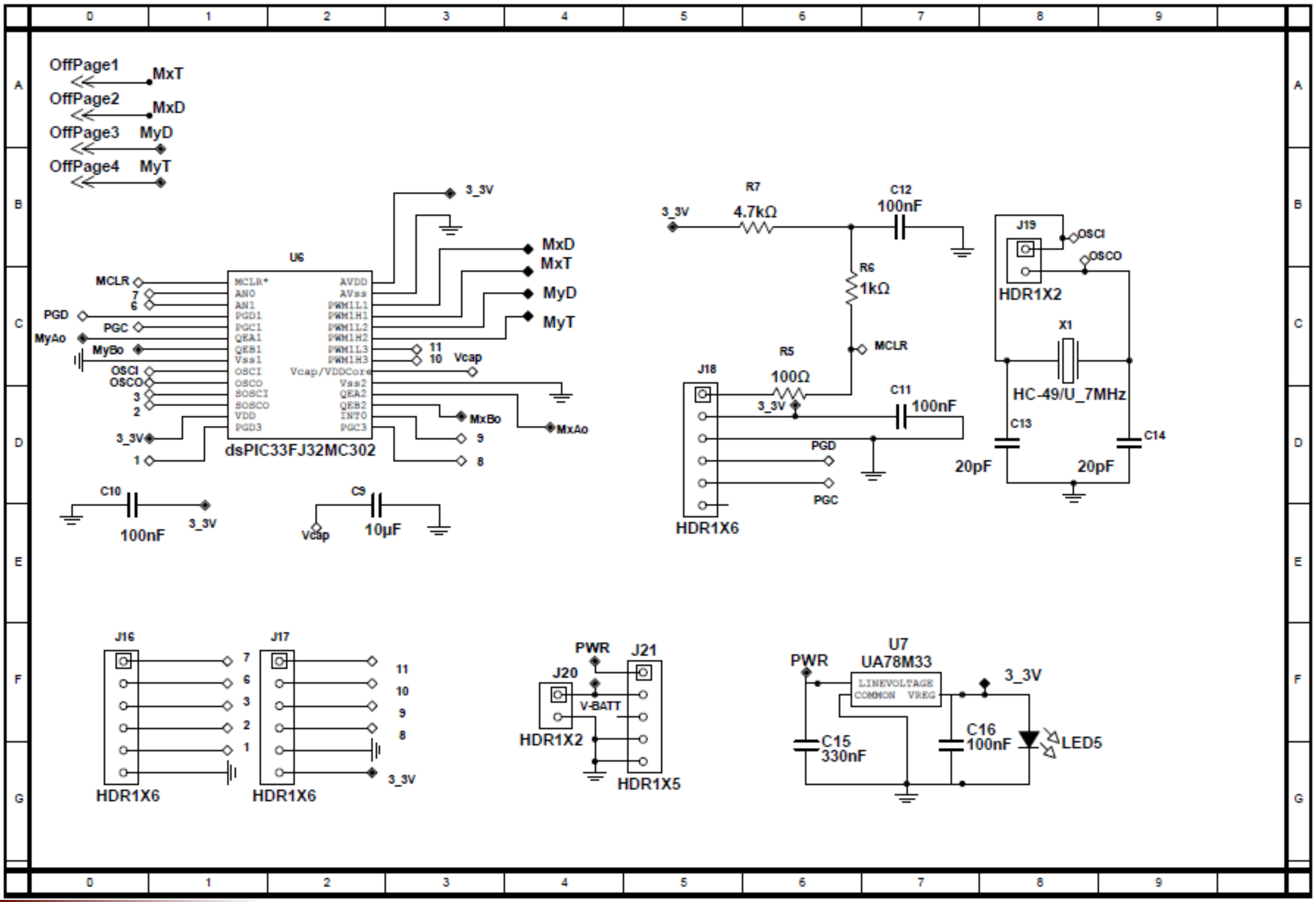
PRODUCTS ★ SYSTEMS

KMCB Schematic



PRODUCTS ★ SYSTEMS

KMCB Schematic



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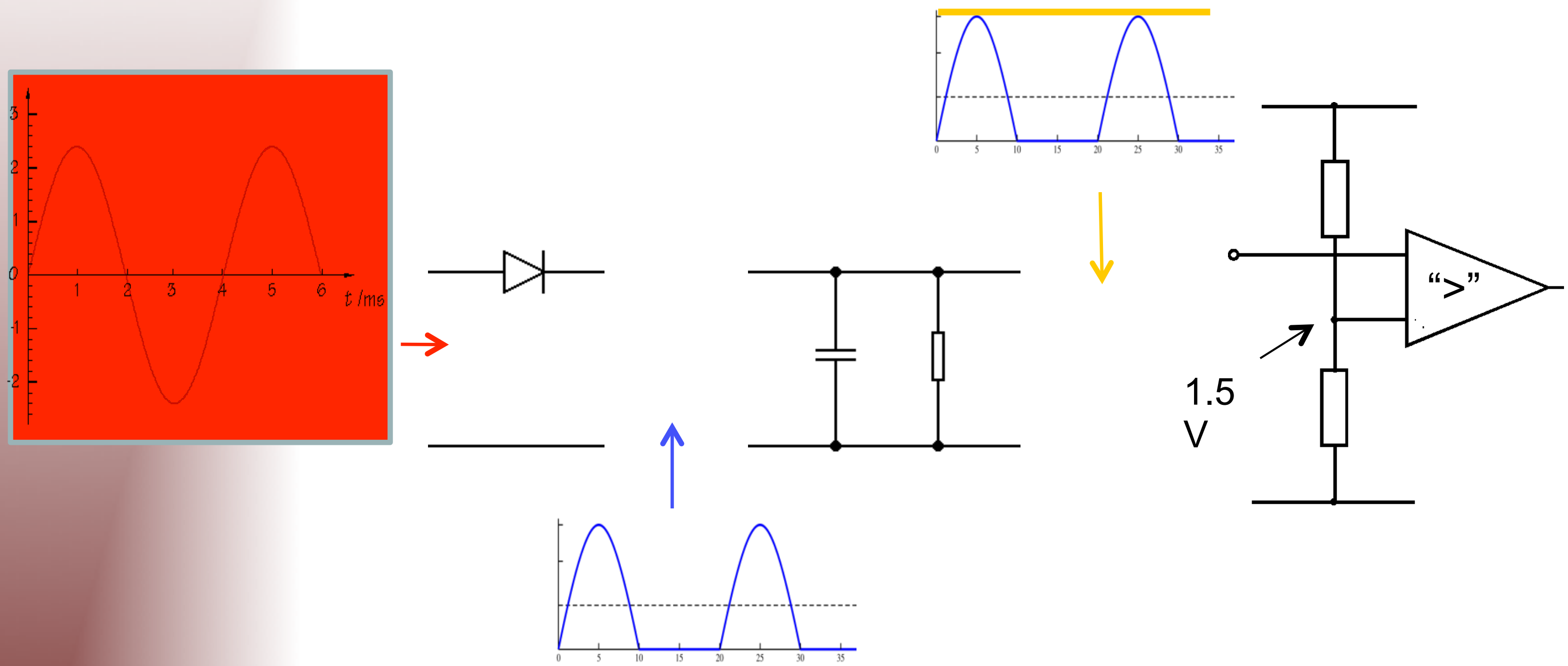
Sensor Circuit

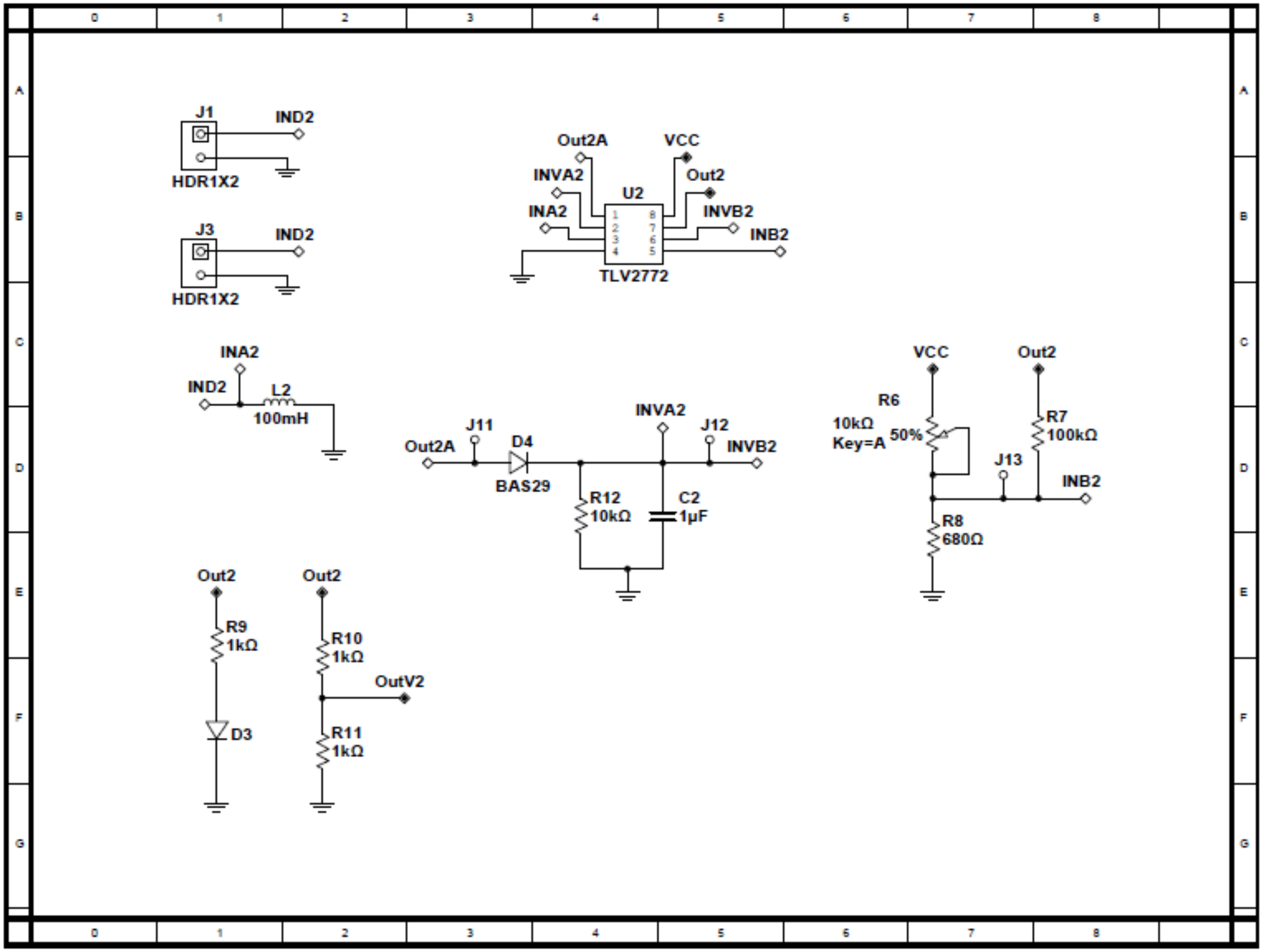


Active Low
Digital Out

0 => signal
1 => no signal

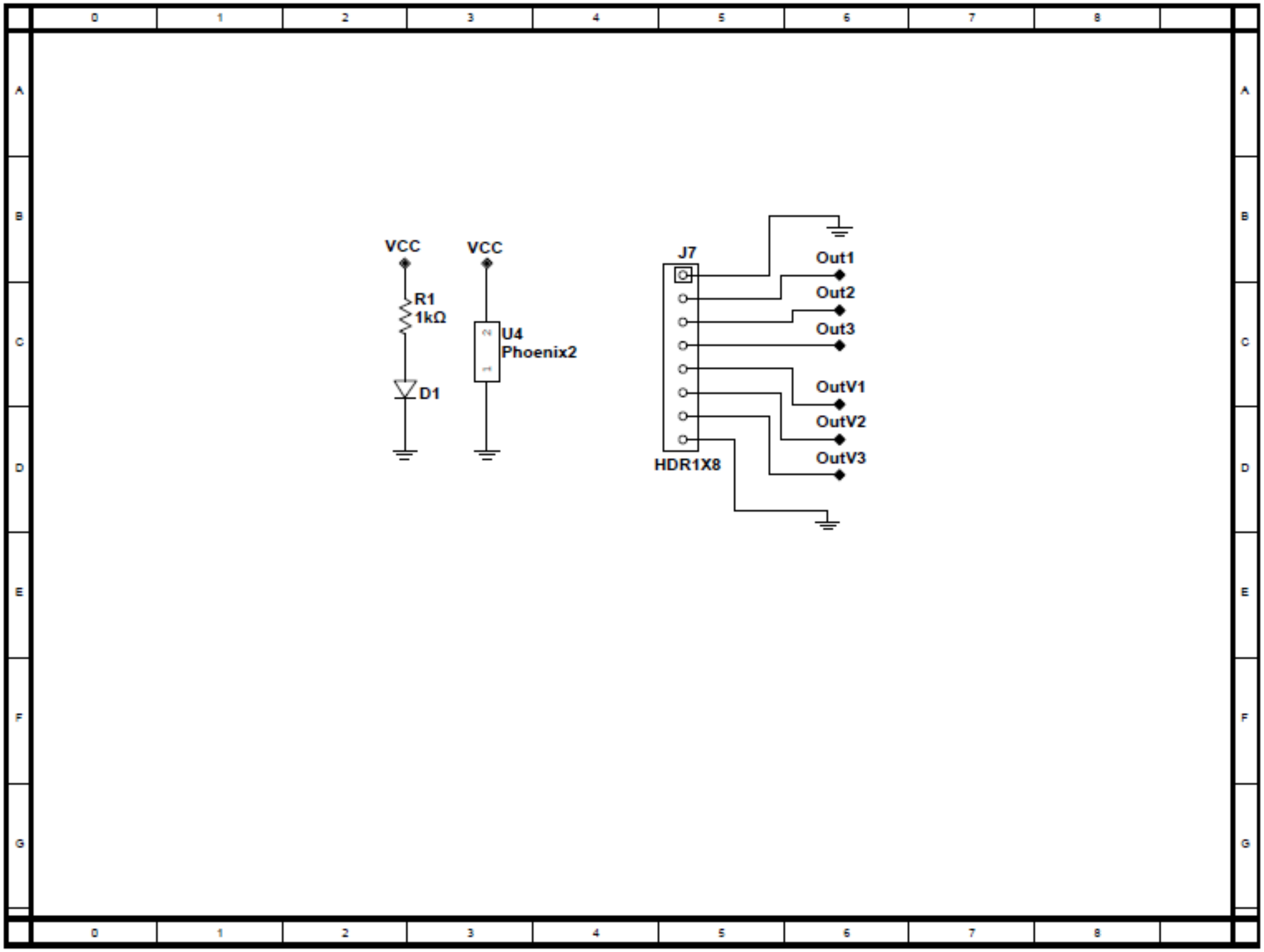
PRODUCTS SYSTEMS

KSB Schematic



PRODUCTS ATM SYSTEMS

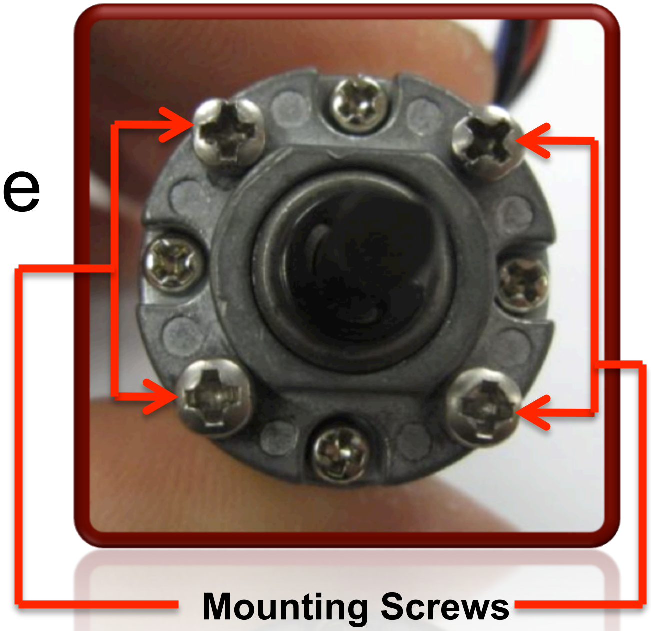
KSB Schematic



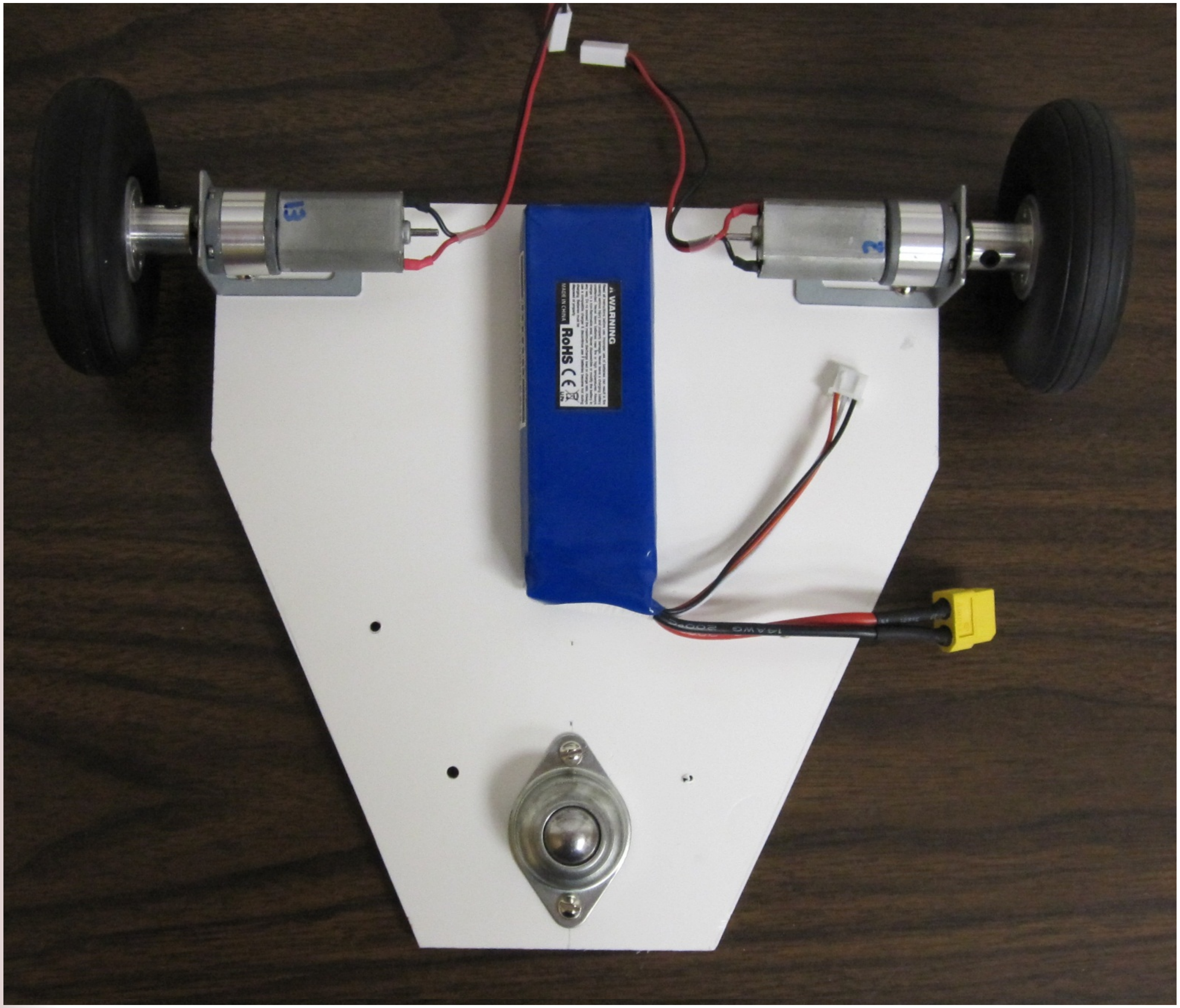
Platform Build

- Mechanical
  - Install ball bearing to base
  - Install motor brackets to base
  - Install motors to brackets
  - Install hubs to wheels
  - Install hubs to motors
- Power
  - Install battery to platform

Figure 3.1



Mechanical

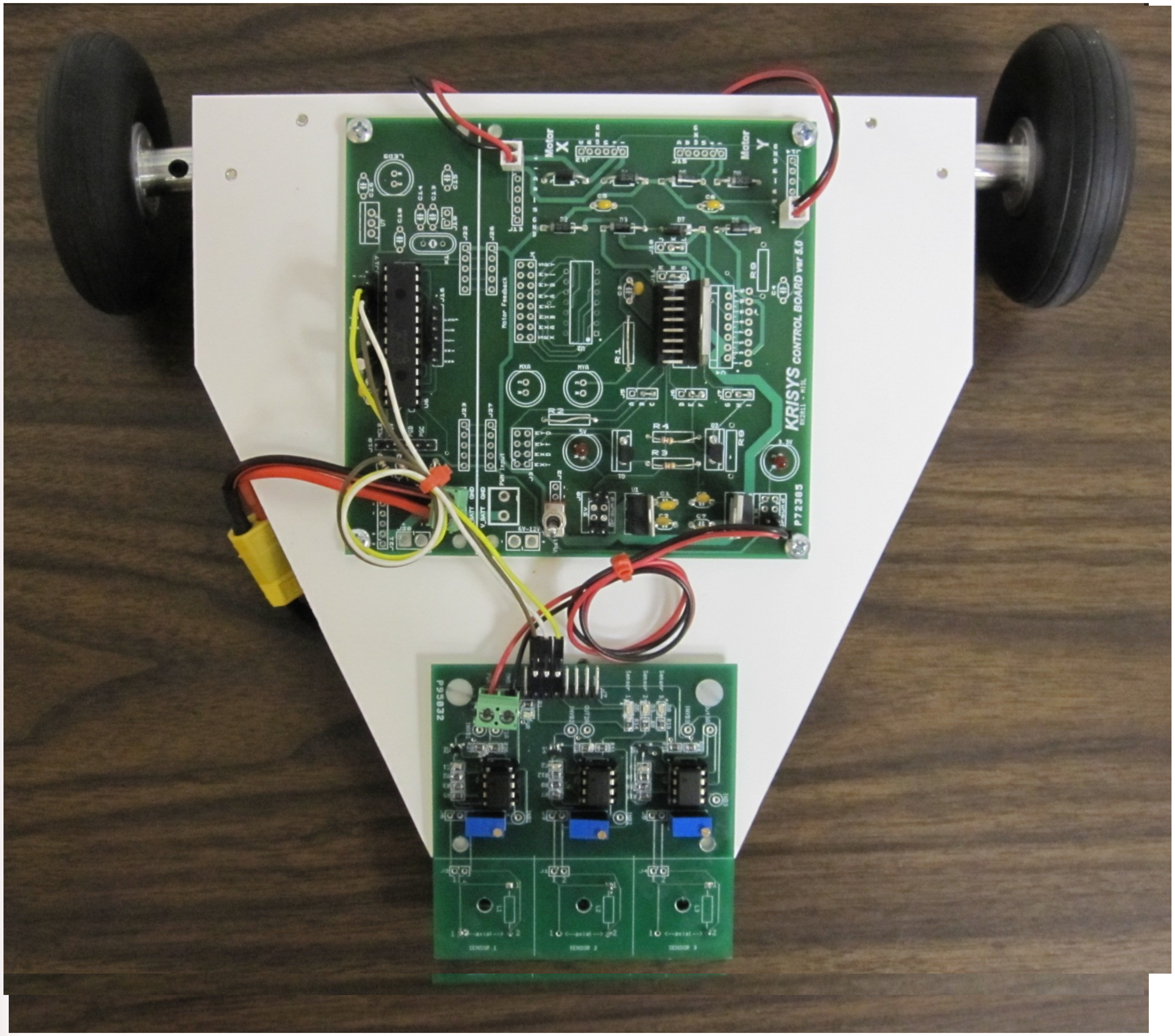


Platform Build

- Electronics
  - Install KMCB to base
  - Install KSB to base
  - Connect KSB to KMCB (3 signal, 2 power)
  - Connect Battery to KMCB
  - Test functionality

- Add personality – Customize !!!

Electronics

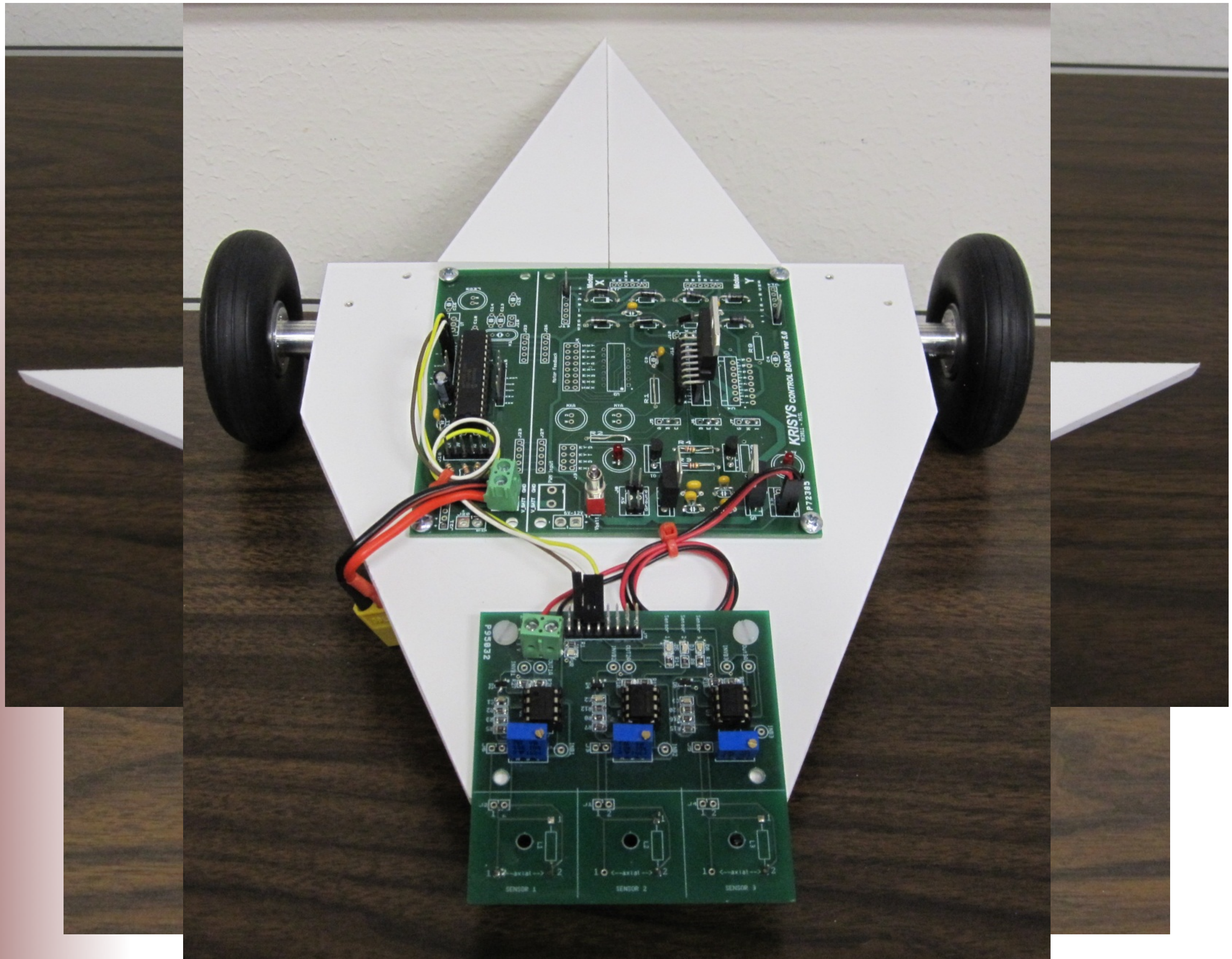


Systematic Testing and Debugging

- Have the devices been properly interfaced?
- Use Mode 0 (Jumper J16-Pin3 to ground)
  - Do you have control of the wheels?
  - Forward, Reverse, L_Turn, R_Turn, Repeat
- Use Mode 1 (Jumper J16-Pin3 to 3.3V)
  - Are you receiving correct information from the sensor board?
  - 101 = Both, 011 = R_Motor, 110 = L_Motor

PRODUCTS ★ SYSTEMS

Customize



PRODUCTS
SYSTEMS

Krisys Robot Quiz

- Wheel diameter measurements (in)
  - 3.12, 2.97, 3.04, 3.13, 3.00, 3.02, 2.98, 2.99, 2.89, 3.03
- Time for 100 revolutions (sec)
  - 14.22, 14.55, 14.32, 14.25, 14.28, 14.30, 14. 51, 14.21, 14.31, 14.30
- Determine:
  - Speed = ____________ MPH
  - Distance traveled (in 10 sec) = _______ Meters
- Answers to two decimal places

Feedback

- Based on robot design and construction
  - Materials
  - PCB fabrication tools
  - Wiki-based instructions / videos
    - krisyswiki.tamu.edu
  - Construction difficulty
  - Time required

Questions / Applications

- Science
- Technology
- Engineering
- Math

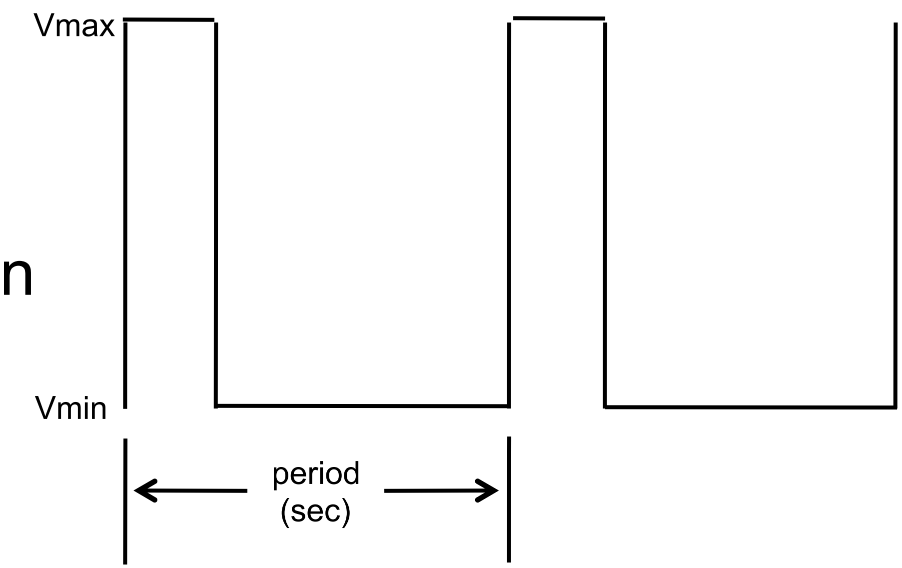
PRODUCTS ★ SYSTEMS

Software

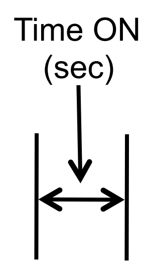
- Speed control - PWM
- Control algorithm
- State machine
- Program structure
- Code development
- Testing
- Optimization

Attributes of Digital Signal

- Amplitude (Voltage)
  - Vmin, Vmax
  - Amplitude (A) = Vmax – Vmin
- Period (seconds)
  - Time to repeat
- Frequency (Hertz)
  - 1/period
- Duty Cycle (percentage)
  - Time ON / period



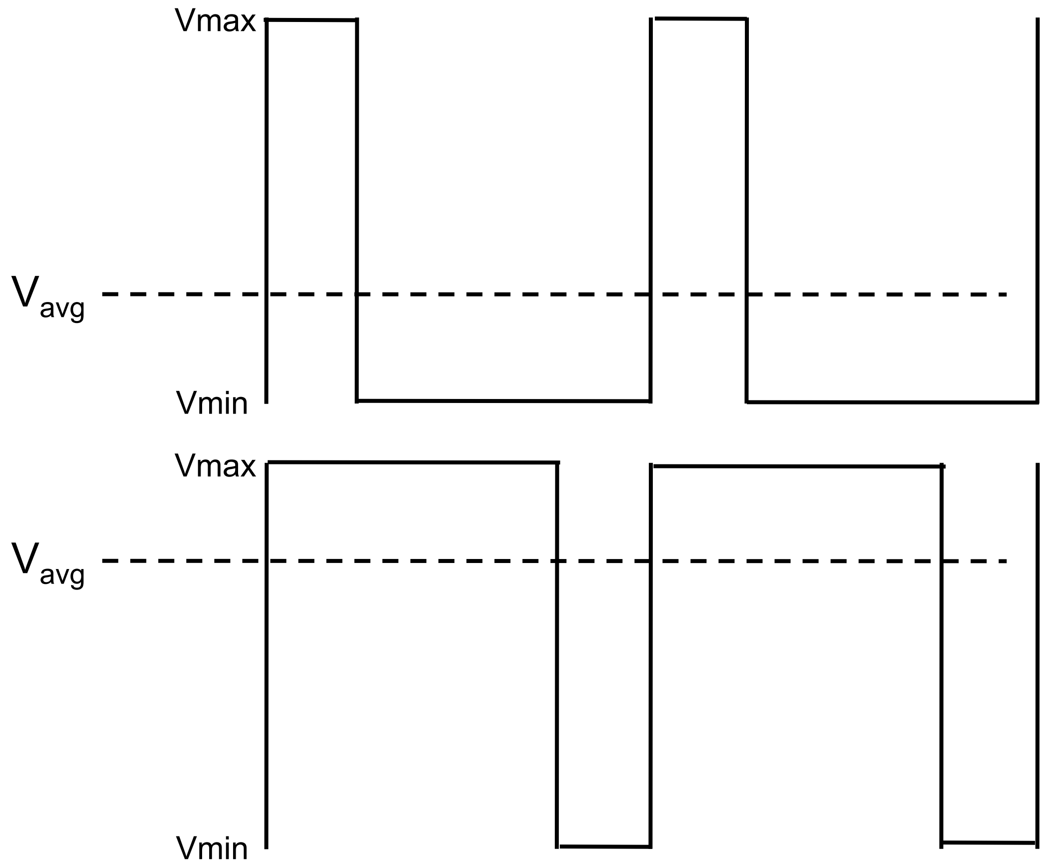
p = 1ms, f = 1000 Hz = 1kHz



t_{on} = 0.2ms
p = 1ms
dc = 20%

Average Voltage

- V_{avg} = function of duty cycle
- V_{avg} ~ A * DC



Algorithm

- Three sensors
  - Left, Middle, Right
  - Active low output => “0” when signal present
  - Calibrate to provide different output combinations
  - Develop control strategy – first pass

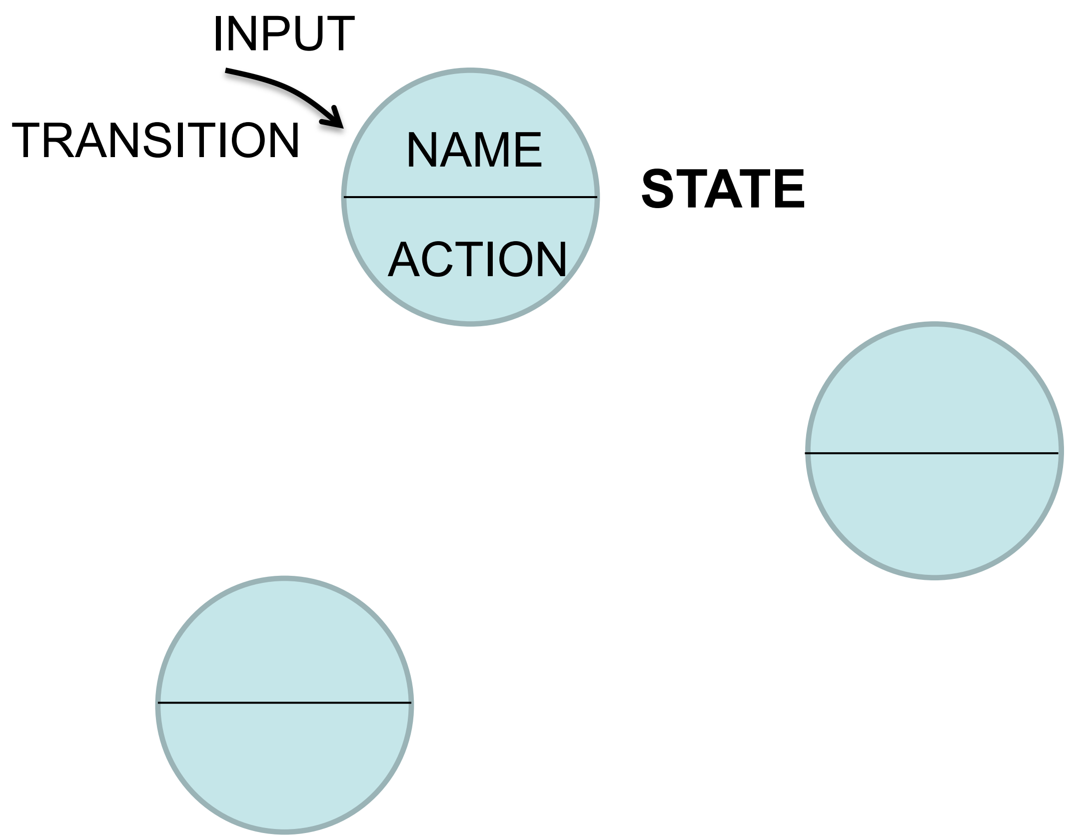
L	M	R	Position	Action	Motor PWM
1	0	1	On line	Straight	L = R
0	0	1			
0	1	1			
1	0	0			
1	1	0			

Algorithm

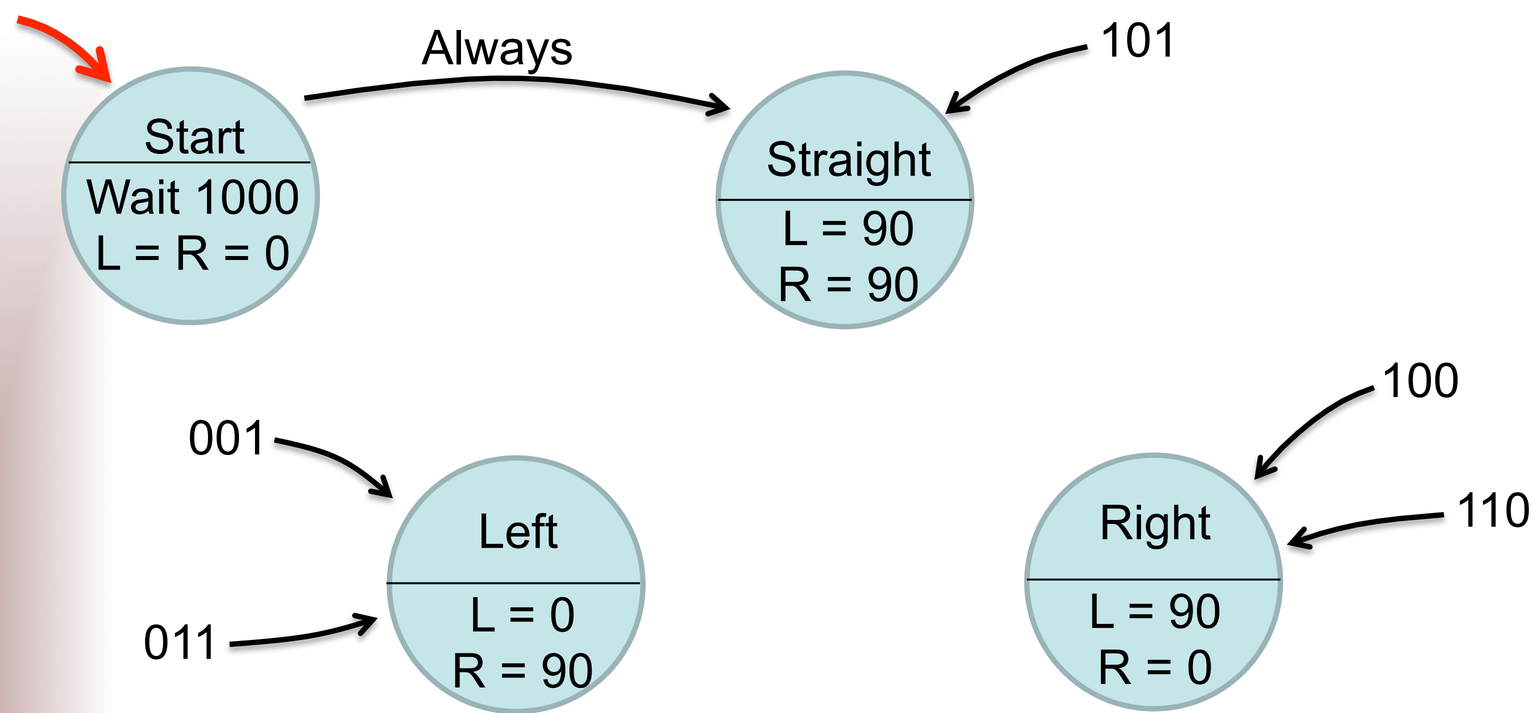
- Three sensors
  - Left, Middle, Right
  - Active low output => "0" when signal present
  - Calibrate to provide different output combinations
  - Develop control strategy – first pass

L	M	R	Position	Action	Motor PWM
1	0	1	On line	Straight	L = R
0	0	1	Slightly Right	Left	L < R
0	1	1	Really Right	Left	L < R
1	0	0	Slightly Left	Right	L > R
1	1	0	Really Left	Right	L > R

State Machine Controller



Initial State Machine Controller



L	M	R	Position	Action	Motor PWM
1	0	1	On line	Straight	L = R
0	0	1	Slightly Right	Left	L < R
0	1	1	Really Right	Left	L < R
1	0	0	Slightly Left	Right	L > R
1	1	0	Really Left	Right	L > R

Questions

- Should LMR = 011 and LMR = 001 be treated the same?
- Will one control strategy work for both races?
- What happens if:
  - Robot gets lost (LMR = 111) ?
  - Is there a difference in response if the robot gets lost turning right vs. turning left?
  - What about illegal states?
- Ready to design your state machine?

Revised Control Strategy

L	M	R	Position	Action	Motors PWM Duty Cycle *
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

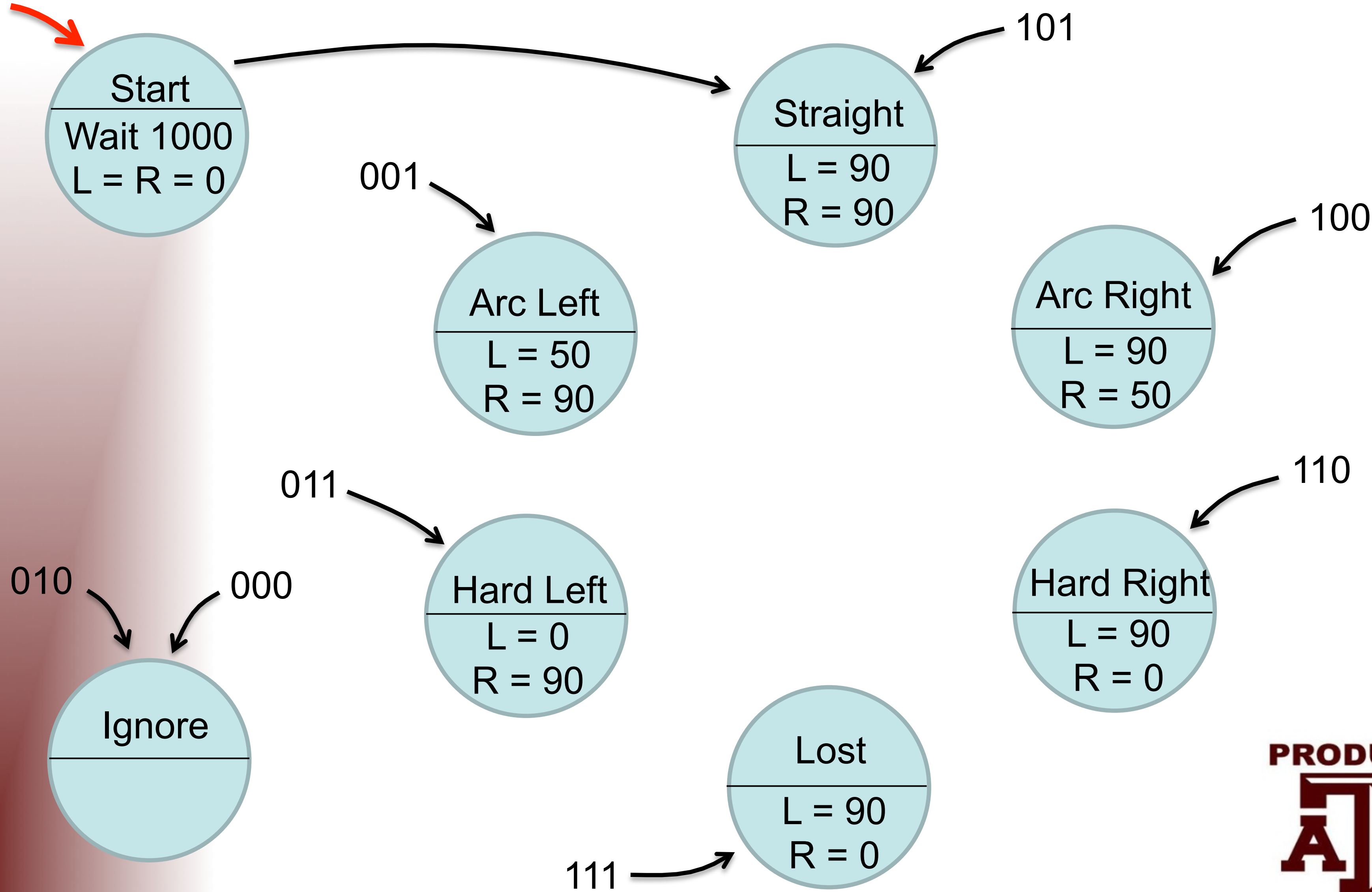
* PWM Duty Cycles are first-pass estimates and should be optimized

Revised Control Strategy

L	M	R	Position	Action	Motors PWM Duty Cycle *
0	0	0	Invalid	Ignore	No Change
0	0	1	Slightly Right	Arc Left	L = 50, R = 90
0	1	0	Invalid	Ignore	No Change
0	1	1	Very Right	Hard Left Turn	L = 0, R = 90
1	0	0	Slightly Left	Arc Right Turn	L = 90, R = 50
1	0	1	Straight	Forward	L = R = 90
1	1	0	Very Left	Hard Right Turn	L = 90, R = 0
1	1	1	Off the Line (Lost)	??? (Reverse or Spin)	L = R = -90 or Hard Turn

* PWM Duty Cycles are first pass estimates and should be optimized

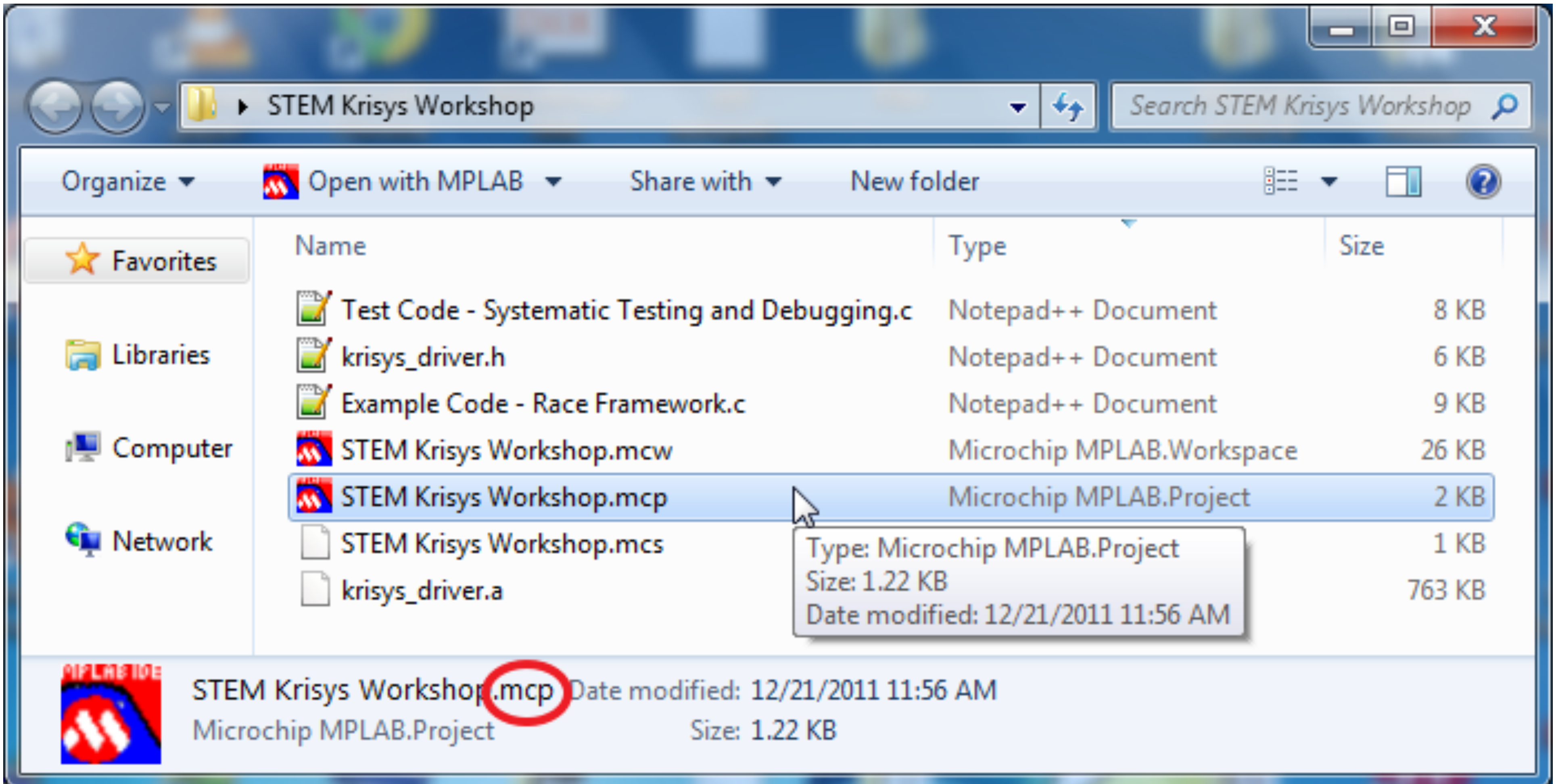
Revised State Machine Controller



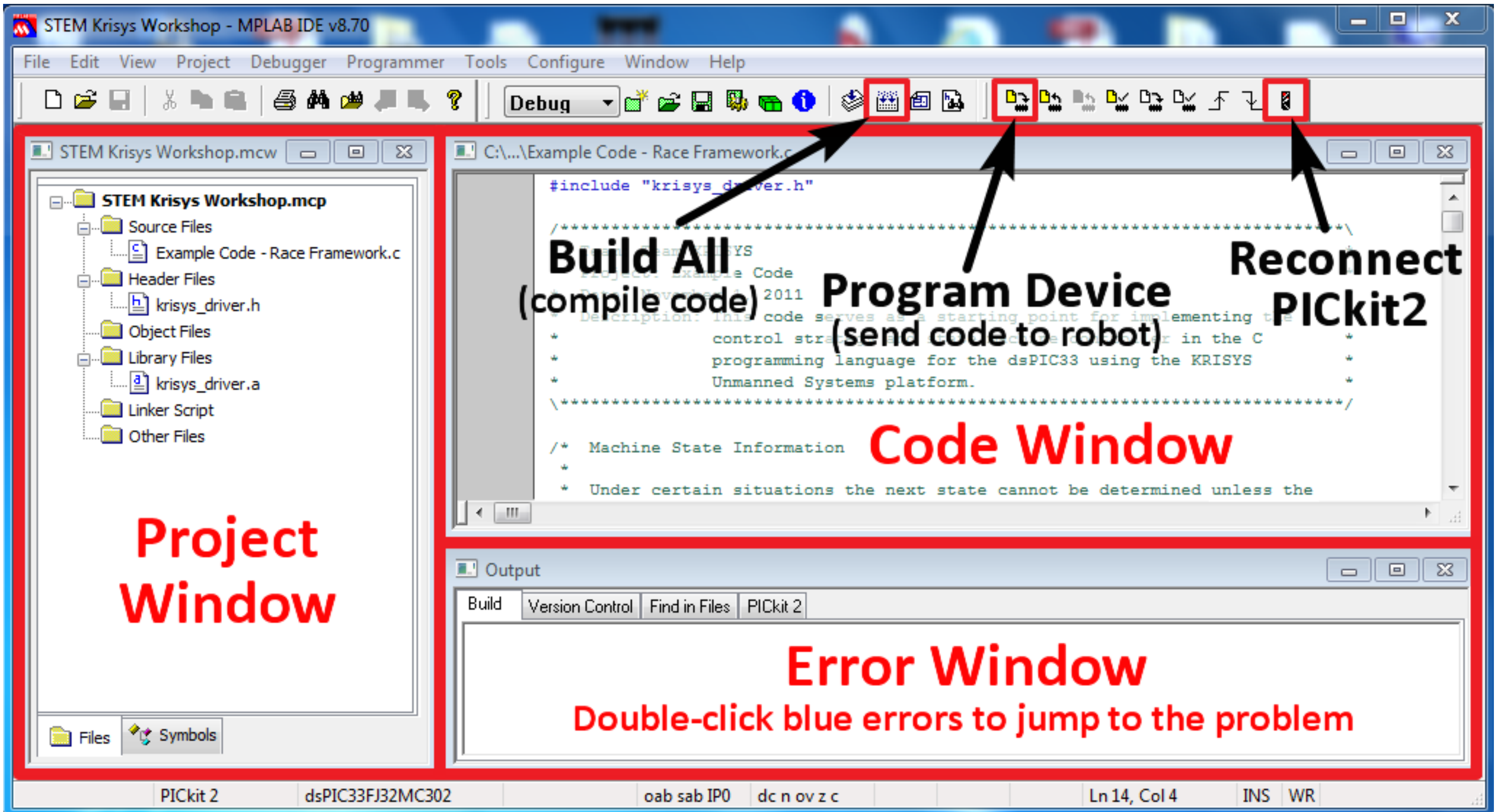
Program Robot

- Complete state machine
- Convert actions to duty cycles for each motor
- Open program structure - MPLAB
- Add code to implement state machine
- Compile code
- Download code to Krisys robot
- Test algorithm and coding
- Optimize everything
- Collect data

Open Program Structure



MPLAB IDE


STEM Krisys Workshop - MPLAB IDE v8.70
File Edit View Project Debugger Programmer Tools Configure Window Help
Debug
STEM Krisys Workshop.mcw
STEM Krisys Workshop.mcp
Source Files
Example Code - Race Framework.c
Header Files
krisys_driver.h
Object Files
Library Files
krisys_driver.a
Linker Script
Other Files
Files
Symbols
Project Window
C:\...\Example Code - Race Framework.c
#include "krisys_driver.h"
control strategy
programming language for the dsPIC33 using the KRISYS
Unmanned Systems platform.
/* Machine State Information
* Under certain situations the next state cannot be determined unless the
Build All
(compile code)
Program Device
(send code to robot)
Reconnect
PICkit2
Code Window
Output
Build
Version Control
Find in Files
PICkit 2
Error Window
Double-click blue errors to jump to the problem
PICkit 2
dsPIC33FJ32MC302
oab sab IP0
dc n ov z c
Ln 14, Col 4
INS
WR

Control Algorithm

1) Initialize and wait 1 second
2) Get state of sensor inputs
3) Process the sensor states
4) Determine the machine state to transition to
5) Set the motor PWM duty cycles
6) Wait a brief moment for platform to move/ respond to new duty cycles
7) Go back to 2

C Program Structure

- Check sensors
- Make decision on “new” action
- Change motor duty cycles
- Repeat

- Recommended starting values:
  – Straight DC = 70 percent LM and RM (tune these for straight motion)
  – Easy Right DC = 70 percent LM and 60 percent RM

C Program Structure

- Check sensors

```c
variable = 4 * SensorL() + 2 * SensorM() + 1 * SensorR();
```

- Make decision

```c
switch(variable) {
    case 0b101:
        /* do something */;
        break;
}
```

C Program Structure

- Change DC

```
case 0b101:
    R_motor(90);
    L_motor(90);
    break;
```

- Repeat process

```
while(1) {
    variable = 4 * SensorL() + 2 * SensorM() + 1 * SensorR();
    switch(variable) {
        case 0b101:
            R_motor(90);
            L_motor(90);
            break;
    }
}
```

```c
#include "krisys_driver.h"

/************************************************************************\
*  Team: Team KRISYS                                                     *
*  Project: Example Code                                                 *
*  Date: November 1, 2011                                                *
*  Description: This code serves as a starting point for implementing the *
*               control strategy and state machine controller in the C    *
*               programming language for the dsPIC33 using the KRISYS     *
*               Unmanned Systems platform.                                *
\************************************************************************/

/*  Machine State Information
 *
 *  Under certain situations the next state cannot be determined unless the
 *  current state is first known (ex. when LMR = 111). This can easily be
 *  solved by storing the machine's current state so that it can be used when
 *  needed.
 *
 *  The problem that arises is, how to store a state? If it were an integer,
 *  it could be stored just like any other variable could be. Why not make it
 *  an integer, or more appropriately encode the states as integers. The
 *  easiest and most simplest way to do this is to use an enumeration. It also
 *  helps make the code easier to read and aids in its documentation.
 */
```

```c
typedef enum {
    START,
    STRAIGHT,
    ARC_LEFT,
    ARC_RIGHT,
    HARD_LEFT,
    HARD_RIGHT,
    LOST_LEFT,
    LOST_RIGHT
} MachineStates;

int main(void)
{
    Init_Krisys();    // Initialize Krisys Controller

    /*  Current State Information
     *
     *  Under certain situations the next state cannot be determined unless the
     *  current state is first known (ex. when LMR = 111). To solve this problem,
     *  the current state information will be stored so that it can be used
     *  when needed.
     */
    MachineStates machineState; // variable to hold the state that the machine is currently in

    unsigned stateOfSensors;  // variable to hold the current input read from the sensors

    Set_motor_direction(1);  // correctly orients the front of the robot
```

```
/*  Start State
 *
 *  For the Start state, the duty cycle applied to both motors should be
 *  zero. There is also a 1 second pause before moving to the Straight
 *  state.
 */
machineState = START;
L_Motor(0);
R_Motor(0);
Wait(1000);  // wait for 1000ms (1 sec)

/*  Move Into the Straight State
 *
 *  Now that 1 second has passed, the machine should unconditionally move
 *  into the Straight state (move into the Straight state regardless of
 *  the sensor inputs).
 *
 *  In the Straight state, both motors should move forward at 90%.
 */
machineState = STRAIGHT;
L_Motor(90);
R_Motor(90);
```

PRODUCTS ★ SYSTEMS

```
/*  Begin Processing Input
 *
 *  All state transitions after this point require that the input first be
 *  processed. The basic control algorithm will be as follows:
 *      1) Get state of sensor inputs
 *      2) Process the sensor states
 *      3) Determine the machine state to transition to
 *      4) Set the motor duty cycles
 *      5) Wait a brief moment for platform to move/respond to new duty cycles
 *      6) Go back to 1
 */
while (1)
{
    /*  Get the Current State of the Sensors
     *
     *  Before a proper decision about the environment can be made
     *  (where the line is), the current state of the sensors must be
     *  retrieved and processed. To simplify the processing algorithm,
     *  the state of the sensors will be stored as bits and packed into
     *  an integer.
     *
     *  The bits are packed as follows:
     *                                   "-" represents unused bits
     *  - - - - - 2 1 0
     *            ^ ^ ^
     *            | | +--  SensorR() : current state of right sensor
     *            | +----  SensorM() : current state of middle sensor
     *            +------  SensorL() : current state of left sensor
     */
    stateOfSensors = 4 * SensorL() + 2 * SensorM() + 1 * SensorR();
```

PRODUCTS ATM SYSTEMS

```
switch(stateOfSensors)  // determine where the line is and respond accordingly
{
    /* All sensors detect the line */
    case 0b000:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;

    /* Outside sensors on the line (middle sensor is not) */
    case 0b010:  //
        machineState = ???;
        /* do something to motor duty cycles */;
        break;

    /* Only the middle sensor is above the line */
    case 0b101:
        machineState = STRAIGHT;
        /* do something to motor duty cycles */;
        break;

    /* Left sensor and middle sensor straddle the line */
    case 0b001:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;

    /* Only the left sensor is above the line */
    case 0b011:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;
```

```
/* Only the right sensor is above the line */
case 0b110:
    machineState = ???;
    /* do something to motor duty cycles */;
    break;

/* Right sensor and middle sensor straddle the line */
case 0b100:
    machineState = ???;
    /* do something to motor duty cycles */;
    break;

/* No sensors detect the line */
case 0b111:
    /*  Determine Next State Transition
     *
     *  Whenever the robot becomes lost (LMR = 111), the next state
     *  is not necessarily known (as is the case with LMR = 101
     *  for example). When lost, the transition to make depends on
     *  the state that the robot is currently in.
     */
    switch (machineState)
    {
```

```
switch (machineState)
{
    case STRAIGHT:    // LMR = 111 and was going straight
        machineState = LOST_RIGHT;
        L_Motor(90);  // make a hard right turn
        R_Motor(0);
        break;
    case ARC_LEFT:      // LMR = 111 and was making a soft left turn
        machineState = LOST_LEFT;
        L_Motor(0);     // make a hard left turn
        R_Motor(90);
        break;
    case ARC_RIGHT:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;
    case HARD_LEFT:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;
    case HARD_RIGHT:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;
    case LOST_LEFT:     // LMR = 111 and was in the lost left state
        machineState = LOST_LEFT;
        L_Motor(0);     // make a hard left turn
        R_Motor(90);
        break;
    case LOST_RIGHT:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;
}
break;
```

```
            /* Impossible to get here since all sensor states are defined */
            default:
                Stop();  // if the platform stops, there is a problem with the code
                break;
        }
        /* wait for a brief moment before getting sensor inputs again */
        Wait(50);
    }

    return 0;
}
```

C Program Example

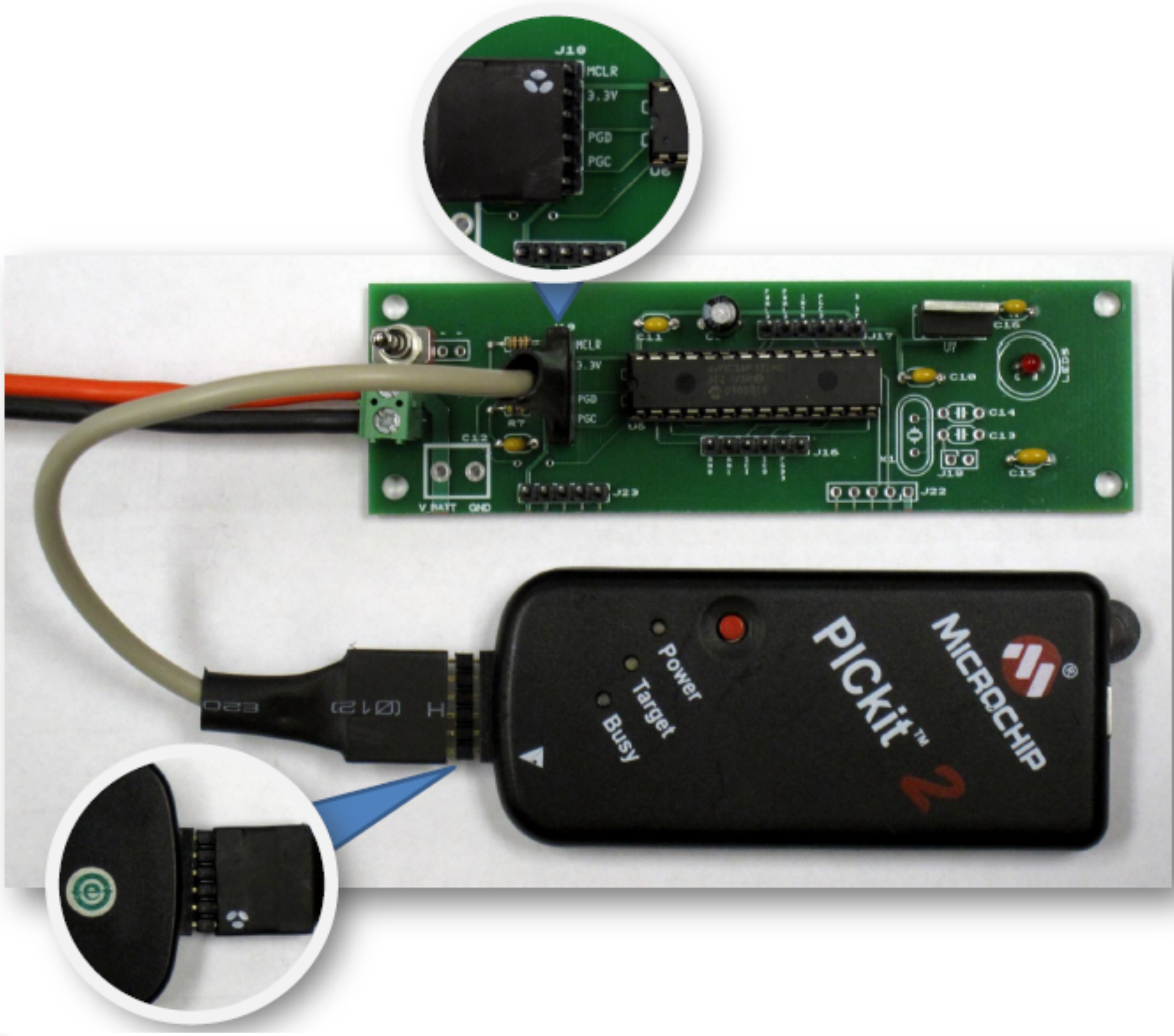
- Current state = STRAIGHT
- Input = 001
- Next State = ARC_LEFT

```
switch(stateOfSensors)  // determine where the line is and respond accordingly
{
    /* All sensors detect the line */
    case 0b000:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;

    /* Outside sensors on the line (middle sensor is not) */
    case 0b010:  //
        machineState = ???;
        /* do something to motor duty cycles */;
        break;

    /* Only the middle sensor is above the line */
    case 0b101:
        machineState = STRAIGHT;
        /* do something to motor duty cycles */;
        break;

    /* Left sensor and middle sensor straddle the line */
    case 0b001:
        machineState = ARC_LEFT;
        L_motor(50);
        R_motor(90);
        break;
```

Getting C code onto Robot

- Translate to robot's language (compile)
  - Build All button ()
- Download Hex File to robot
  - Program Device button ()
- Test race algorithm

PICkit Connection



Data Collection

1. Measure wheel diameter
2. Measure time to travel 10 feet at chosen motor duty cycle
3. Determine speed in MPH
4. Determine distance (in meters) robot can travel in straight line, if
   - Battery capacity is 2200 mAHrs
   - Robot uses 600 mA at speed given in 3 above

- What is acceleration of robot

Questions / Applications

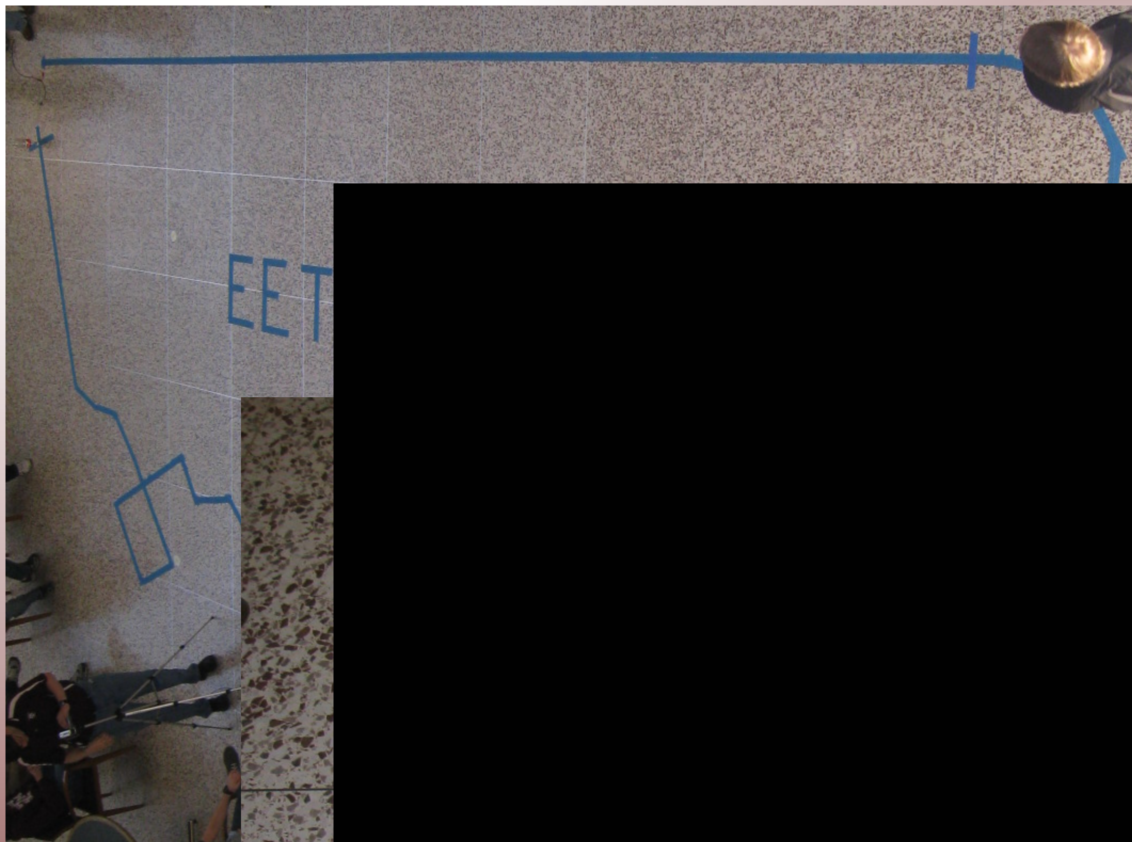
- Science
- Technology
- Engineering
- Math

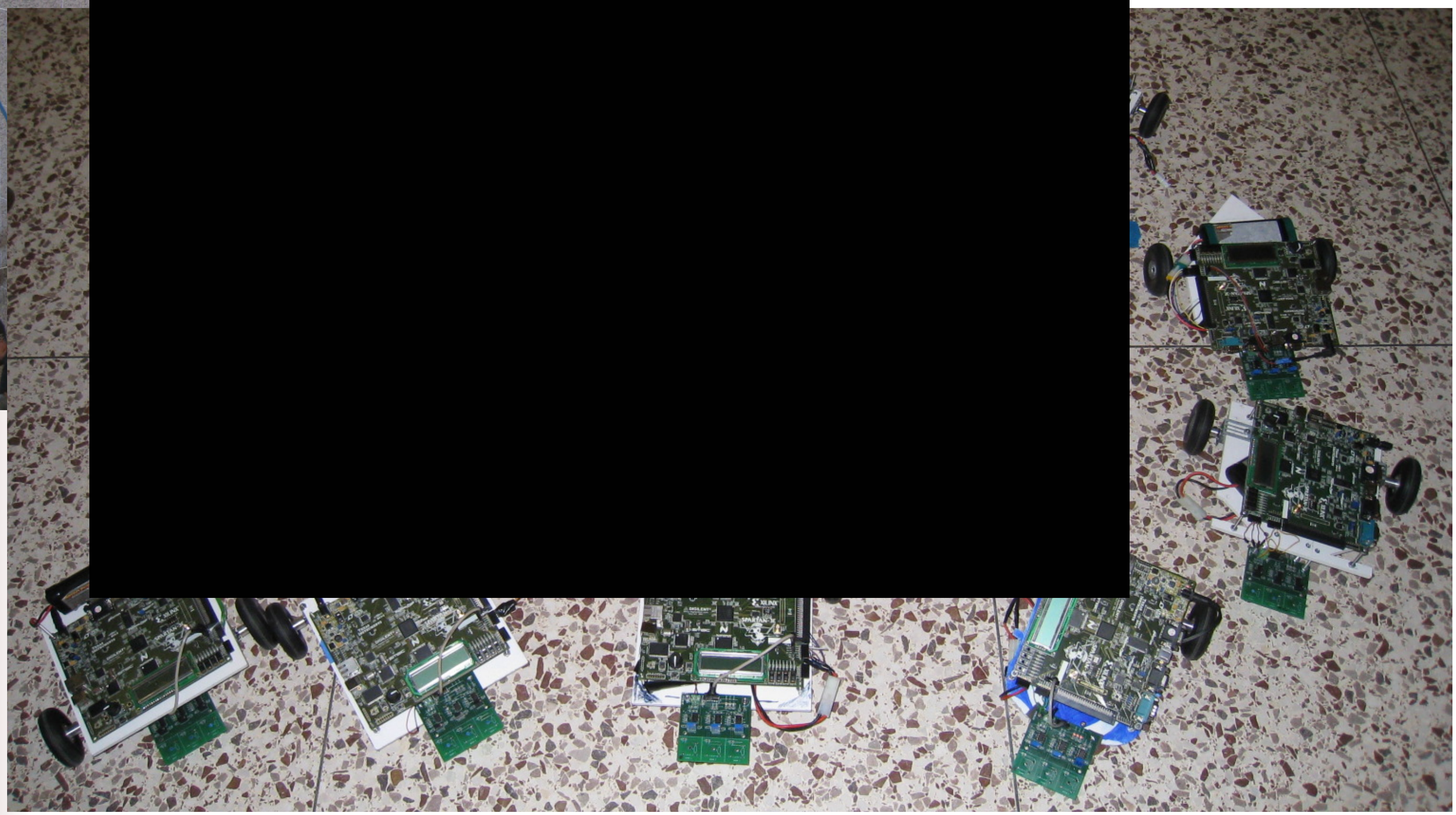
Feedback

- Materials
- Construction difficulty
- Time required

Krisys Race of Champions

PRODUCTS ★ SYSTEMS





Take Away

- Are you interested in using Krisys in your classes?
- Via email, provide five specific examples of how you will use a Krisys robot for STEM teaching and outreach at your school
- Receive a Krisys robot kit
  - **Must assemble KSB and KMCB PCBs**
- **Five kits are available**

PRODUCTS ★ SYSTEMS

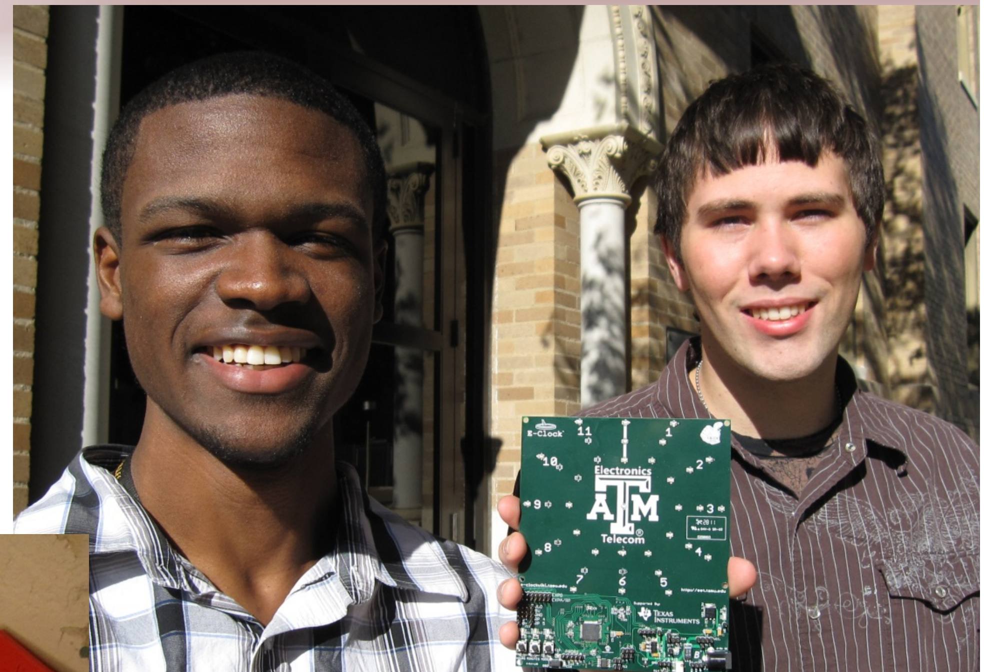
E-Clock™

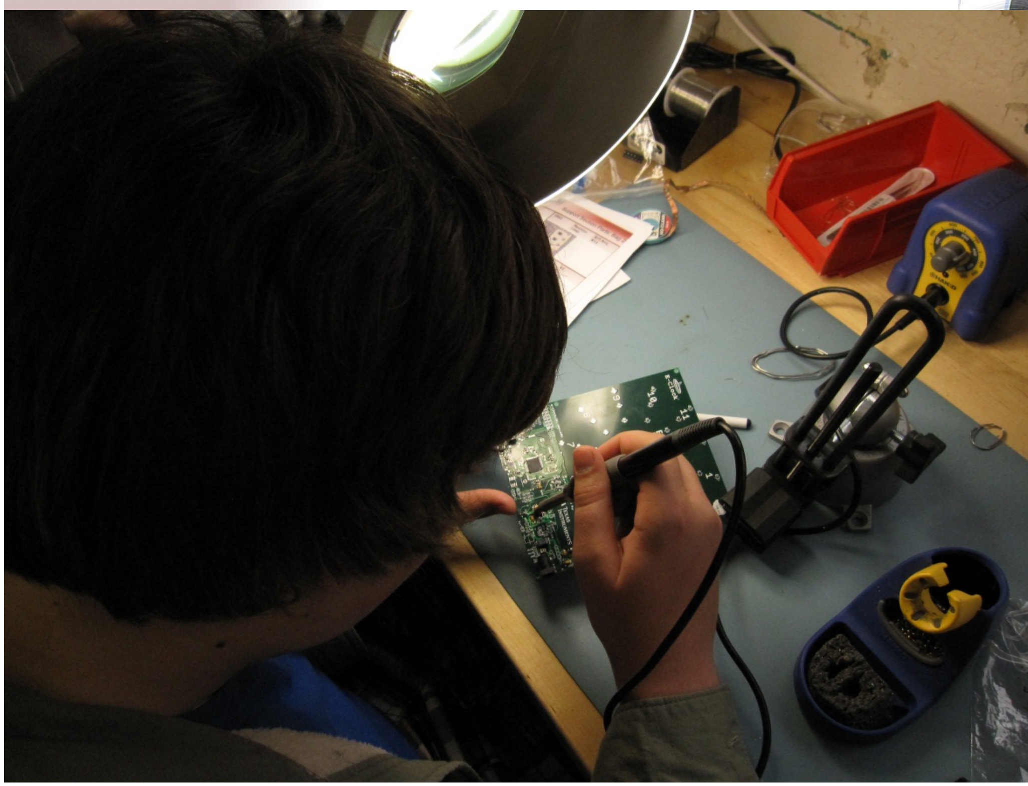
- Outreach Kit
- Wiki
- Build
- Expand
- Contribute

PRODUCTS ATM SYSTEMS

PRODUCTS ★ SYSTEMS

E-Clock™





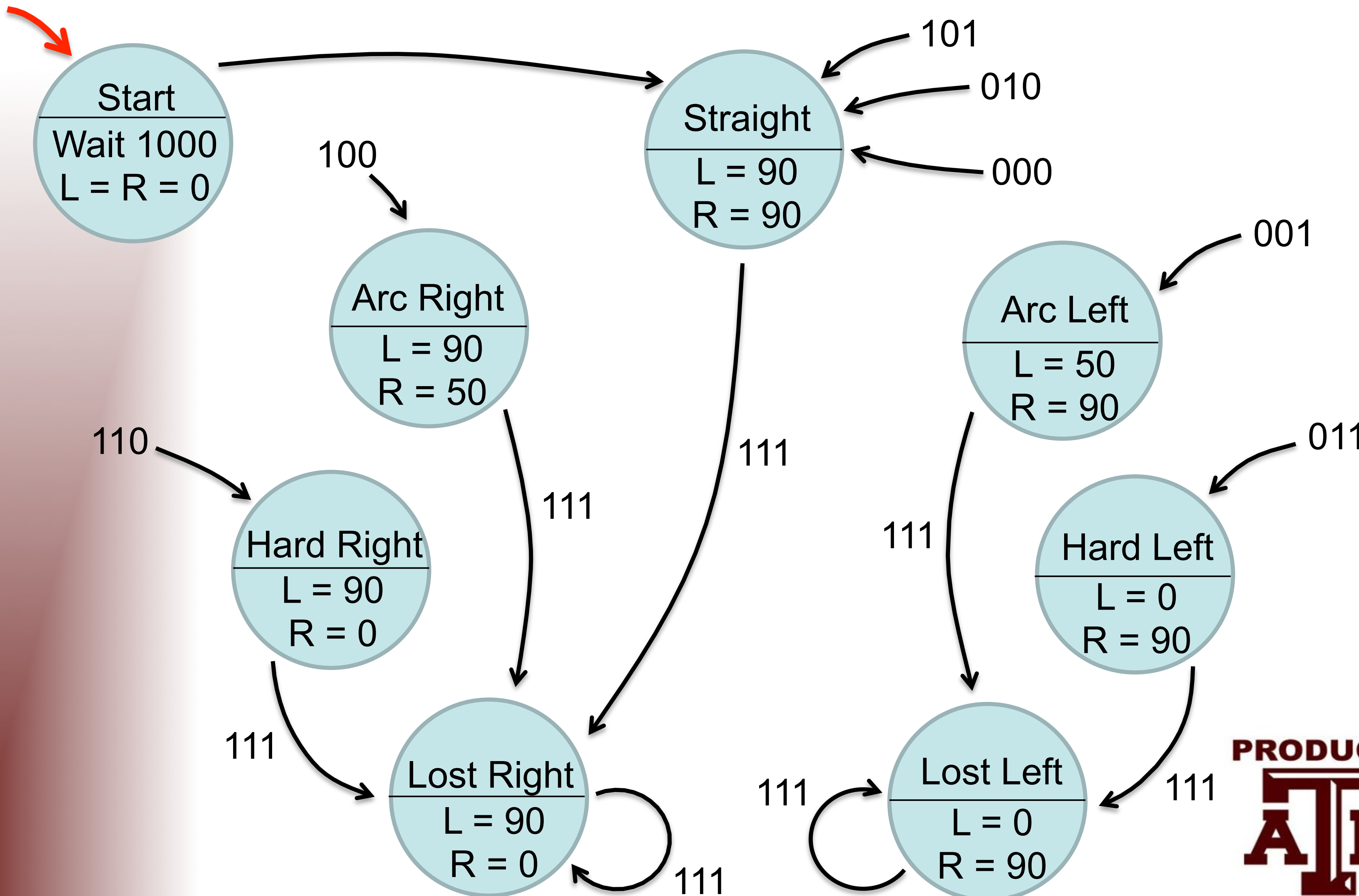
Optimum Algorithm

- What is this worth to you?
- If all robots use the same code, what will the results of the race be?
- Would adding more sensors improve the control process?
- How would you improve your robot's racing ability?
- What factor(s) should be held constant to have an "open" race?

Final Control Strategy

L	M	R	Position	Action	Motors
0	0	0	??? (Fork in Track)	Choose one (Right or Left Turn) or Go Straight	Hard Turn or L = R = 90
0	0	1	Slightly Right	Arc Left	L = 50, R = 90
0	1	0	??? (Between 2 Lines)	Choose one (Right or Left Turn) or Go Straight	Hard Turn or L = R = 90
0	1	1	Very Right	Hard Left Turn	L = 0, R = 90
1	0	0	Slightly Left	Arc Right Turn	L = 90, R = 50
1	0	1	Straight	Forward	L = R = 90
1	1	0	Very Left	Hard Right Turn	L = 90, R = 0
1	1	1	Off the Line (Lost)	??? (Reverse or Spin)	L = R = -90 or Hard Turn

Final State Machine Controller



PRODUCTS
ATM
SYSTEMS

ELECTRONICS ★ TELECOM

KRISYS
Unmanned Systems

STEM
Teachers Summit

Handout

Electronics
ATM
Telecom

Seminar Overview

- Hour 1 – Learning
  - Hardware
    - Mechanical
    - Electronics
  - Software
    - Sensing
    - Control
- Hour 2 – Doing
  - Build robot
  - Develop control algorithm
  - Generate software
- Hour 3 – Integration
  - Testing / Optimizing
  - Feedback – survey
- Hour 4 – Krisys Race of Champions
  - Drag Race, Road Race
  - 2011 STEM Teacher Summit Bragging Rights

Hardware

- Mechanical
  - 1 Base – 8”x8”x1/4”
  - 2 DC motors with brackets
  - 2 Wheel hubs
  - 2 Rubber wheels – ¾” width x 3” diameter
  - 1 Ball bearing third wheel
- Power
  - 7.4V Lithium-Ion battery

Questions

- Empirical data provide the following information for a 7.4 V battery directly connected to two Krisys Robot motors
  - Total resistance is 12 ohms
  - Each motor turns at a rate of 240 Rev/min

- Determine the following
  - Diameter of robot wheel: ______________
  - Speed of robot in MPH: ______________
  - Current draw of robot in mA: ______________
  - Capacity of battery needed for 30 minutes of operation: ___________
  - Distance robot could travel on fully charged battery: _____________

Electronics
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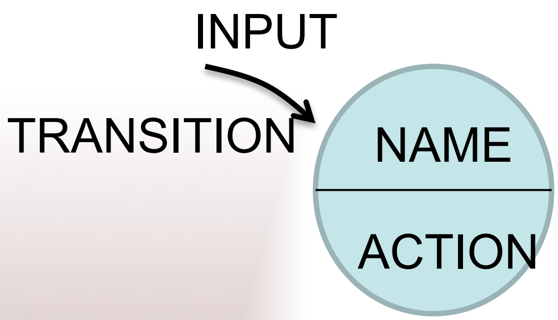
Algorithm

- Three sensors
  - Left, Middle, Right
  - Active low output => “0” when signal present
  - Calibrate to provide different output combinations
  - Develop control strategy – first pass

L	M	R	Position	Action	Motor PWM
1	0	1	On line	Straight	L = R
0	0	1			
0	1	1			
1	0	0			
1	1	0			

State Machine Controller



Revised Control Strategy

L	M	R	Position	Action	Motors PWM Duty Cycle *
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

* PWM Duty Cycles are first pass estimates and should be optimized

Revised State Machine

Systematic Testing and Debugging

- Do you have control of the wheels?
- Are you receiving correct information from the sensor board?
- Have the devices been properly interfaced?

Take Away

- Are you interested in using Krisys in your class?
- Provide ten cool ideas to leverage Krisys robot for STEM teaching and outreach
- Receive a Krisys robot kit
  - **Must assemble both KSB and KMCB PCBs**
- Five kits are available

E-Clock™

- Outreach Kit
- Wiki
- Build
- Expand
- Contribute

Optimum Algorithm

- What is this worth to you?
- If all robots use the same code, what will the results of the race be?
- Would adding more sensors improve the control process?
- How would you improve your robot's racing ability?
- What factor(s) should be held constant to have an "open" race?

KRISYS Unmanned Systems

STEM Teachers Summit

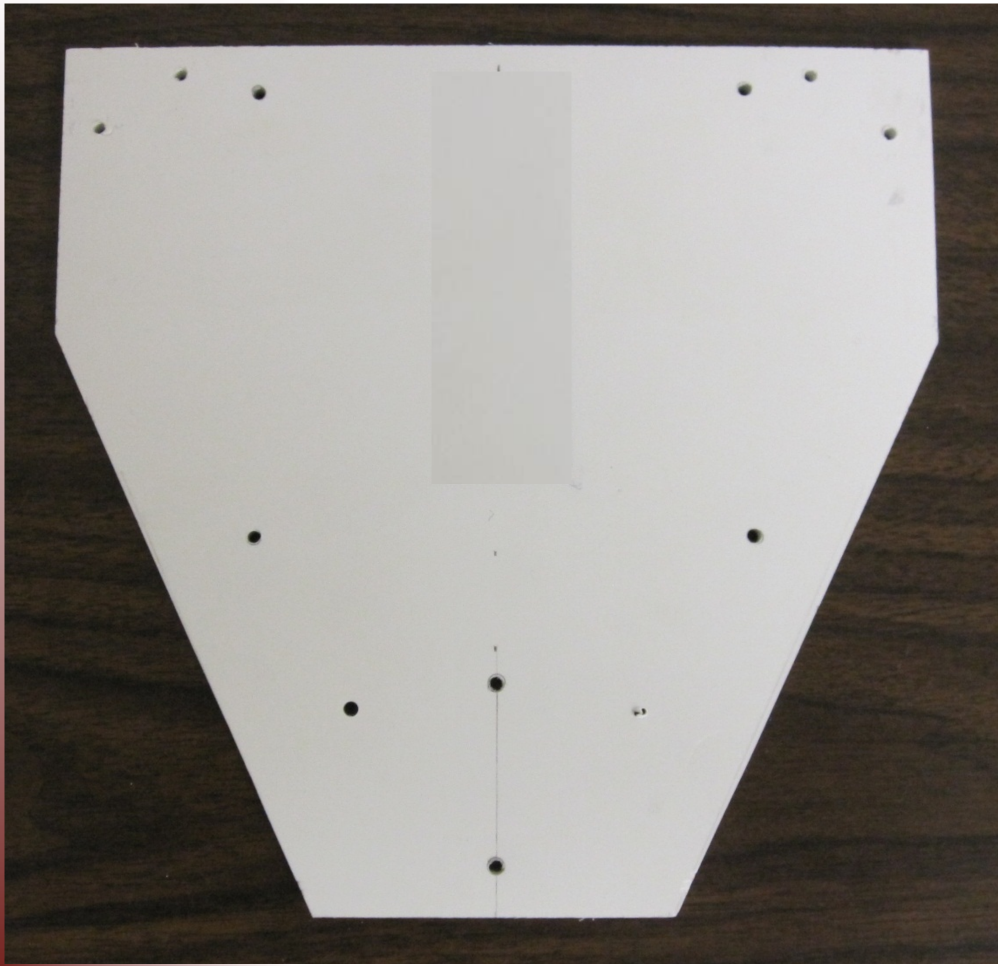
Hardware Build Manual

PRODUCTS ATM SYSTEMS

Platform Build

- Mechanical
  - Install ball bearing to base
  - Install motor brackets to base
  - Install motors to brackets
  - Install hubs to wheels
  - Install hubs to motors
- Power
  - Install battery to platform

Mechanical



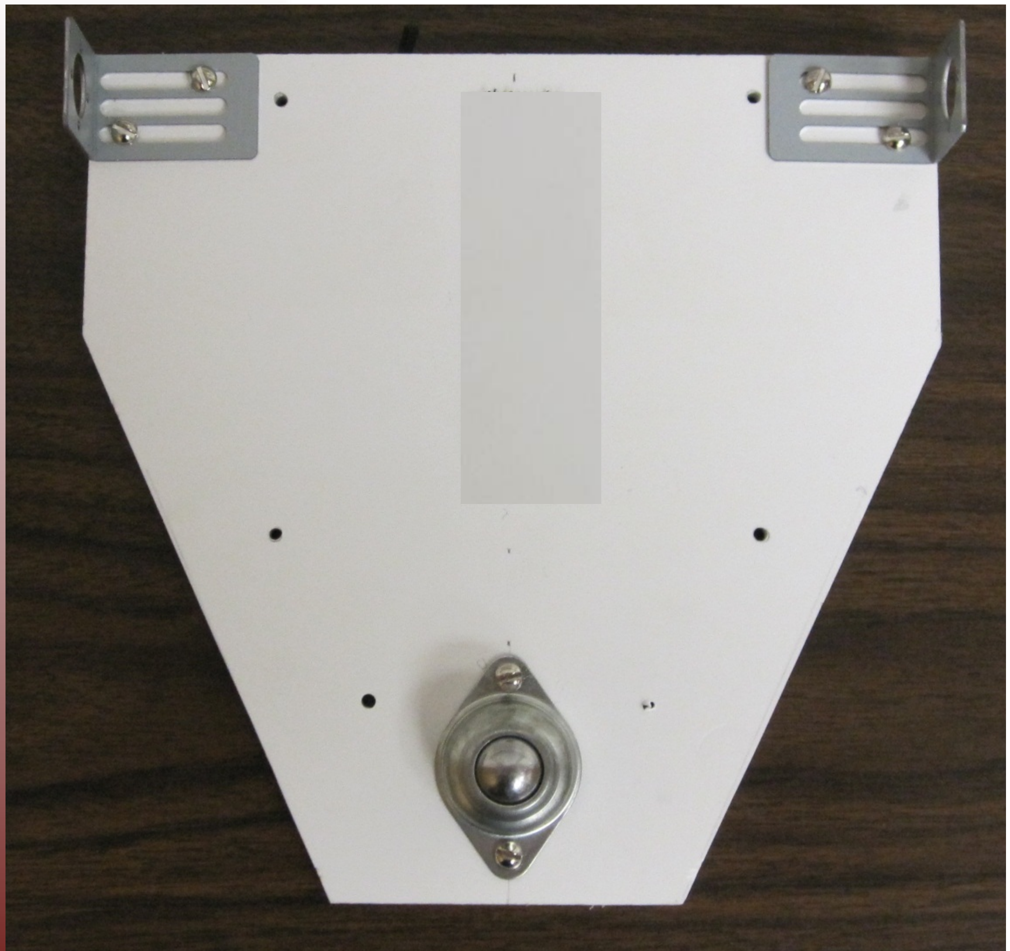
1. Start with an 8” x 8” base
2. Cut the design
3. Premark and drill mounting holes

Mechanical

1. Start with an 8” x 8” base
2. Cut the design you wish
3. Premark and drill mounting holes
4. **Attach the ball bearing as the front wheel**

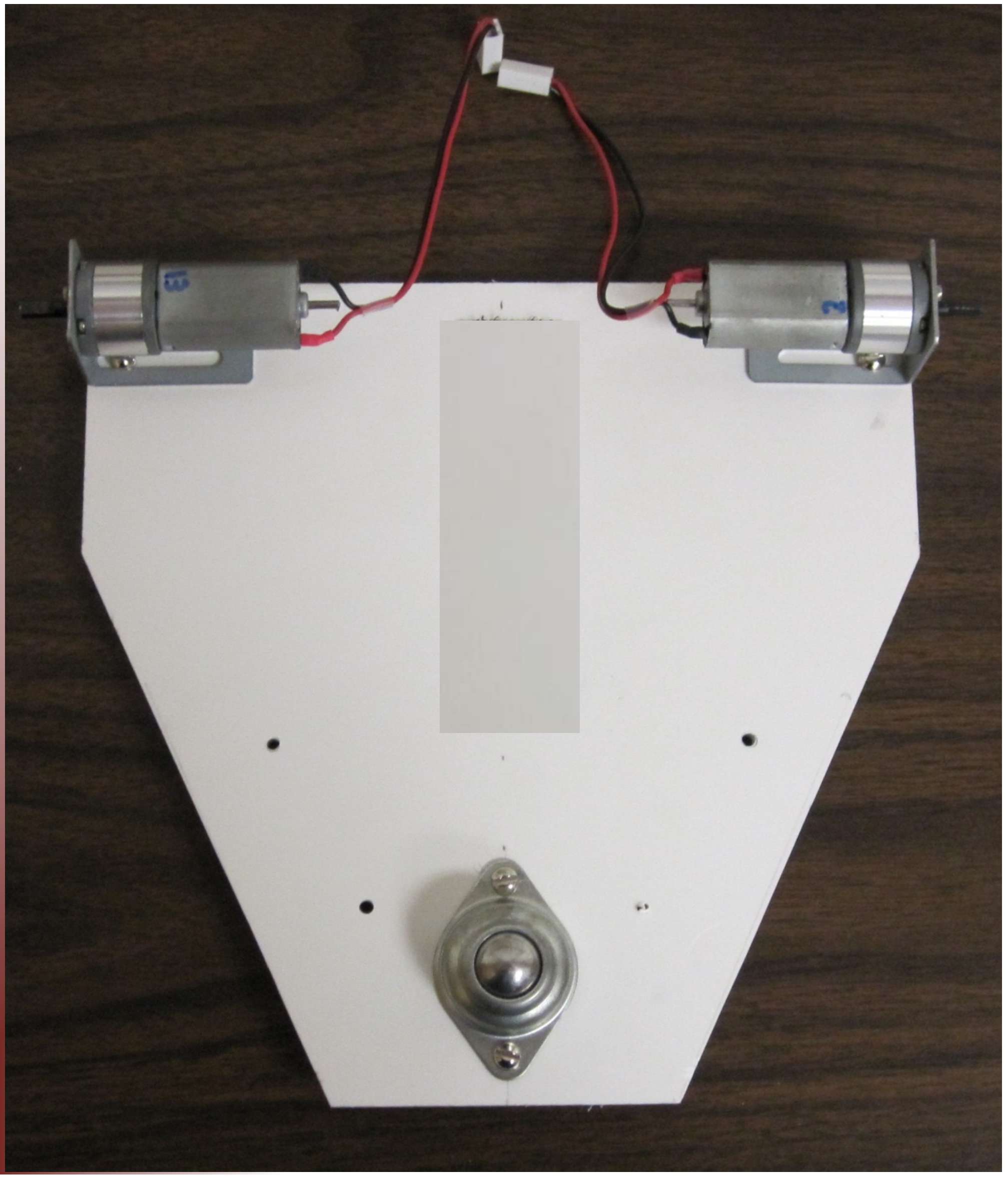
PRODUCTS ATM SYSTEMS

Mechanical

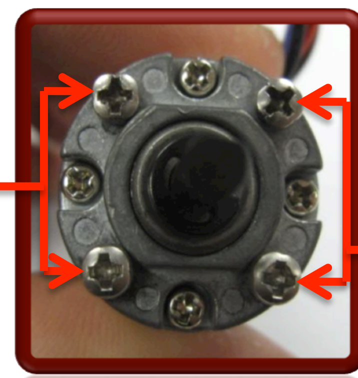


1. Start with an 8” x 8” base
2. Cut the design you wish
3. Premark and drill mounting holes
4. Attach the ball bearing as the front wheel
5. **Attach left and right motor brackets**

Mechanical



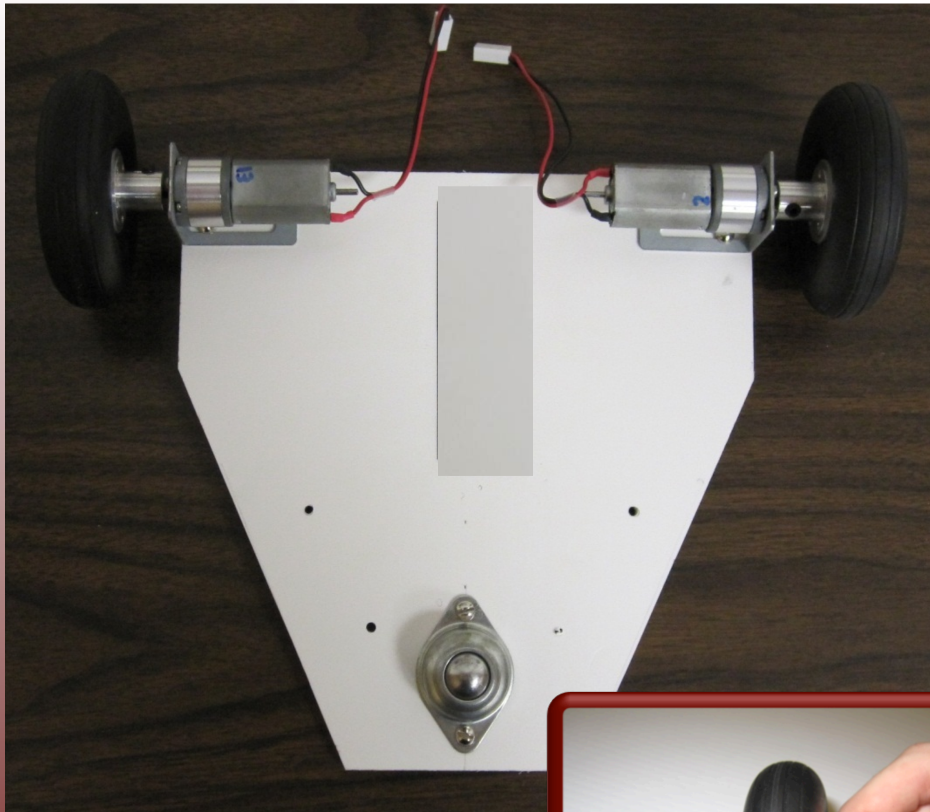
1. Start with an 8” x 8” base
2. Cut the design you wish
3. Premark and drill mounting holes
4. Attach the ball bearing as the front wheel
5. Attach left and right motor brackets
6. **Attach left and right motors to brackets using four small mounting screws supplied with motors (be sure you use the correct four screws)**



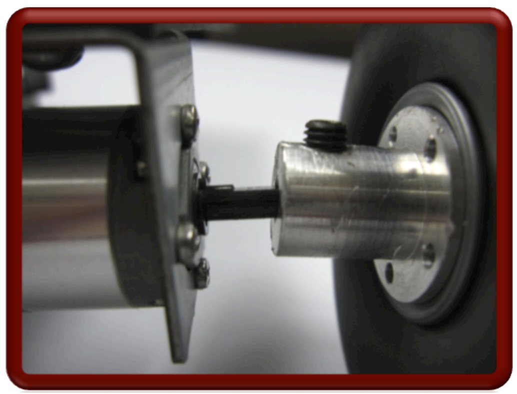
Mounting Screws

PRODUCTS ATM SYSTEMS

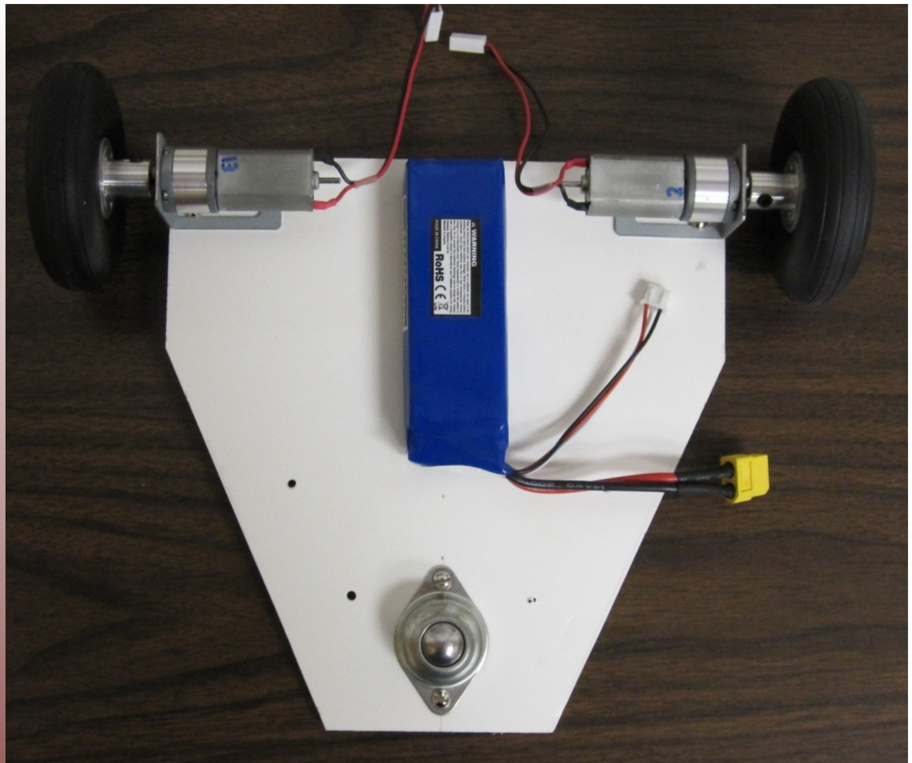
Mechanical



1. Start with an 8” x 8” base
2. Cut the design you wish
3. Premark and drill mounting holes
4. Attach the ball bearing as the front wheel
5. Attach left and right motor brackets
6. Attach left and right motors to brackets using four small mounting screws supplied with motors (be sure you use the correct four screws)
7. **Attach hubs to wheels**
8. **Attach hubs to motor shafts**



Mechanical



1. Start with an 8” x 8” base
2. Cut the design you wish
3. Premark and drill mounting holes
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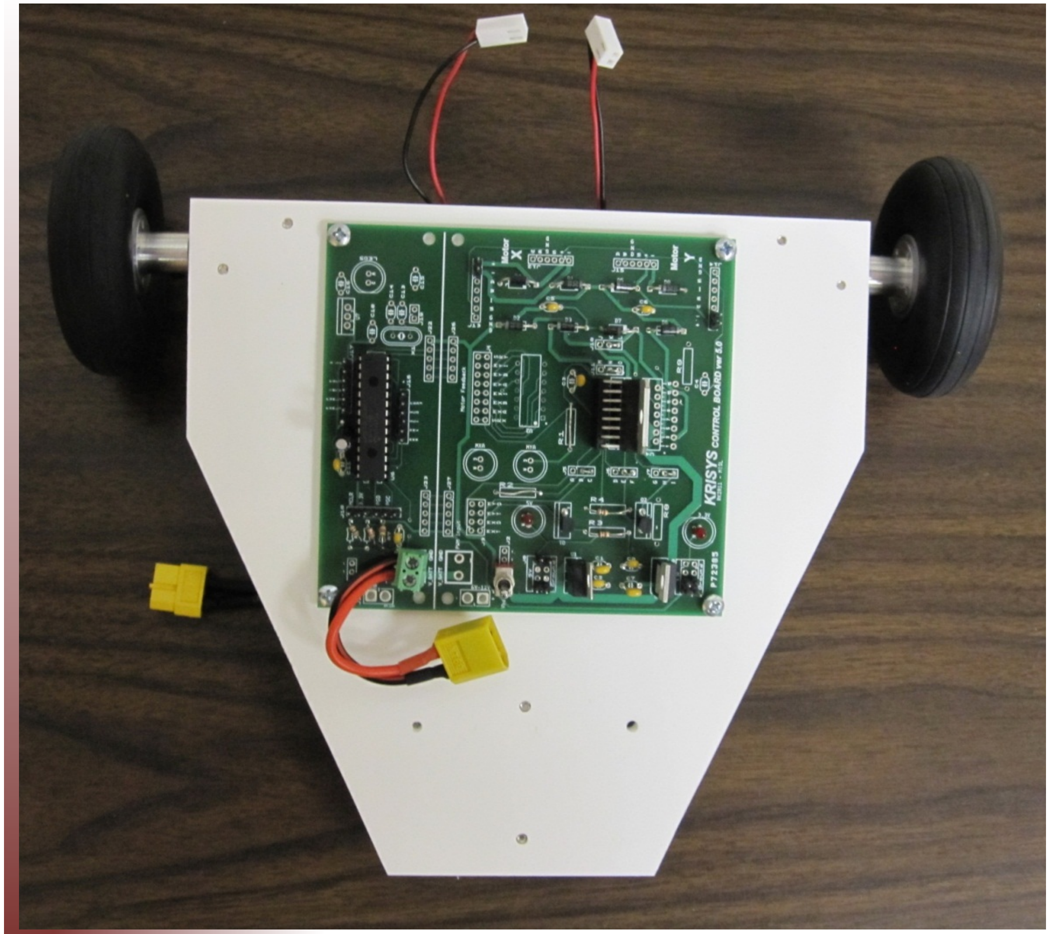
5. Attach left and right motor brackets
6. Attach left and right motors to brackets using four small mounting screws supplied with motors (be sure you use the correct four screws)
7. Attach hubs to wheels
8. Attach hubs to motor shafts
9. **Attach battery**

Platform Build

- Electronics
  - Install KMCB to base
  - Install KSB to base
  - Connect KSB to KMCB (3 signal, 2 power)
  - Connect Battery to KMCB
  - Test functionality

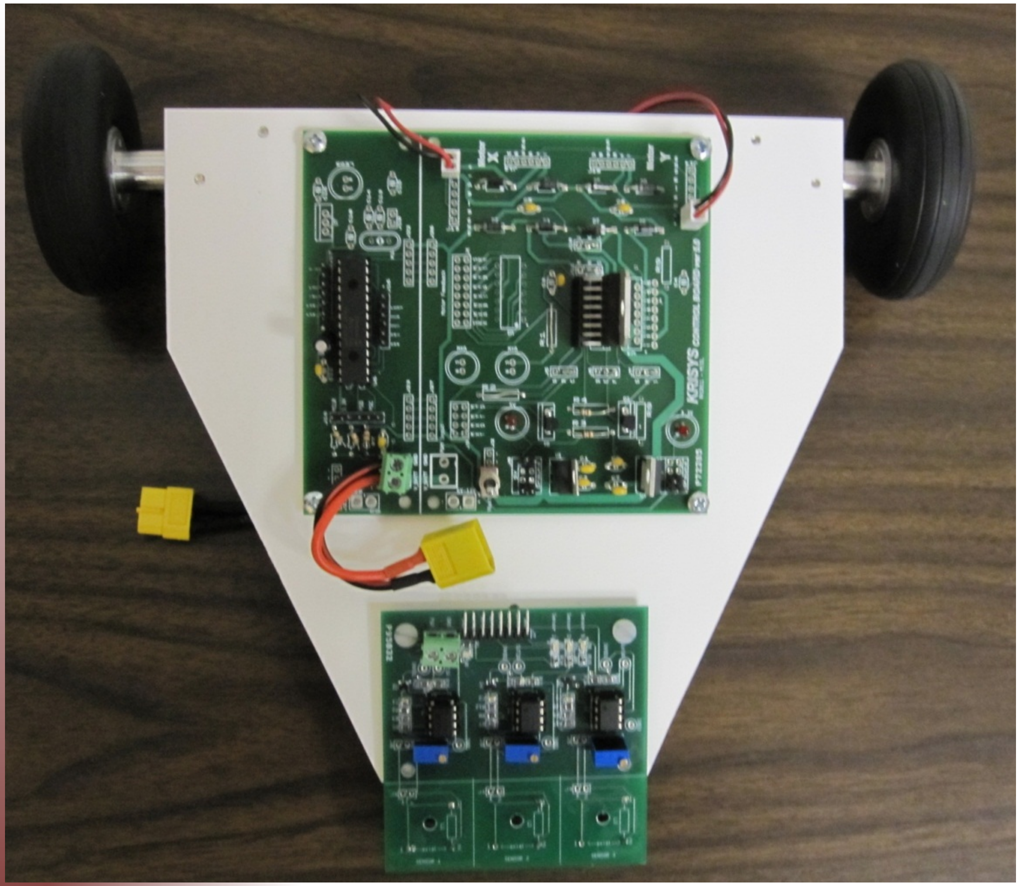
- Add personality – Customize !!!

Electronics



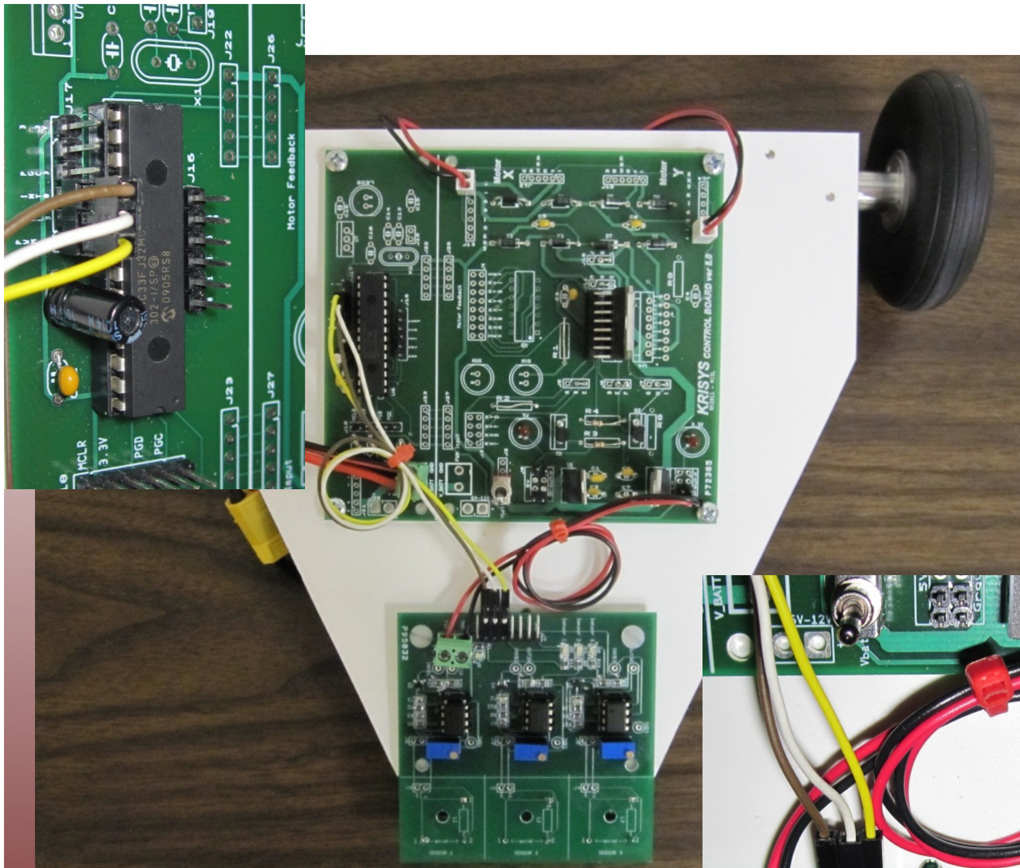
1. **Attach KMCB to top of base**

Electronics

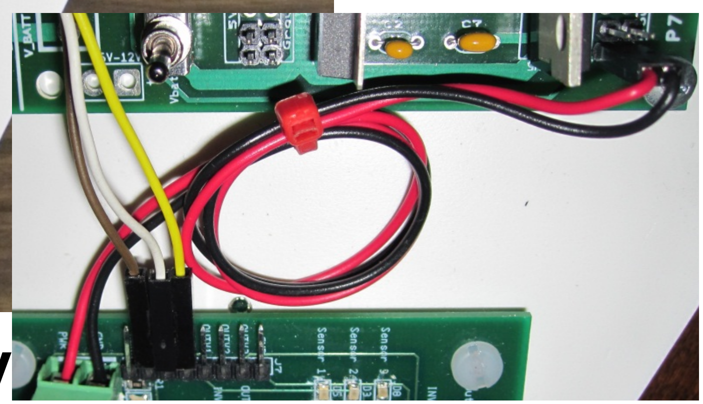


1. Attach KMCB to top of base
2. **Attach KSB to top of base**

Electronics



1. Attach KMCB to top of base
2. Attach KSB to top of base
3. **Interconnect KSB power to KMCB ***
4. **Interconnect KSB sensor outputs to KMCB ***
5. **Interconnect battery with KMCB**
6. **Test mechanical and electronic assembly**



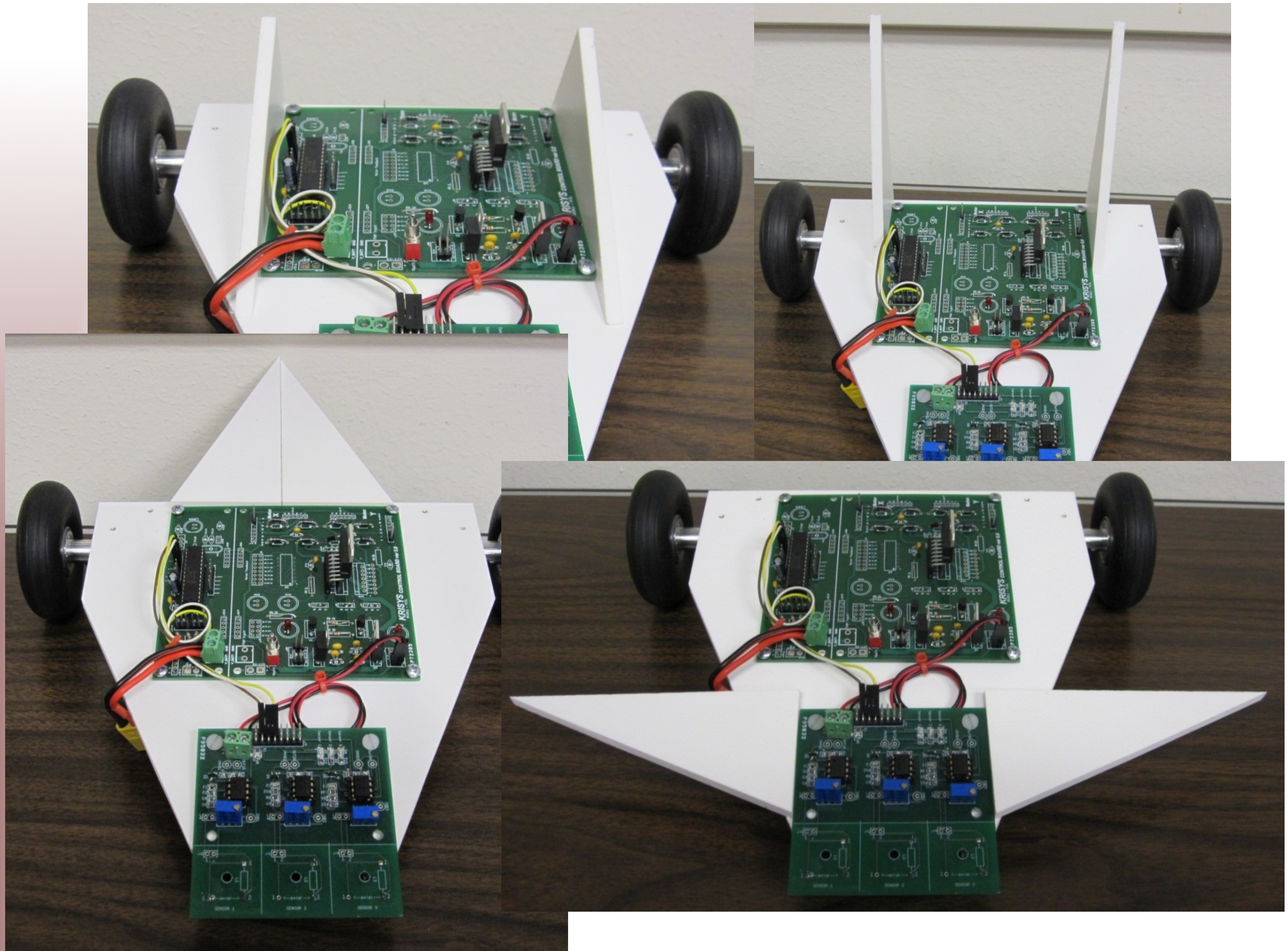
*** Wire colors may vary**

Systematic Testing and Debugging

- Have the devices been properly interfaced?
- Use Mode 0 (Jumper J16-Pin3 to ground)
  - Do you have control of the wheels?
  - Forward, Reverse, L_Turn, R_Turn, Repeat
- Use Mode 1 (Jumper J16-Pin3 to 3.3V)
  - Are you receiving correct information from the sensor board?
  - 101 = Both, 011 = R_Motor, 110 = L_Motor

PRODUCTS ★ SYSTEMS

Customize



PRODUCTS
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Krisys Robot Quiz

- Wheel diameter measurements (in)
  - 3.12, 2.97, 3.04, 3.13, 3.00, 3.02, 2.98, 2.99, 2.89, 3.03
- Time for 100 revolutions (sec)
  - 14.22, 14.55, 14.32, 14.25, 14.28, 14.30, 14. 51, 14.21, 14.31, 14.30
- Determine:
  - Speed = ___________ MPH
  - Distance traveled (in 10 sec) = _______ Meters
- Answers to two decimal places

Feedback

- Based on robot design and construction
  - Materials
  - PCB fabrication tools
  - Wiki-based instructions / videos
    - krisyswiki.tamu.edu
  - Construction difficulty
  - Time required

Questions / Applications

- Science
- Technology
- Engineering
- Math

Take Away

- Are you interested in using Krisys in your classes?
- Via email, provide five specific examples of how you will use a Krisys robot for STEM teaching and outreach at your school
- Receive a Krisys robot kit
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E-Clock™

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PRODUCTS SYSTEMS

PRODUCTS SYSTEMS

KRISYS

Unmanned Systems

STEM
Teachers Summit

Software Development Manual

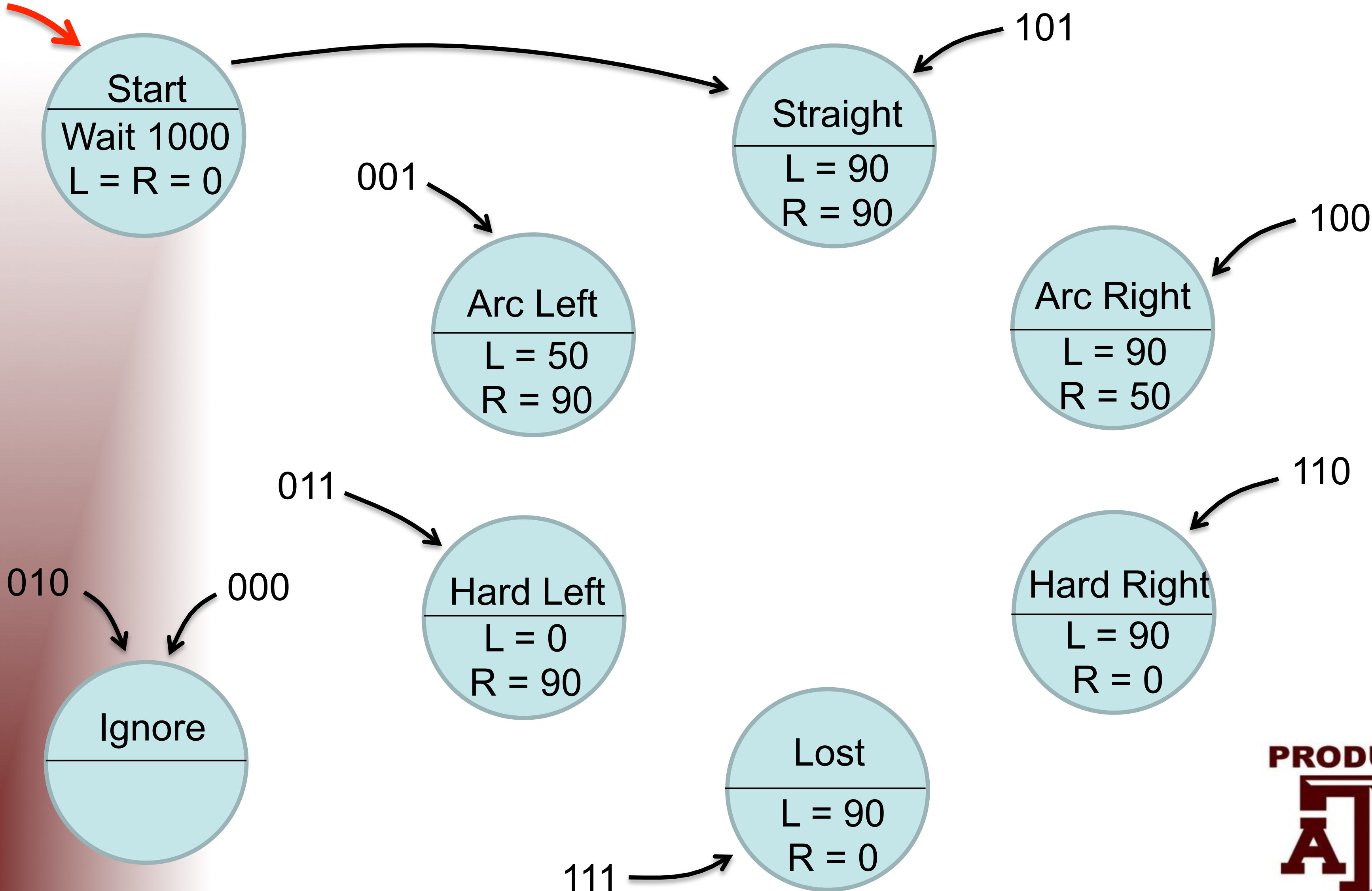
PRODUCTS ATM SYSTEMS

Revised Control Strategy

L	M	R	Position	Action	Motors PWM Duty Cycle *
0	0	0	Invalid	Ignore	No Change
0	0	1	Slightly Right	Arc Left	L = 50, R = 90
0	1	0	Invalid	Ignore	No Change
0	1	1	Very Right	Hard Left Turn	L = 0, R = 90
1	0	0	Slightly Left	Arc Right Turn	L = 90, R = 50
1	0	1	Straight	Forward	L = R = 90
1	1	0	Very Left	Hard Right Turn	L = 90, R = 0
1	1	1	Off the Line (Lost)	??? (Reverse or Spin)	L = R = -90 or Hard Turn

* PWM Duty Cycles are first-pass estimates and should be optimized

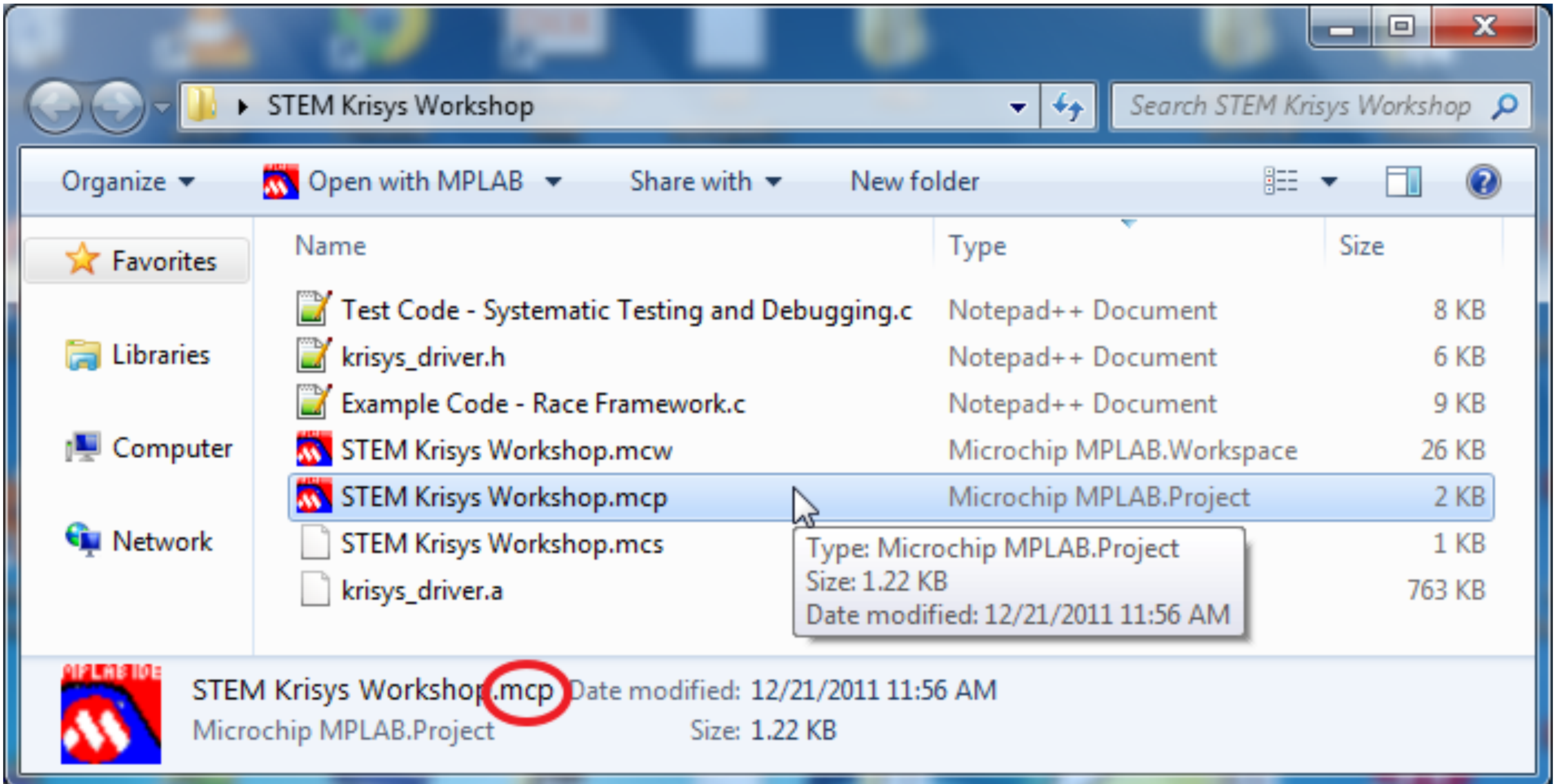
Revised State Machine Controller



Program Robot

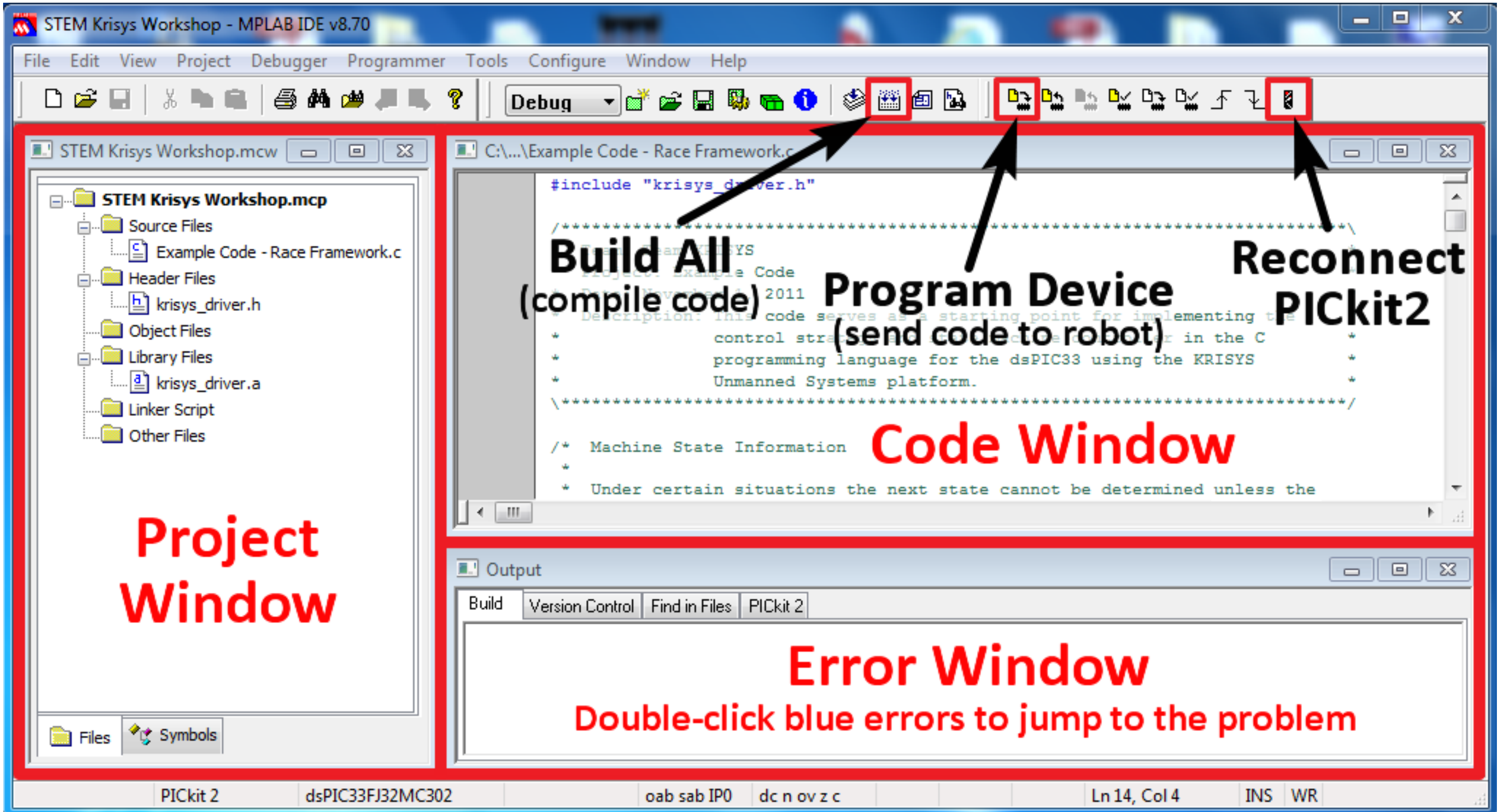
- Complete state machine
- Convert action to duty cycles for each motor
- Open program structure - MPLAB
- Add code to implement state machine
- Compile code
- Download code to Krisys Robot
- Test algorithm and coding
- Optimize everything
- Collect data

Open Program Structure



PRODUCTS ★ SYSTEMS

MPLAB IDE



Control Algorithm

1) Initialize and wait 1 second
2) Get state of sensor inputs
3) Process the sensor states
4) Determine the machine state to transition to
5) Set the motor PWM duty cycles
6) Wait a brief moment for platform to move/ respond to new duty cycles
7) Go back to 2

C Program Structure

- Check sensors
- Make decision on action
- Change Duty Cycle (DC)
- Repeat

- Recommended starting values:
  - Straight DC = 70 percent LM and RM (adjust these for straight motion)
  - Easy Right DC = 70 percent LM and 60 percent RM

C Program Structure

- Check sensors

```c
variable = 4 * SensorL() + 2 * SensorM() + 1 * SensorR();
```

- Make decision

```c
switch(variable) {
    case 0b101:
        /* do something */;
        break;
}
```

C Program Structure

- Change DC

```
case 0b101:
    R_motor(90);
    L_motor(90);
    break;
```

- Repeat process

```
while(1) {
    variable = 4 * SensorL() + 2 * SensorM() + 1 * SensorR();
    switch(variable) {
        case 0b101:
            R_motor(90);
            L_motor(90);
            break;
    }
}
```

C Program Example

- Current State = STRAIGHT
- Input = 001
- Next State = ARC_LEFT

```c
switch(stateOfSensors)  // determine where the line is and respond accordingly
{
    /* All sensors detect the line */
    case 0b000:
        machineState = ???;
        /* do something to motor duty cycles */;
        break;

    /* Outside sensors on the line (middle sensor is not) */
    case 0b010:  //
        machineState = ???;
        /* do something to motor duty cycles */;
        break;

    /* Only the middle sensor is above the line */
    case 0b101:
        machineState = STRAIGHT;
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        break;

    /* Left sensor and middle sensor straddle the line */
    case 0b001:
        machineState = ARC_LEFT;
        L_motor(50);
        R_motor(90);
        break;
```
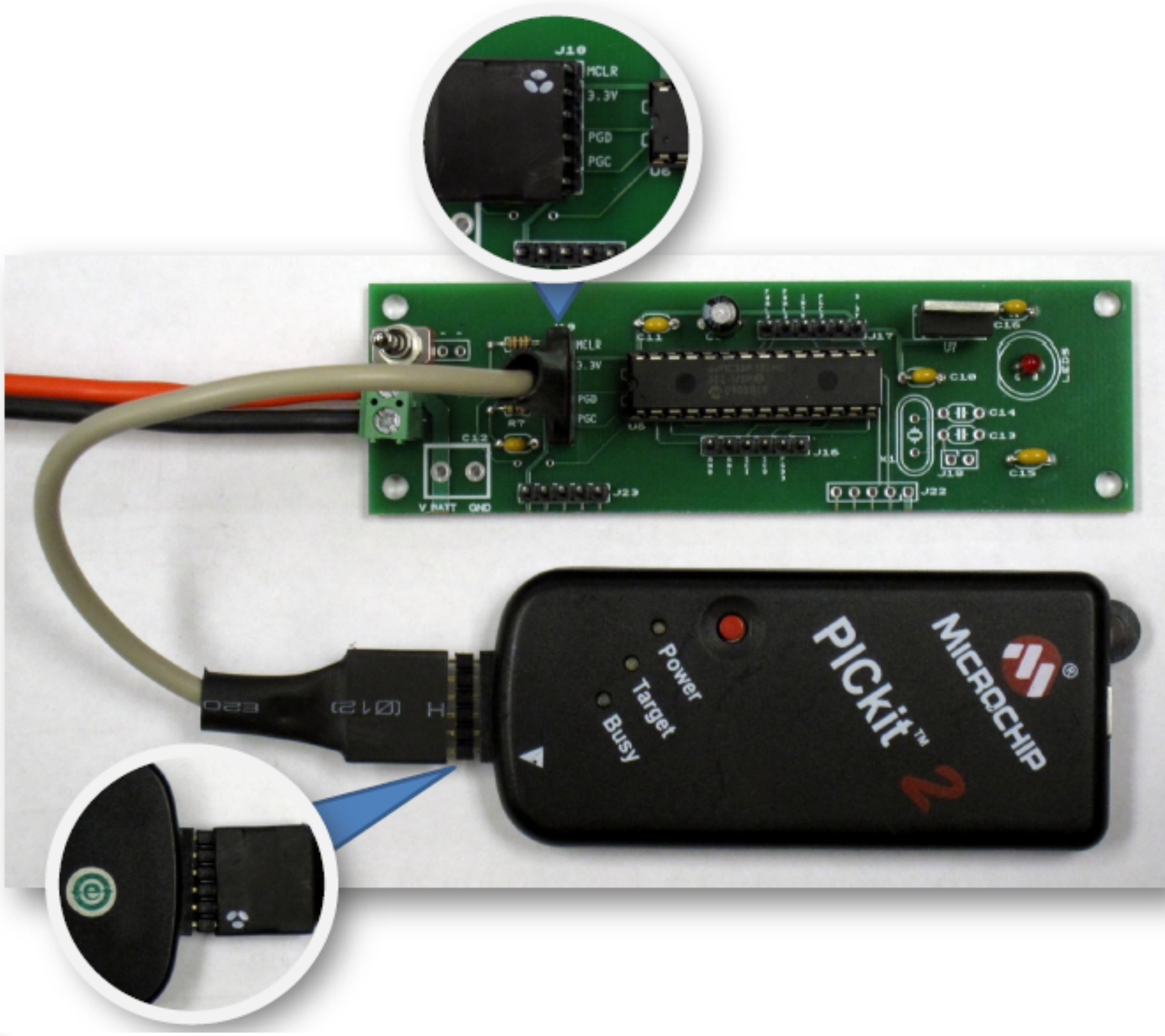

Getting C code onto Robot

- Translate to robot’s language (compile)
  – Build All button ()
- Download Hex File to robot
  – Program Device button ()
- Test race algorithm

PICkit Connection



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1. Measure wheel diameter
2. Measure time to travel 10 feet at chosen motor duty cycle
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4. Determine distance (in meters) robot can travel in straight line, if
   - Battery capacity is 2200 mAHrs
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- What is acceleration of robot

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PRODUCTS ★ SYSTEMS

E-Clock™

- Outreach Kit
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PRODUCTS
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STATION 1

MATCH THE GRAPH

This activity can be found at the following URL
http://education.ti.com/educationportal/sites/US/sectionHome/activitybook_section_datacollection.html

5

Match the Graph

Math Objectives:

- Examine rate of change
- Analyze and interpret the graph of a function

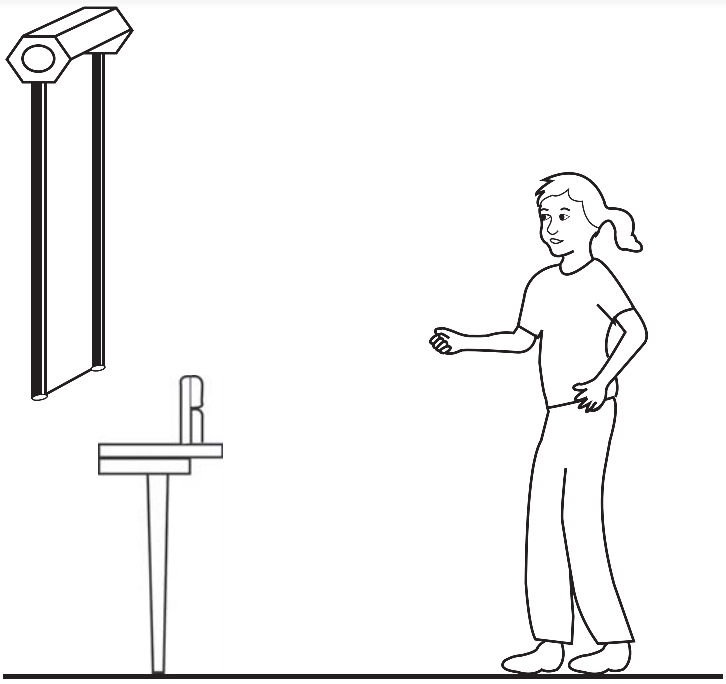
Materials: (Per Group)

- TI-83/TI-84 Plus Family
- Calculator-Based Ranger™ (CBR 2™)
- Vernier EasyData™ Application

OVERVIEW

Participants will work in groups to gain experience using the CBR 2 and EasyData App as they practice walking to match a distance/time graph.

Have several students do the *Match the Graph* activity in the front of the class as a demonstration before having students work in their own groups. The room should be set up with an aisle down the middle. Set up a CBR 2 and point it down the aisle. Connect it to a TI ViewScreen calculator so the class can see both the participant walking down the aisle and the data projected from the TI-84 Plus.



SETUP

1. Set up the activity as shown in the picture above.
2. Link the CBR 2 motion detector directly to the TI-84 Plus. You can use either the I/O Unit-to-Unit cable or the mini-USB cable.
3. The EasyData App will launch automatically if the mini-USB cable is used. If you are using the I/O unit-to-unit cable, you will need to press the [APPS] key, scroll down to highlight the EasyData App and press [ENTER] to launch the App.

4. Press Y= to access the **File** menu and select **1:New**. This resets the program and clears out old data. (In general, the “soft keys” at the bottom of the screen are accessed by pressing the top row of keys on the calculator.) **See Figure 1.**

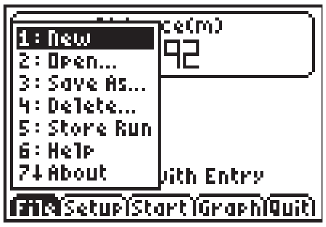


Figure 1

5. The default unit of measurement on the EasyData App is meters. This activity will be done in feet. To change the units of measurement, select the **Setup** menu soft key by pressing the WINDOW key on the top row of the calculator. From the **Setup** menu, choose **1:Dist** by pressing 1 or ENTER since **1** is highlighted. **See Figure 2.**

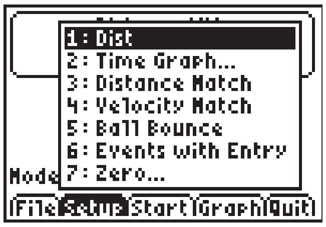


Figure 2

6. From the Units menu, select **2:(ft)** by pressing 2 or scroll down until the **2** is highlighted and press ENTER. Then select **OK**. **See Figure 3.**

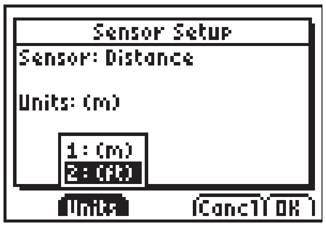


Figure 3

DATA COLLECTION

1. You will be returned to the main screen of the EasyData App. The App senses the CBR 2 and starts giving a distance reading across the top of the screen. Select **Setup** and choose **3:Distance Match. See Figure 4.**

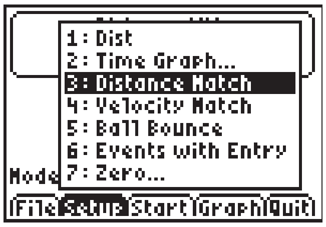


Figure 4

2. Select **Start** (by pressing ZOOM) and follow the instructions on the screen. **Distance Match** automatically takes care of the settings. **See Figure 5.**

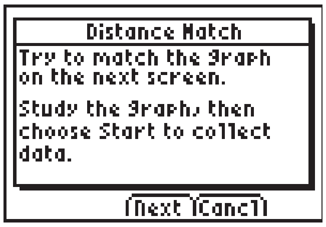


Figure 5

3. Select **Next** (by pressing ZOOM) to display the graph that is to be matched for this activity. Take a moment to study the graph with your students. Have them answer questions 1–5 on their worksheet. **See Figure 6.**

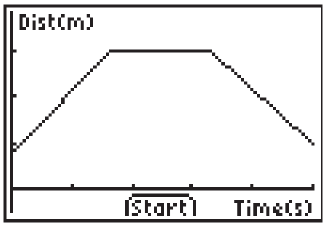


Figure 6

4. Select **Start** to begin the activity. As the walker starts to move, a trace of the walker's path will be displayed in real time along with the original graph. **See Figure 7.**

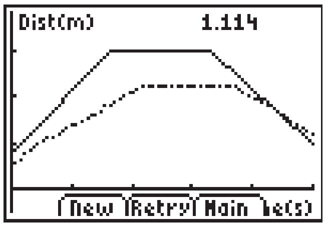


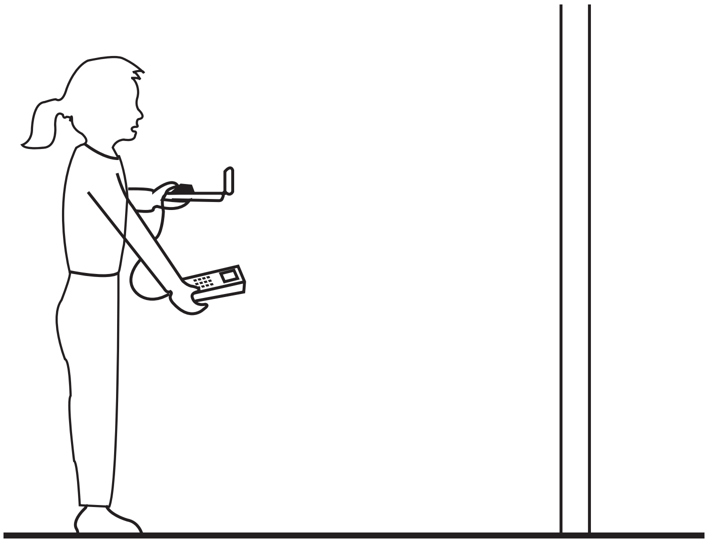
Figure 7

5. Choose a student or two to do a brief demo of the graph match application for the entire class. Select **Retry** to display the same graph again and select **New** to display a new graph. Take a moment to study one of the walks. Have students answer questions 6–9 on their worksheets. **See Figure 7.**

6. Outline the directions to be used for this activity.

   - Students earn up to five points in each of five areas: starting point, direction, rate, deviation, and teamwork.
   - "Starting point" points are earned for being close to the actual starting point.
   - In the "Direction" section, students earn points by going the correct direction.
   - "Rate" points are earned for walking the same rate as that in the graph, resulting in the same or parallel lines.
   - Students get "Overall Fit" points for not deviating from the graph.
   - For working as a team and helping the walker, the students earn "Teamwork" points.

7. If you have enough CBR 2 units, allow students to practice with their group for 5–10 minutes. An alternative setup is to have the student hold the calculator and CBR 2 while pointing the CBR 2 at the wall as shown below. Students should take turns in their groups having each participant gain experience using the CBR 2 and in walking to match the graph.



8. If you only have one CBR 2, have one student from each group take a practice "walk" in front of the entire class while their progress is viewed on the overhead. Their team members may offer advice.

9. After the practice "walk," randomly pick a team to match a graph. Then follow with the other teams in succession. For example, if you randomly pick team 4, the teams will follow in this order: 5, 6, 1, 2, 3, 4. Let the first team make a second attempt at the end. Give each team one minute or less to discuss the match.

10. Solicit scores for the group by a show of hands. Record the score given by most students rather than trying to average the scores. Let each student use the table on the worksheet to keep track of the scores.

WORKSHEET ANSWERS

1. Time
2. Seconds, 1 second
3. Distance
4. Could be feet or meters, depending on your settings; 1 foot or 1 meter
5. Depends on first graph that is displayed for the class demo
6. Depends on first graph that is displayed for the class demo
7. Backward. If the line slopes up, as the **X-**values (time) increase, so must the distances from the CBR 2 represented by the change in the **Y-**values. To increase these distances the walker needs to move farther away.
8. Forward. If the line slopes down, as the **X-**values (time) increase, the distances from the CBR 2 represented by the change in the **Y-**values must decrease. To decrease these distances the walker needs to move closer to the CBR 2.
9. Stand still. If the line is flat, the slope is zero. This means that as the time increases the distances remain the same.

ACTIVITY 5

Name: ______________________

Match the Graph

Math Objectives:

- Examine rate of change
- Analyze and interpret the graph of a function

Materials: (Per Group)

- TI-83/TI-84 Plus Family
- Calculator-Based Ranger™ (CBR 2™)
- Vernier EasyData™ Application

1. What physical property is represented along the **X-**axis? ______________________

2. What are the units? How far apart are the tick marks? ______________________

3. What physical property is represented along the **Y-**axis? ______________________

4. What are the units? How far apart are the tick marks? ______________________

5. For the first sample graph your teacher displays, how far from the CBR 2 motion detector do you think the walker should stand to begin? ______________________

6. Did the walker begin too close, too far, or just right? ______________________

7. Should you walk forward or backward for a segment that slopes up? ______________________

Why? ______________________

8. Should you walk forward or backward for a segment that slopes down? ______________________

Why? ______________________

9. What should you do for a segment that is flat? ______________________

Why? ______________________

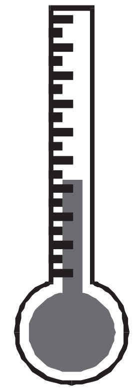
SCORING DIRECTIONS FOR GRAPH MATCH

Give each team a score from 1–5 based on the following criteria. (1 is lowest, 5 is highest.)

	Starting Point	Direction	Rate	Overall Fit	Team Work	Total
Group 1						
Group 2						
Group 3						
Group 4						
Group 5						
Group 6						

Station 2

Cooling Down

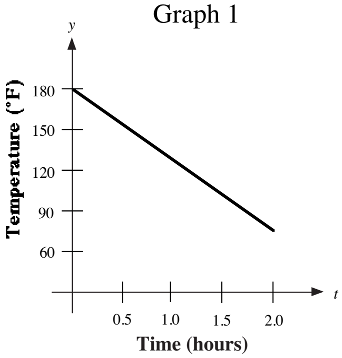


Activity: Cooling Down

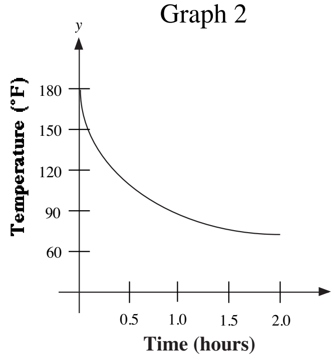
Consider a cup of hot water at approximately 180° F that is placed in a room where the temperature is 74° F. Think about the cooling effect.

1. How will the water cool over time?

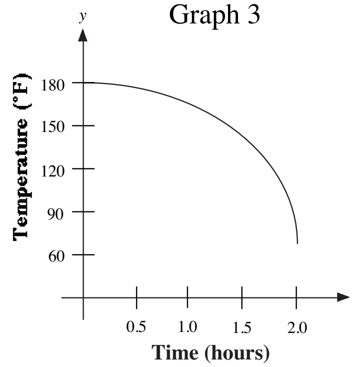
Graph 1



Graph 2

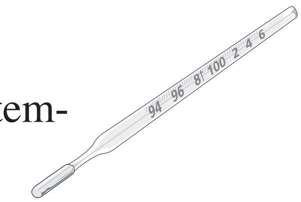


Graph 3



2. Describe a situation implied by each graph.

Use a thermometer.



We will simulate the water cooling down by recording the temperature data of a thermometer cooling down.

Group Roles:

Temperature reader—handles the thermometer and calls out the temperature.
Timer—keeps track of the elapsed time.
Recorder—records the data.

3. Use the thermometer to determine the room temperature. ________
4. Pour hot, not boiling water (≈ 180º F) into a cup. Place the thermometer in the cup for about a minute to heat up.
5. Predict the number of seconds that you think it will take your thermometer to “cool down” to room temperature. _________
6. Remove the thermometer from the cup of hot water. (Make sure to move the thermometer away from the steam of the cup.) Begin collecting data immediately.
   Although the independent variable is time, you may find it easier to call out temperature decreases of 2º and record the elapsed time. The data recorder is responsible for recording all data. Be ready for quick readings initially.

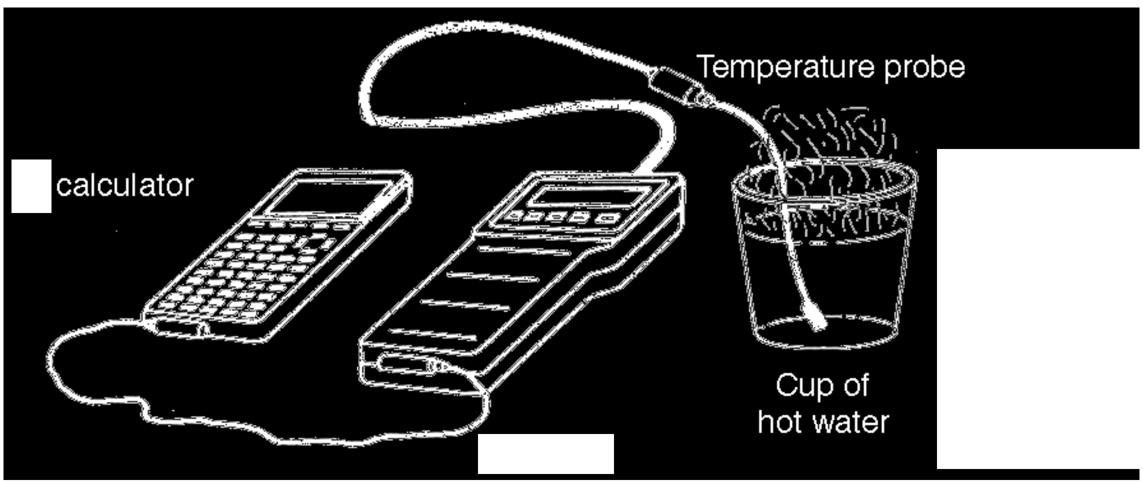
Elapsed Time (seconds)	Temperature (ºF or ºC)

7. What patterns do you see in the data?

Use a graphing calculator and an electronic data collection device with a temperature probe.

We will simulate the water cooling down by recording the temperature data of a temperature probe cooling down.

Group Roles:
Temperature reader—handles the temperature probe.
Calculator—handles the graphing calculator.
Recorder—handles the electronic data collection device.



3. Use the temperature probe to determine the room temperature. ______

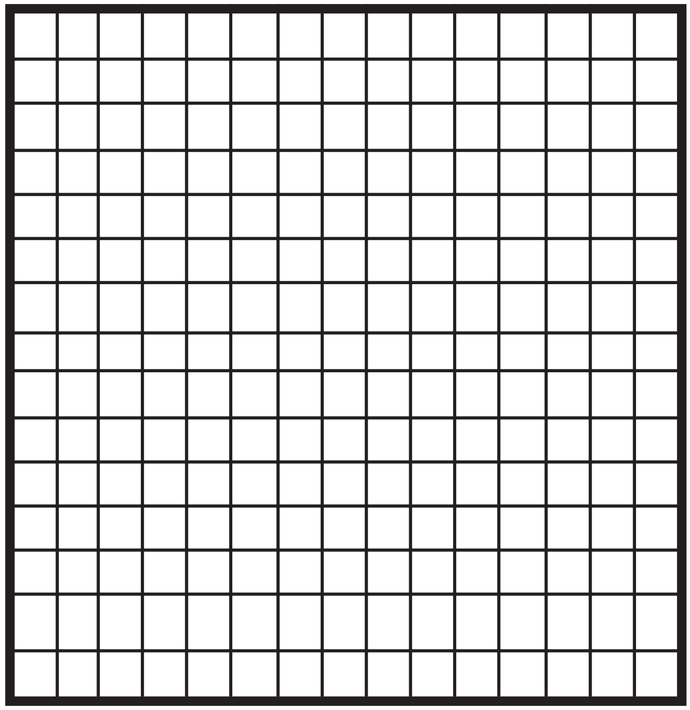
4. Pour hot, not boiling water (≈ 180º F) into a cup. Place the temperature probe in the cup for about a minute to heat up.

5. Predict and record the number of seconds that you think it will take your thermometer to “cool down” to room temperature.

6. Remove the thermometer from the cup of hot water. (Make sure to move the thermometer away from the steam of the cup.) Begin collecting data immediately.

7. What patterns do you see in the data?

8. Sketch a scatter plot of the data collected on the grid below.



9. What family of functions has the characteristics seen in the graph of the data? What is different about the graph of the data and the general function in this family?

10. Adjust a list of data collected to create a scatter plot with a horizontal asymptote at $y = 0$. Use a graphing calculator to find an exponential regression equation of the form $y = ab^x$ that best fits the data.

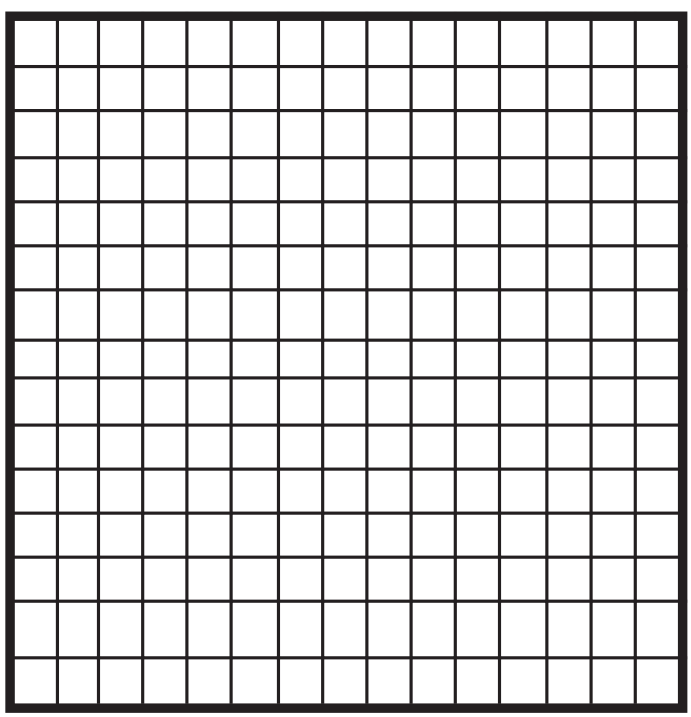
11. Does this regression equation model the actual data? If not, how can you adjust it so that it does?

Reflect and Apply

1. Convert the °C to °F by creating a new list L_5 that is equal to $1.8 \cdot L_4 + 32$. Record findings.

2. How are the two graphs related to each other. Why?

3. Create a scatter plot of L_1, L_5.
   Select a window that will accommodate both the original scatter plot and the new scatter plot. Sketch the plots below.



4. Compare and contrast the two graphs. Do the two graphs run parallel? If so, why? If not, why not?

Station 3

Dampened Harmonic Motion

This activity can be found at the following URL
http://education.ti.com/educationportal/sites/US/sectionHome/activitybook_section_datacollection.html

Damped Harmonic Oscillators

Catherine Tabor and Michelle Buraczyk

Standards

Students are expected to:

- Analyze mathematical relationships to connect and communicate mathematical ideas.
- Apply mathematics to problems arising in everyday life, society and the workplace.
- Use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process as well as the reasonableness of the solution.
- Select tools, including real objects, manipulatives, paper/pencil, and technology, as appropriate and/or techniques, such as mental math, estimation, and number sense, as appropriate so solve problems.
- Communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, and language as appropriate.
- Create and use representations to organize, record, and communicate mathematical ideas.
- Make connections between multiple representations of functions and algebraically construct new functions.
- Analyze and use functions to model real world problems.
- Use the composition of two functions to model and solve real-world problems.
- Graph functions, including exponential, logarithmic, sine, cosine, rational, polynomial, and power functions with various bases, including the natural log function, and their transformations, including $a \cdot f(x)$, $f(x) + d$, $f(x+c)$, $f(b \cdot x)$ for specific values of a, b, c, and c, in mathematical and real-world problems.
- Develop and use a sinusoidal function that models a situation in mathematical and real-world problems.
- Use trigonometric identities such as reciprocal, quotient, Pythagorean, cofunctions, even/odd, and sum and difference identities for cosine and sine to simplify trigonometric expressions in mathematical and real-world problems.

Factors that influence data collection:

- weight of object at end of spring
- how fast the spring is being pulled down
- distance the weight is pulled down
- time period of data collection
- height of ring stand
- possible data change if different object is used

The Setup

Make sure that you monitor the set up and try to keep the students from over stretching their springs.

The Experiment

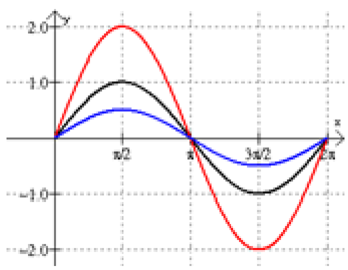
Make sure to watch that students are pulling in straight down or pushing straight up. Otherwise the pendulum effect will cause other issues.

Answers:

1. *What do you notice about the motion?* Hopefully students will notice that as time passes, the spring oscillates less and less.
Does the motion stay consistent? No the amplitude decreases as time moves forward.
How does the motion change? Just in case the students only answered NO to previous question, let them know that that is not going to be a good enough answer.
2. Create an accurate sketch when you are happy with your results. Don't forget to use labels and scale.
Answers will vary.

3. Based upon the 1st period and your knowledge of transformations, what is the function for the graph? The graph is a sine graph. The exact function will vary.

$$y = A\sin(B(x - C)) + D$$



3. Based upon the 1st period and your knowledge of transformations, what is the function for the graph?

4. What do you notice about the amplitude of the functions as a whole?

The amplitude should be decreasing as time moves forward.

5. Does the period of the wave change?

The period should not be changing.

6. Is there a difference between pulling the weight down or compressing the weight and then letting go?

As long as you do it the same amount, pushing it up or pulling it down should have not changed the result.

7. Find the values of the peaks on the screen by tracing the graph.

Peak Number	Amplitude
1	
2	
3	
4	
5	

Answers will vary.

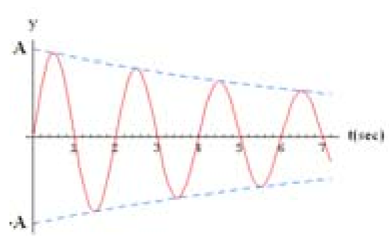
8. Graph these points on a grid.
Answers will vary.

9. Based on your knowledge of parent functions, what would model this graph the best? Use the regression feature on your calculator to find the model.

The new equation should be that of an exponential curve. Some students may try to fit a linear equation, so make sure that you are leading them to the correct conclusion.

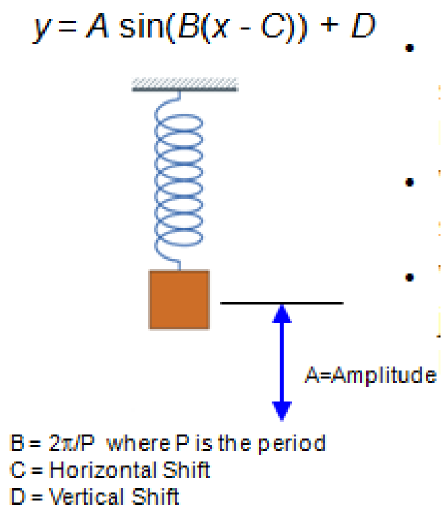
10. How do you think the new function will fit into our original model? What do you think will be our new equation?
The new function will replace *A* as the amplitude, since this is the way that the amplitude is changing. Notice that the amplitude is curving downward.

11. Put the new equation in Y= and sketch the new graph.
The sketches will vary, but all should show the amplitude decreasing as time increases.



Damped Harmonic Oscillators

Simple Harmonic Motion

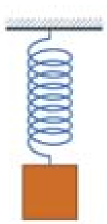


- Simple Harmonic Motion is used to describe the motion of simple oscillators, pendulums and vibrations in a perfect world. It also describes the motion of Ferris Wheels.
- *Why do we need to study anything else?* We don't live in a perfect world. Oscillators slow down. Pendulums return to equilibrium. Sound waves travel away unless replenished.
- *What is wrong with just using simple harmonic motion?* Not all motion can be described this way. It is sufficient for introductory ideas and general discussion, but real-world concepts rarely follow a simple model. Complex and compound models are often needed to fully describe a motion.

The Setup

- Ring stand
- Object for end of spring
- Paper plate to increase area for detection (place this between the spring and weight, if necessary)
- CBR
- TI Calculator

Before collecting data, pull down the spring (gently, about 10-15 cm) and let it go.



1. What do you notice about the motion? Does the motion stay consistent? How does the motion change?

The Experiment

Set the spring in motion by gently pulling it down.
After the motion begins to deteriorate, start the data collection on the CBR.
Collect the data for 10 seconds.
View the graph. You may have to try this multiple times before you get a good image.
Try pushing up and releasing instead of pulling the weight down.

2. Create an accurate sketch when you are happy with your results. Don’t forget to use labels and scale.

The Basic Function

3. Based upon the 1st period and your knowledge of transformations, what is the function for the graph?

4. What do you notice about the amplitude of the functions as a whole?

5. Does the period of the wave change?

6. Is there a difference between pulling the weight down or compressing the weight and then letting go?

7. Find the values of the peaks on the screen by tracing the graph.

Peak Number	Amplitude
1	
2	
3	
4	
5	

8. Graph these points on a grid.

9. Based on your knowledge of parent functions, what would model this graph the best? Use the regression feature on your calculator to find the model.

10. How do you think the new function will fit into our original model? What do you think will be our new equation?

11. Put the new equation in Y= and sketch the new graph.

Station 4

What Goes Up

TEACHER INFORMATION

Activity
10

What Goes Up: Position and Time for a Cart on a Ramp

1. There are currently four Motion Detectors that can be used for this lab activity. Listed below is the best method for connecting your type of Motion Detector. Optional methods are also included:

   Vernier Motion Detector: Connect the Vernier Motion Detector to a CBL 2 or LabPro using the Motion Detector Cable included with this sensor. The CBL 2 or LabPro connects to the calculator using the black unit-to-unit link cable that was included with the CBL 2 or LabPro.

   MDC cable

   CBR: Connect the CBR directly to the graphing calculator's I/O port using the extended length I/O cable that comes with the CBR.

   Optionally, the CBR can connect to a CBL 2 or LabPro using a Motion Detector Cable. This cable is not included with the CBR, but can be purchased from Vernier Software & Technology (order code: MDC-BTD).

   I/O cable

   CBR 2: The CBR 2 includes two cables: an extended length I/O cable and a Calculator USB cable. The I/O cable connects the CBR 2 to the I/O port on any TI graphing calculator. The Calculator USB cable is used to connect the CBR 2 to the USB port located at the top right corner of any TI-84 Plus calculator.

   Optionally, the CBR 2 can connect to a CBL 2 or LabPro using the Motion Detector Cable. This cable is not included with the CBR 2, but can be purchased from Vernier Software & Technology (order code: MDC-BTD).

   I/O cable USB cable

   Go! Motion: This sensor does not include any cables to connect to a graphing calculator. The cable that is included with it is intended for connecting to a computer's USB port. To connect a Go! Motion to a TI graphing calculator, select one of the options listed below:

   Option I–the Go! Motion connects to a CBL 2 or LabPro using the Motion Detector Cable (order code: MDC-BTD) sold separately by Vernier Software & Technology.

   Option II–the Go! Motion connects to the graphing calculator's I/O port using an extended length I/O cable (order code: GM-CALC) sold separately by Vernier Software & Technology.

   Option III–the Go! Motion connects to the TI-84 Plus graphing calculator's USB port using a Calculator USB cable (order code: GM-MINI) sold separately by Vernier Software & Technology.

2. When connecting a CBR 2 or Go! Motion to a TI-84 calculator using USB, the EasyData application automatically launches when the calculator is turned on and at the home screen.

3. A four-wheeled dynamics cart is the best choice for this activity. (Your physics teacher probably has a collection of dynamics carts.) A toy car such as a Hot Wheels or Matchbox car is too small, but a larger, freely-rolling car can be used. A ball can be used, but it is very difficult to have the ball roll directly up and down the ramp. As a result the data quality is strongly dependent on the skill of the experimenter when a ball is used.

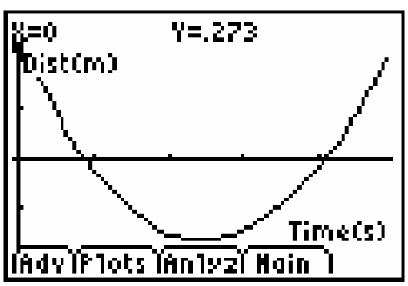
4. If a channeled track which forces a ball to roll along a line is used as the ramp, a ball will yield satisfactory data.

5. Note that the ramp angle should only be a few degrees above horizontal. We suggest an angle of five degrees. Most students will create ramps with angles much larger than this, so you might want to have them calculate the angles of their tracks. That will serve both as a trigonometry review and ensure that the ramps are not too steep.

6. It is critical that the student zeroes the Motion Detector in a location that will be crossed by the cart during its roll. If the cart does cross the zero location (both on the way up and the way down), there will be two *x*-axis crossings as required by the analysis. If the student does not zero the Motion Detector, or zeroes it in a location that is not crossed by the cart during data collection, then the analysis as presented is not possible.

7. If the experimenter uses care, it is possible to have the cart freely rolling throughout data collection. In this case (as in the sample data below) there is no need to select a region or adjust the time origin, saving several steps.

SAMPLE RESULTS



Raw Data in EasyData

Data with parabolic model

Model equation

DATA TABLE

y-intercept	First *x*-intercept	Second *x*-intercept
0.273	0.40	2.0

Product of *x*-intercepts	0.8
Sum of *x*-intercepts	2.4

a	0.341
b	– 0.818
c	0.273

ANSWERS TO QUESTIONS

1. Model equation is $y = 0.273 - 0.818\ x + 0.341\ x^2$ (depends on data collected).
2. Model parabola is an excellent fit, as expected since the vertices were taken from the experimental data.
3. Regression quadratic equation is $y = 0.285 - 0.797\ x + 0.326\ x^2$, or nearly the same as that obtained using the vertex form.
4. The parameters in the calculator's regression are nearly the same as those determined from the vertex form of the equation.
5. The Motion Detector records distance *away* from itself. Since the detector was at the top of the ramp, the cart was at its closest (minimum distance) to the detector when the cart was at its highest point.
6. If the experiment were repeated with the Motion Detector at the bottom of the ramp, the distance data would still be parabolic. However, the parabola would open downward, and the coefficient *a* would change sign.

Activity
10

What Goes Up: Position and Time for a Cart on a Ramp

When a cart is given a brief push up a ramp, it will roll back down again after reaching its highest point. Algebraically, the relationship between the position and elapsed time for the cart is quadratic in the general form

$$y = ax^2 + bx + c$$

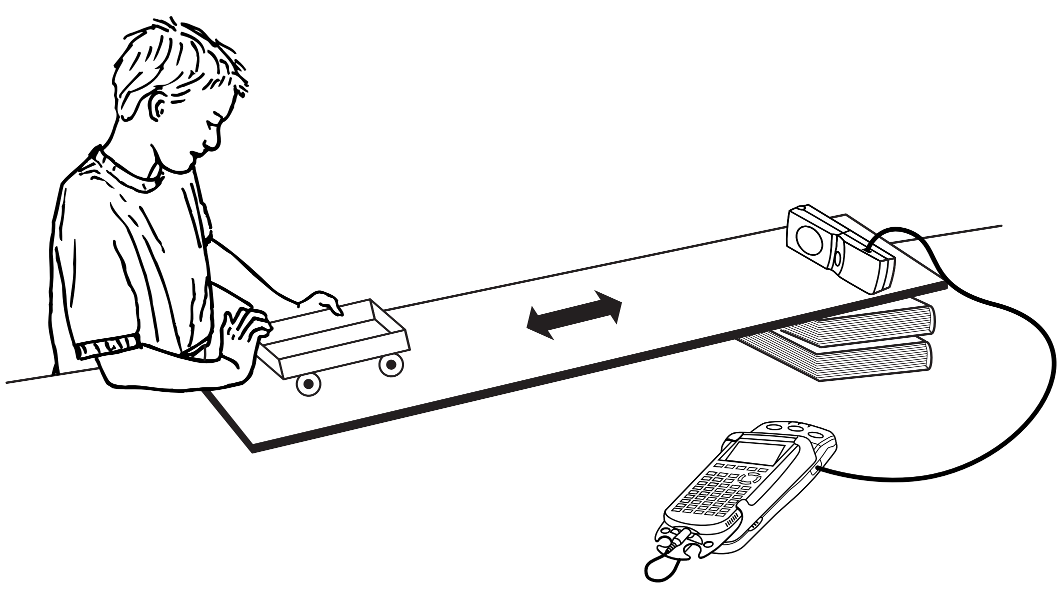
where y represents the position of the cart on the ramp and x represents the elapsed time. The quantities a, b, and c are parameters which depend on such things as the inclination angle of the ramp and the cart's initial speed. Although the cart moves back and forth in a straight-line path, a plot of its position along the ramp graphed as a function of time is parabolic.

Parabolas have several important points including the vertex (the maximum or minimum point), the y-intercept (where the function crosses the y-axis), and the x-intercepts (where the function crosses the x-axis). The x- and y-intercepts are related to the parameters a, b, and c given in the equation above according to the following properties:

1. The y-intercept is equal to the parameter c.
2. The product of the x-intercepts is equal to the ratio $\frac{c}{a}$.
3. The sum of the x-intercepts is equal to $-\frac{b}{a}$.

These properties mean that if you know the x- and y-intercepts of a parabola, you can find its general equation.

In this activity, you will use a motion detector to measure how the position of a cart on a ramp changes with time. When the cart is freely rolling, the position versus time graph will be parabolic, so you can analyze this data in terms of the key locations on the parabolic curve.



OBJECTIVES

- Record position versus time data for a cart rolling up and down a ramp.
- Determine an appropriate parabolic model for the position data using the *x*- and *y*-intercept information.

MATERIALS

TI-83 Plus, TI-83, or TI-73
CBL 2™ or LabPro® data collection device
DATAMATE software
TI CBR™ or Vernier Motion Detector
4-wheeled cart
Board or track at least 1.2 m
Books to support ramp

PROCEDURE

1. Place one or two books beneath one end of the board to make an inclined ramp. The inclination angle should only be a few degrees. Place the motion detector at the top of the ramp. Remember that the cart must never get closer than 0.4 m to the detector, so if you have a short ramp you may want to use another object to support the detector.

2. Connect the motion detector into the DIG/SONIC port of the CBL 2 or the DIG/SONIC 1 port of the LabPro data collection device. Use the unit-to-unit cable to connect the TI graphing calculator to the data collection device. Firmly press in the cable ends.

3. Turn on the calculator and start the DATAMATE software. Press [CLEAR] to reset the software.

4. So that the zero reference position of the motion detector will be about a quarter of the way up the ramp, you will zero the detector while the cart is in this position.

   a. Select SETUP from the main screen.
   b. Select ZERO from the setup screen.
   c. Select DIG-DISTANCE from the SELECT CHANNEL screen.
   d. Hold the cart still, about a quarter of the way up the ramp. The exact position is not critical, but the cart must be freely rolling through this point in Step 6.
   e. Press [ENTER] to zero the motion detector.

5. Practice rolling the cart up the ramp so that you release the cart below the point where you zeroed the detector, and so that the cart never gets closer than 0.4 m to the detector. Be sure to pull your hands away from the cart after it starts moving so the motion detector does not detect your hands.

6. Select START to begin data collection. You will hear the data collection device beep. Wait for about a second, and then roll the cart as you practiced earlier. Data collection will run for five seconds.

7. Press [ENTER] to display the DISTANCE graph.

8. Examine the distance versus time graph. The graph should contain an area of smoothly changing distance. The smoothly changing portion must include two $y = 0$ crossings.

   Check with your teacher if you are not sure whether you need to repeat the data collection. To repeat data collection, press [ENTER] to return to the graph selection screen, and select MAIN SCREEN; then return to Step 6.

ANALYSIS

1. Since the cart may not have been rolling freely on the ramp the whole time data was collected, you need to remove the data that does not correspond to the free-rolling times. In other words, you only want the portion of the graph that appears parabolic. DATAMATE allows you to select the region you want using the following steps.

   a. Starting from the distance graph, press [ENTER].
   b. Select SELECT REGION from the graph selection screen.
   c. Move the left bound cursor to the left edge of the parabolic region using the cursor keys.
   d. Press [ENTER] to record the left bound.
   e. Move the right bound cursor to the right edge of the parabolic region using the cursor keys.
   f. Press [ENTER] to record the right bound. Once the calculator finishes performing the selection, you will see the selected portion of the graph filling the width of the screen.

2. Since the cart was not rolling freely when data collection started, adjust the time origin for the graph so that it starts with zero. To do this, you will need to leave DATAMATE.

   a. Press [ENTER] to return to the graph selection screen.
   b. Select MAIN SCREEN from the graph selection screen.
   c. Select QUIT to leave DATAMATE. Follow instructions on the calculator screen to return to the calculator home screen.

3. To adjust the time origin, subtract the minimum time in the time series from all the values in the series. That will start the time series from zero.

   TI-73

   a. Access lists by pressing [2nd] [STAT]. Press the number next to L1; this enters L1 on the home screen.
   b. Press [−].
   c. To enter the min() function press [MATH], use [▸] to highlight the NUM menu, and press presing the number adjacent min(to paste the command to the home screen.
   d. Enter L1 again, as you did before, and press [)] to close the minimum function.
   e. Press [STO▸], and enter L1 a third time to complete the expression L1 – min(L1) → L1. Press [ENTER] to perform the calculation.

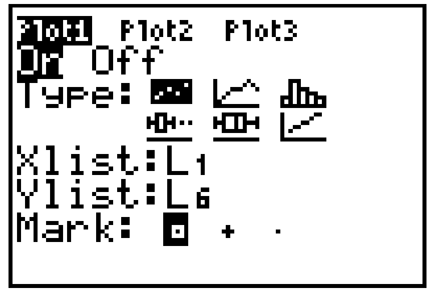
   TI-83 and TI-83 Plus

   a. Press [2nd] [L1].
   b. Press [−].
   c. To enter the min() function press [MATH], use [▸] to highlight the NUM menu, and press the number adjacent min(to paste the command to the home screen.
   d. Press [2nd] [L1] again and press [)] to close the minimum function.
   e. Press [STO▸], and press [2nd] [L1] a third time to complete the expression L1 – min(L1) → L1. Press [ENTER] to perform the calculation.

4. You can find the two *x*-intercepts and the *y*-intercept by tracing across the parabola. Redisplay the graph with the individual points highlighted.

   a. Press [2nd] [STAT PLOT] ([PLOT] on the TI-73) and press [ENTER] to select Plot 1.

b. Change the Plot1 settings to match the screen shown here. Press [ENTER] to select any of the settings you change.



c. Press [ZOOM] and then select ZoomStat (use cursor keys to scroll to ZoomStat) to draw a graph with the *x* and *y* ranges set to fill the screen with data.

d. Press [TRACE] to determine the coordinates of a point on the graph using the cursor keys.

Trace across the graph to determine the *y*-intercept along with the first and second *x*-intercepts. You will not be able to get to exact *x*-intercepts because of the discrete points, but choose the points closest to the zero crossing. Round these values to 0.01, and record them in the first Data Table on the *Data Collection and Analysis* sheet.

5. Determine the product and sum of the *x*-intercepts. Record these values in the second Data Table on the *Data Collection and Analysis* sheet.

6. Use the intercept values, along with the three intercept properties discussed in the introduction, to determine the values of *a*, *b*, and *c* for the general form parabolic expression $y = ax^2 + bx + c$. Record these values in the third Data Table.

   Hint: Write an equation for each of the three properties; then solve this system of equations for *a*, *b*, and *c*.

⇒ Answer Question 1 on the *Data Collection and Analysis* sheet.

7. Now that you have determined the equation for the parabola, plot it along with your data.

   a. Press [Y=].
   b. Press [CLEAR] to remove any existing equation.
   c. Enter the equation for the parabola you determined in the Y1 field. For example, if your equation is $y = 5x^2 + 4x + 3$, enter 5*x²+4*x+3 on the Y1 line.
   d. Press [GRAPH] to see the data with the model graph superimposed.

⇒ Answer Question 2 on the *Data Collection and Analysis* sheet.

8. You can also determine the parameters of the parabola using the calculator's quadratic regression function.

   TI-73

   a. Press [2nd] [STAT] and use the cursor keys to highlight CALC.
   b. Press the number next to QuadReg and to copy the command to the home screen.
   c. After the QuadReg command, press [2nd] [STAT] and select L1 by pressing the number next to L1. Then press [,]. Repeat the procedure to select L6.
   d. After selecting L6, press [,] then press [2nd] [VARS].
   e. Press the number next to Y-Vars.
   f. Press [ENTER] to select Y1 and copy it to the expression.

      On the home screen, you will now see the entry QuadReg L1, L6, Y1. This command will perform a quadratic regression with L1 as the *x*-values and L6 as the *y*-values. The resulting regression line will be stored in equation variable Y1.

   g. Press [ENTER] to perform the regression.

⇒ Record the regression equation with its parameters in Question 3 on the *Data Collection and Analysis* sheet.

h. Press GRAPH to see the graph.

⇒ Answer Questions 4-6 on the *Data Collection and Analysis* sheet.

TI-83 and TI-83 Plus

a. Press STAT and use the cursor keys to highlight CALC.
b. Press the number adjacent to QuadReg to copy the command to the home screen.
c. Press 2nd [L1] , 2nd [L6] , to enter the lists containing the data.
d. Press VARS and use the cursor keys to highlight Y-VARS.
e. Select Function by pressing ENTER.
f. Press ENTER to copy Y1 to the expression.

   On the home screen, you will now see the entry QuadReg L1, L6, Y1. This command will perform a quadratic regression using the *x*-values in L1 and the *y*-values in L6. The resulting regression line will be stored in equation variable Y1.

g. Press ENTER to perform the regression.

⇒ Record the regression equation with its parameters in Question 3 on the *Data Collection and Analysis* sheet.

i. Press GRAPH to see the graph.

⇒ Answer Questions 4-6 on the *Data Collection and Analysis* sheet.

DATA COLLECTION AND ANALYSIS

Name ______________________

Date ______________________

DATA TABLES

y-intercept	First *x*-intercept	Second *x*-intercept

Product of *x*-intercepts	
Sum of *x*-intercepts	

a	
b	
c	

QUESTIONS

1. Substitute the values of a, b, and c you just found into the equation $y = ax^2 + bx + c$. Record the completed modeling equation here.

2. Is your parabola a good fit for the data?

3. Record the regression equation from Step 8 with its parameters.

4. Are the values of *a*, *b*, and *c* in the quadratic regression equation above consistent with your results from your earlier calculation?

5. In the experiment you just conducted, the vertex on the parabolic distance versus time plot corresponds to a minimum on the graph even though this is the position at which the cart reaches its maximum distance from the starting point along the ramp. Explain why this is so.

6. Suppose that the experiment is repeated, but this time the motion detector is placed at the bottom of the ramp instead of at the top. Make a rough sketch of your predicted distance versus time plot for this situation. Discuss how the coefficient *a* would be affected, if at all.

Appendix

Information on the Easy Data Application

Appendix C EasyData Reference

In this book, you use the TI-83 Plus or TI-84 Plus graphing calculators connected to a data-collection device to collect, examine, analyze, and graph data in the activities. Once EasyData is installed on your calculator, it can be accessed by pressing the APPS key.

How Do I Get EasyData on My Calculator

EasyData is part of the bundle of APPS that come preloaded on all new TI-84 Plus and TI-84 Plus Silver Edition graphing calculators manufactured after January, 2005. To check to see if EasyData is on your calculator, press APPS and scroll through the list of loaded applications. If your graphing calculator does not contain the EasyData App, you can download EasyData from the Vernier website www.vernier.com/easy.html and use TI Connect to transfer it to your graphing calculator.

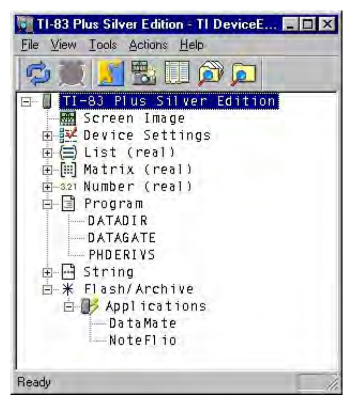
Using TI Connect to Load EasyData

TI Connect for Windows and Macintosh is very easy to use. The TI-83 Plus and TI-83 Plus Silver Edition need to be running operating system 1.15 or newer to work with TI Connect.

Windows Computers running Windows 98, NT 4.x, 2000 or ME, and XP

1. Connect the TI-GRAPH LINK cable, or the TI Connectivity cable to the serial or USB port of your computer and to the port at the bottom edge of the TI-83 Plus graphing calculator.

   If you are using the TI-84 Plus or TI-84 Plus Silver Edition, connect the TI USB Cable to the USB port of your computer and to the USB port at the top edge of your graphing calculator.



2. Start the TI Connect software on your computer. Click on Device Explorer.

3. The program will identify the attached device and call up a window representing the contents.

4. Loading programs and applications onto a TI graphing calculator is very easy. All you have to do is drag the program or application from wherever you have it on your computer to the Device Explorer window, and it will copy onto your graphing calculator.

5. The program should now be loaded into your calculator. To confirm this, press APPS on the calculator to display the loaded applications.

Macintosh Computers running Mac® OS X 10.2 (Jaguar), 10.3 (Panther), and 10.4 (Tiger).

1. Connect the TI-GRAPH LINK cable, or the TI Connectivity cable to the USB port of your computer and to the port at the bottom edge of the TI-83 Plus, or TI-83 Plus Silver Edition graphing calculator.

   If you are using the TI-84 Plus or TI-84 Plus Silver Edition graphing calculator, connect the TI USB Cable to the USB port of your computer and to the USB port at the top edge of your graphing calculator.

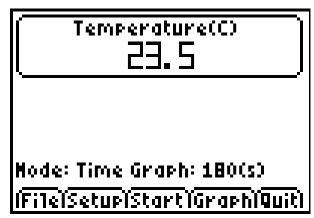
2. Turn the calculator on. On the computer, start TI Device Explorer.

3. The program will identify the attached device and call up a window representing the contents.

4. Loading programs onto a TI graphing calculator is very easy. All you have to do is drag the program to the device's window and it will copy onto your graphing calculator.

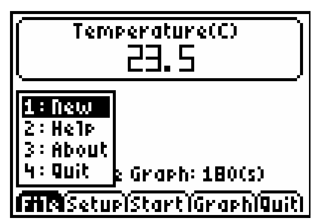
5. The program should now be loaded into your calculator. To confirm this, press APPS on the calculator to display the loaded applications.

Main Screen[1]



The Main screen of EasyData is shown at the right. The top portion of the screen displays the sensor currently in use–in this case a temperature probe. A sensor reading is also displayed. The lower portion of the screen displays the default data-collection mode for the sensor. Five options are listed across the bottom of the screen, which correspond to the five calculator keys directly below each option. The Main screen of EasyData can be used as a meter; the sensor readings are updated approximately every second.

File Menu



The File menu contains four options. When you select File by pressing the Y= key, a pop up menu appears, as shown. When you select the first option, **New**, the EasyData program is reset, and it will return to the Main screen. You should select **New** at the beginning of an experiment as a matter of routine or when you want to confirm that the program has all of the default values in place for the sensor and the data collection. Select **Help** to view the four screens of the help tips for EasyData. Select **About** to see the splash screen, which tells you which version of EasyData you are running and the firmware version of any connected interface. After a moment, the program will return to the Main screen. Select **Quit** to exit EasyData.

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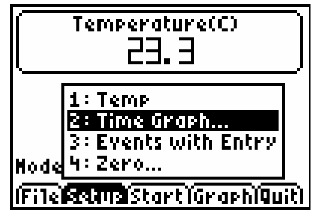
[1] The following description applies to EasyData version 1.0. Information about EasyData version 2 can be found on the Vernier web site (www.vernier.com/easy).

Setup Menu

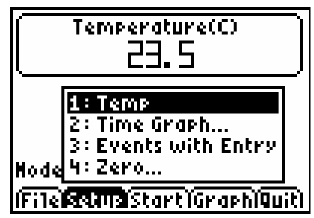


The Setup menu lists options for the sensors in use, the data-collection mode, and zeroing a sensor. Shown is the Setup menu when a temperature probe is used. Please see the next section for more information about the Setup menu.

Start, Graph, and Quit Options

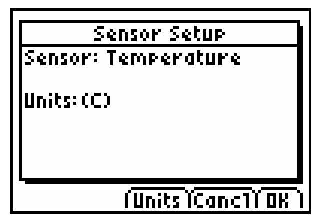
Select Start to begin data collection. Select Graph to view a graph of data that you have already collected. Select Quit to exit the EasyData application.

Using the Setup Menu



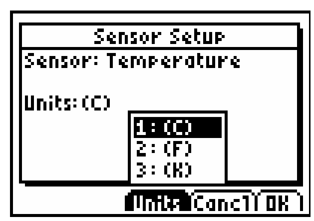
The Setup menu offers a list of options that depends on the sensor(s) being used. The figure to the right shows the Main screen of EasyData when Setup is selected. The sensor in use is displayed at the top of the list, followed by the data-collection options. The last item listed is **Zero...**, the option to zero a sensor. The following example shows you how to use the Setup menu with a temperature probe.

1: TEMP



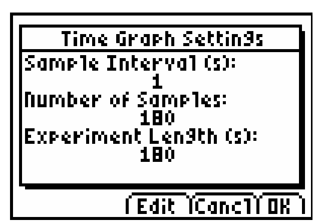
When you select **1: TEMP**, the Sensor Setup screen is displayed. This screen identifies the sensor and the units of measure. There are three options displayed at the bottom of the screen: Units, Cancl, and OK.

When you select Cancl or OK, you are sent back to the Main screen.

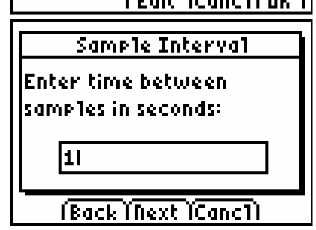


When you select Units, you can view the units of measure that are available for use with the sensor. For example, when using a temperature probe you may choose to display and record the temperature readings in degrees Celsius, degrees Fahrenheit, or the Kelvin absolute temperature scale. (Kelvin temperature values are not referred to as "degrees", nor is the degree sign used.)

2: Time Graph…

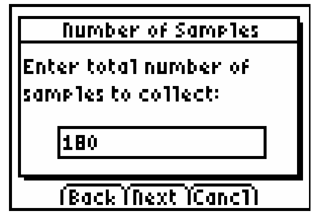


When you select the time graph option, the time graph default settings for your sensor are displayed. Please note that these are the default values for the auto-ID sensor being used with EasyData. There are three options displayed at the bottom of the screen: Edit, Cancl, and OK. When you select Cancl or OK, you are sent back to the Main screen.

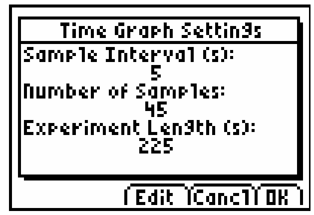


Select Edit to change the time graph settings. The first screen to appear is the Sample Interval screen. It displays the current data collection interval, in seconds, with the cursor next to the value. You can delete the current value by pressing CLEAR or by pressing ◀ and DEL. You can also type over the current value by pressing ◀ and entering a new sample interval. Note that EasyData allows only certain sample intervals. If you enter a sample interval that EasyData does not support, an error message will appear and a sample interval will be chosen for you.

If, at any time, you wish to stop what you are doing and return to the Main screen, select Cancl. The original values will be restored.

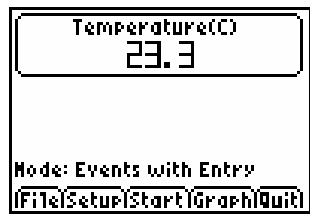


When you have entered a new sample interval, or decided to use the default interval, you may continue by selecting Next. A new screen will appear, entitled “Number of Samples”, which displays the default value. You may delete and enter numbers in this screen as you did with the sample interval screen. Again, note that EasyData allows a maximum number of samples based on the sensor in use.



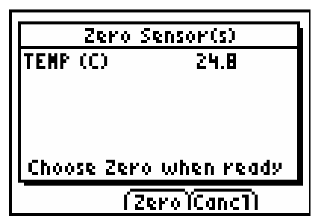
When you have made the desired changes, select Next. The new time graph settings will be displayed. EasyData always expresses time in seconds; it cannot be changed to minutes or hours. If you select Cancl from this screen, the original settings will be restored and you will go to the Main screen. If you select Edit, you will go back to the sample interval screen. Select OK to accept the new time graph settings and return to the Main screen.

3: Events with Entry…



When you select the Events with Entry option, you are changing the data-collection mode to one that is independent of time. There are no other choices to be made, thus after you select **Events with Entry…**, the screen goes blank for a second or two and then returns to the Main screen. The new mode is displayed at the bottom of the screen.

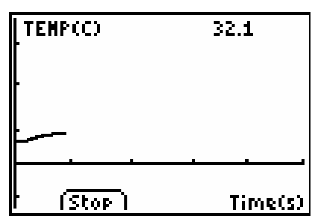
4: Zero…



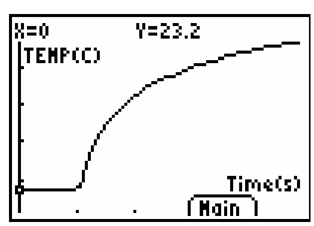
Select this option when you wish to set the current sensor reading to zero. Allow the sensor readings to stabilize, and then select Zero.

Data Collection

Time Graph



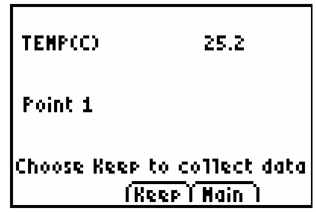
In most instances data is plotted as it is collected. This is known as live data collection. If the data-collection rate is too fast or too slow, the data collection will be non-live and “Sampling” will appear on the screen until data collection has finished.



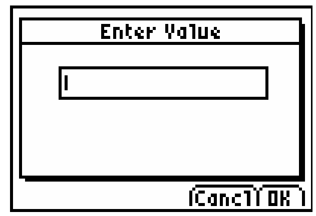
To collect data, select Start from the Main screen. During live data collection the screen will change to a graph and the data will be plotted. The data collection will cease automatically, according to the sampling parameters. However, you can halt the data collection early by selecting Stop. After the data collection ends, the graph autoscales to best fit the data. The calculator vernacular for this process is “ZoomStat”. At right is the autoscaled version of the previous graph. Press ▶ or ◀ to trace the data and examine individual data pairs which are displayed at the top of the graph. Select Main to return to the Main screen.

Events with Entry

Select Start from the Main screen to begin data collection.
The screen will change to display a sensor reading and list the data point that you will be collecting. When the reading has stabilized, select Keep to collect the data point.



The “Enter Value” dialog box will appear. The cursor will rest in a box beneath the title. Type the value for the independent variable (X-value), and then select OK. Repeat this process to collect subsequent data points.



After you have collected two data points, the screen will display a graph of your data. The current sensor reading will appear at the top of the screen, and you will have two options from this point on. Select Keep to collect a data point, or select Stop to halt the data collection and see an autoscaled graph of your data.

Using the Sample Data Files

The CD inside the back cover of this book includes sample data files for each calculator for each activity. The sample data lets you evaluate the activity without setting up and performing the activity procedures. To use the sample data, use TI-Connect to drag the sample data files onto your graphing calculator. Once the sample data files have been loaded, proceed to the Analysis section of the activity and follow the instructions for working with the data.

MATH EXPECTATIONS FOR INCOMING TAMU FRESHMEN

Every student at TAMU must take a Math Placement Exam (MPE). The MPE website (https://mathplacement.tamu.edu/) contains information regarding which exam students should take, the logistics of the exam, the purpose of the exam, and other information. One of the most valuable pieces of information on the website is a sample exam that shows students the level of mathematics they must know to be successful on the exam. The sample MPE for prospective engineers can be found in the last few pages of this document and the solutions to the problems can be found at the math placement website. Students must get at least 22 of the problems on the MPE (out of 33) correct to be placed into calculus I.

The mathematics department expects incoming engineering students to have a good foundation in the following areas:

- Algebraic Skills
- Logarithmic Functions
- Exponential Functions
- Rational Functions
- Piecewise Defined Functions
- Vectors
- Parametric Equations

An archive of calculus exams given by the math department since 1995 can be found at http://www.math.tamu.edu/courses/math151/common-exams/. As a math teacher of prospective college students you are encouraged to look at the past common exams, especially exam 1, to see the level of mathematics expected by incoming freshmen.

As a teacher of mathematics you can better prepare your students for college by following the tips below.

Tip #1: Teach for conceptual understanding, not just procedural proficiency.

Tip #2: Do not give them formula sheets for exams. Require them to know formulas.

Tip #3: Give full length exams and expect them to finish within the class period.

Tip #4: Don't allow test corrections.

Tip #5: Minimize the amount of extra credit given to students.

Tip #6: Provide challenging problems; combine concepts and skills within a single problem and put these problems on exams. Example: Find all solutions to the equation $x^2e^x - 2xe^x - 3e^x = 0$.

Tip #7: Give comprehensive exams. Over the course of a semester a typical calculus student takes 3 exams (which makes up 50% of their grade) and 1 final exam (which makes up 25% of their grade).

Tip #8: Don't allow students to use calculators on exams. If this is not possible, try to minimize the time you allow the use of a calculator.

Tip #9: Require your students to read and comprehend material in mathematics textbooks.

Tip #10: Require your students to do arithmetic by hand, especially operations on rational expressions.

1. Find the x and y intercepts for the function $f(x) = x^3 - 9x$.
2. Find the domain of:
   (a) $f(x) = \sqrt{-x^2 - 4x + 5}$
   (b) $g(t) = \ln(4t - 3)$
   (c) $h(x) = \dfrac{1}{x^3 + 3x^2 - x - 3}$
3. Simplify the expression. Write your answer using positive rational exponents. $\left(\dfrac{2}{\sqrt{x^5}}\right)\left(\sqrt[3]{4x}\right)$
4. If we begin with the graph of $f(x) = \sqrt{x}$, shift 4 units to the right, shrink vertically by a factor of $\dfrac{1}{2}$, and shift upward 10 units, write an equation for the transformed graph.
5. Solve for x: $\log(x + 2) + \log(x - 1) = 1$.
6. Factor completely: $3x^2(4x^2 + 1)^8 + 64x^4(4x^2 + 1)^7$.
7. How far from the base of an 18 foot tall pole must a person be standing if the angle of elevation from the ground to the pole is 41°?
8. Find $f \circ g$ if $f(x) = \dfrac{x}{x+1}$ and $g(x) = \dfrac{2}{x}$. Simplify.
9. Perform the indicated operation and simplify: $\dfrac{8}{x+1} - \left(\dfrac{y}{z+2} \div \dfrac{y-4}{w}\right)$
10. Solve for x: $e^{2x} - 2e^x - 3 = 0$.
11. Find the equation of the line passing through the point $(5, 1)$ with slope 7. Next, find y when $x = -4$.
12. If $f(x) = \sqrt{x + 4}$, find and simplify $\dfrac{f(2 + h) - f(2)}{h}$.
13. Simplify $\dfrac{(x^2y^4)^5(x^3y)^{-3}}{xy}$.
14. Simplify $\sqrt[3]{a^3b}\sqrt[3]{64a^4b^2}$.
15. Perform the operations and simplify.
    $$\frac{x^2}{x^2 - x - 2} - \frac{4}{x^2 + x - 6} + \frac{x}{x^2 + 4x + 3}.$$

16. Find all zero's and vertical asymptotes for $f(x) = \dfrac{3x^2 - 14x - 5}{4x^2 - 17x - 15}$

17. If θ is in quadrant II and $\sin\theta = \dfrac{1}{7}$, what is $\cos\theta$?

18. Use properties of logarithms to expand the expression $\ln\left(\dfrac{\sqrt{x}y^5}{(z+1)^4}\right)$.

19. Evaluate $\sec\dfrac{2\pi}{3} - \tan\dfrac{\pi}{6}$.

20. If we begin with a rectangle with length 5 inches and width 4 inches, then increase the length by 8%, what is the change in area?

21. Evaluate $f(2) - f(-3)$ If

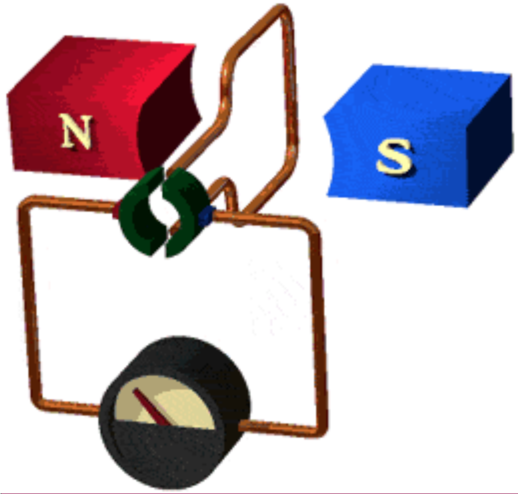
$$f(x) = \begin{cases} x^3 + 1 & , \quad \text{if } \ x > 1 \\ 2x^2 - 3 & , \quad \text{if } \ x \leq 1 \end{cases}$$

22. Simplify the expression $\dfrac{\cos^2\theta}{1 + \sin\theta}$.

23. Evaluate $\log_4 \dfrac{1}{\sqrt[3]{16}}$.

24. Simplify $\dfrac{\frac{1}{a} - b}{\frac{1}{b^3} + a}$.

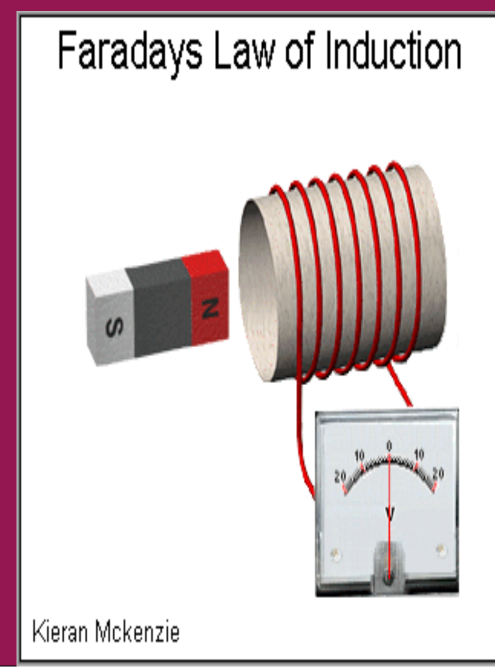
25. A bacteria culture contains 1200 bacteria and doubles every day. How many hours will it take the culture to reach 10000 bacteria?



TEXAS A&M UNIVERSITY

Physics Workshop

Dr. Tatiana Erukhimova
Department of
Physics & Astronomy



64 Faculty

- 2 Nobel Laureates
- 3 National Academy of Science
- 1 American Academy of Arts and Sciences
- 9 Distinguished Professors

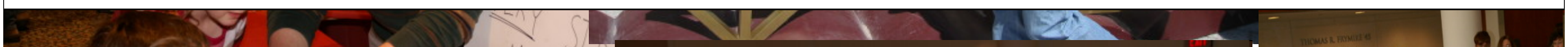
Physics Faculty teach introductory physics classes P218 (Mechanics) and P208 (Electricity & Optics) to all engineering students

Physics & Engineering Festival
March 30-31

Over 100 demonstrations! About 4000 attendees

Physics Shows

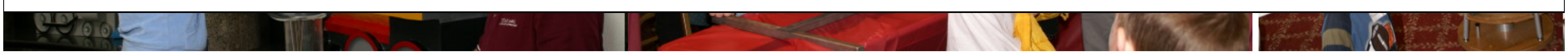
in schools, summer camps, libraries



Saturday Morning Physics

for High School Students

7 Saturdays each spring



Curved Space:
VERY
4141

Today's demonstrations

- *can be made with household materials*
- *require little preparation*
- *modest budget*
- *can be easily shown in the classroom*

I can't help but see physics everywhere I go now. It's pretty neat.

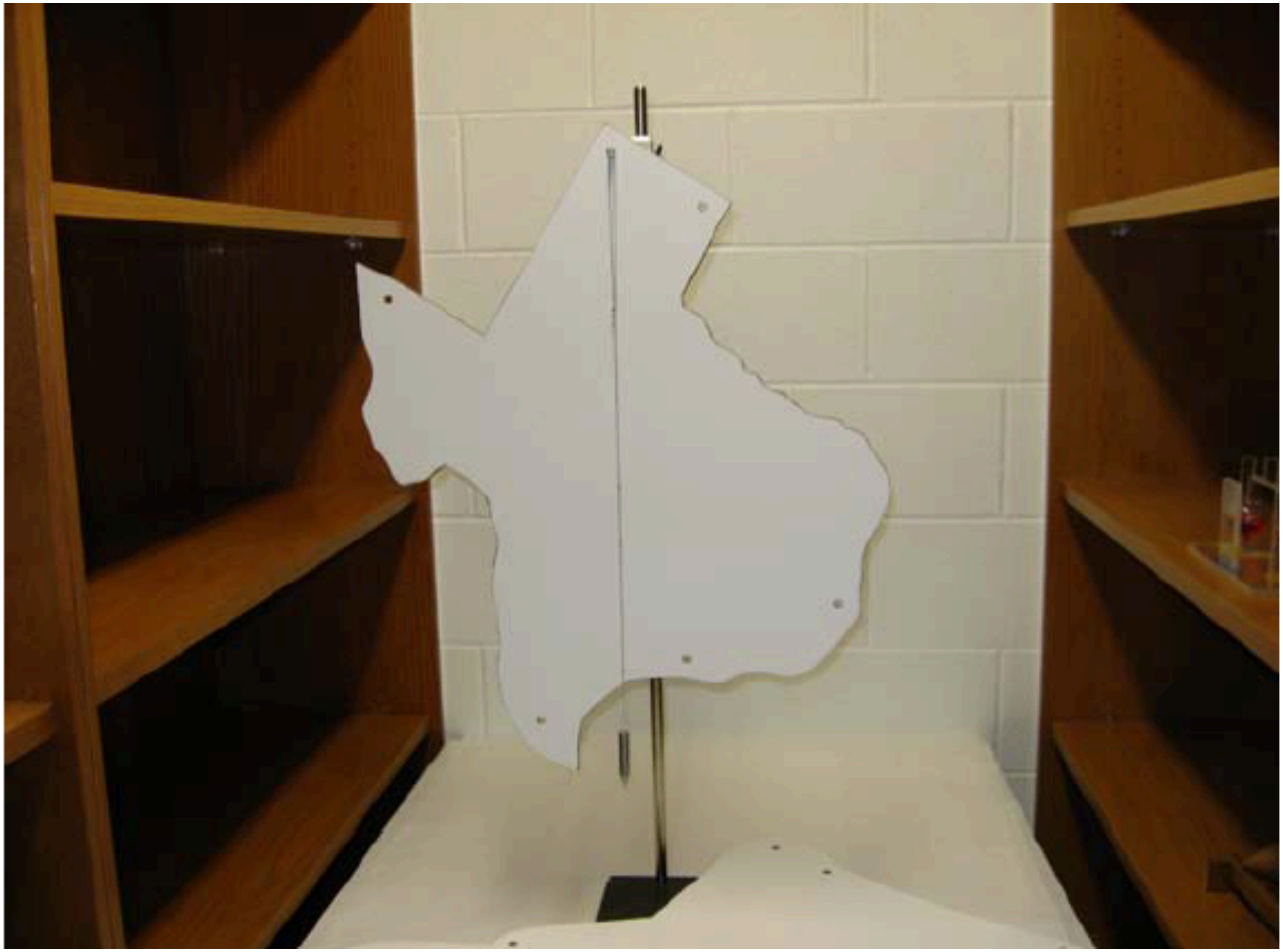
From Physics 218 (Mechanics) student's evaluations

Balance of Forces and Torques
Concept of Center of Mass

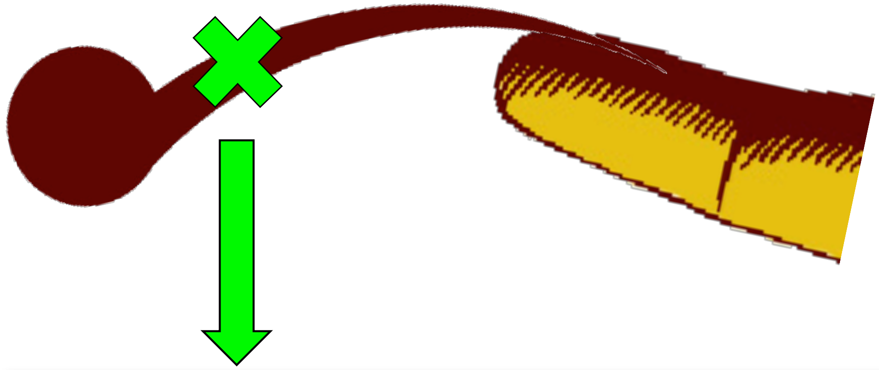
$$\sum \vec{F}_{ext} = 0 \qquad \sum \vec{\tau}_{ext} = 0$$

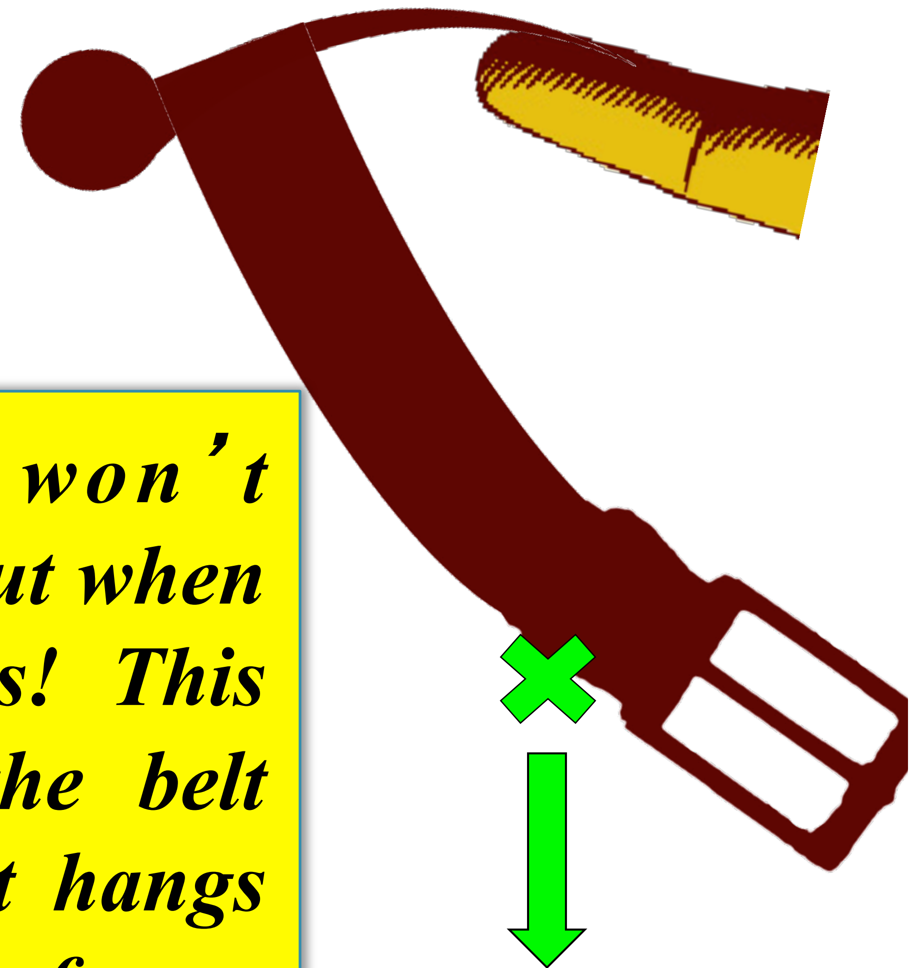
$$\vec{\tau} = \vec{r} \times \vec{F} \quad or \quad \tau = r_{\perp} \cdot F$$

Map of Texas



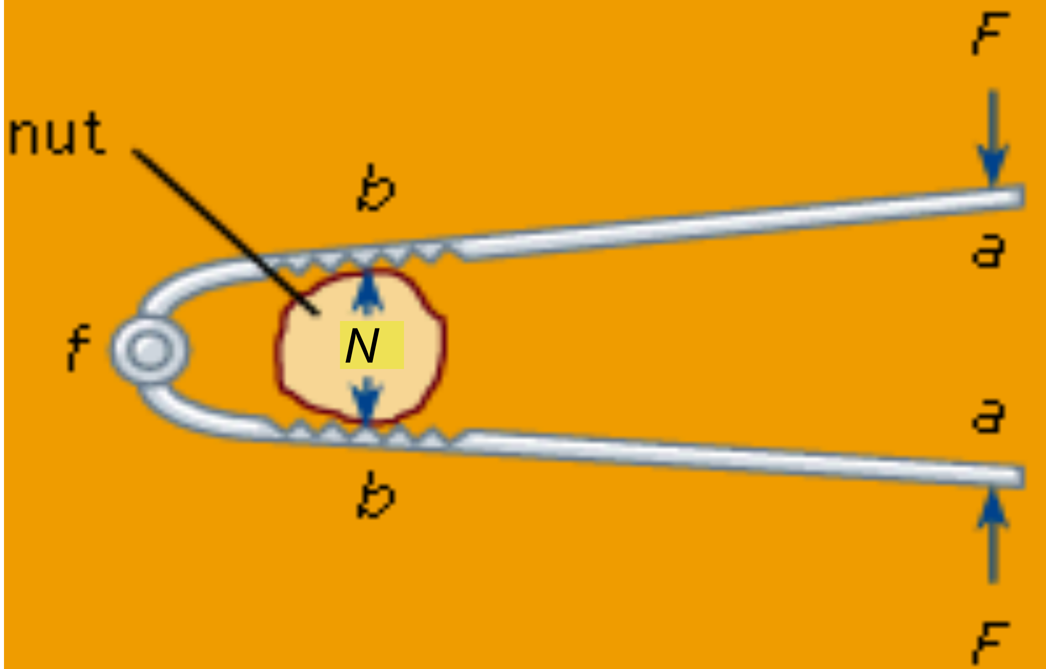
Skyhooks





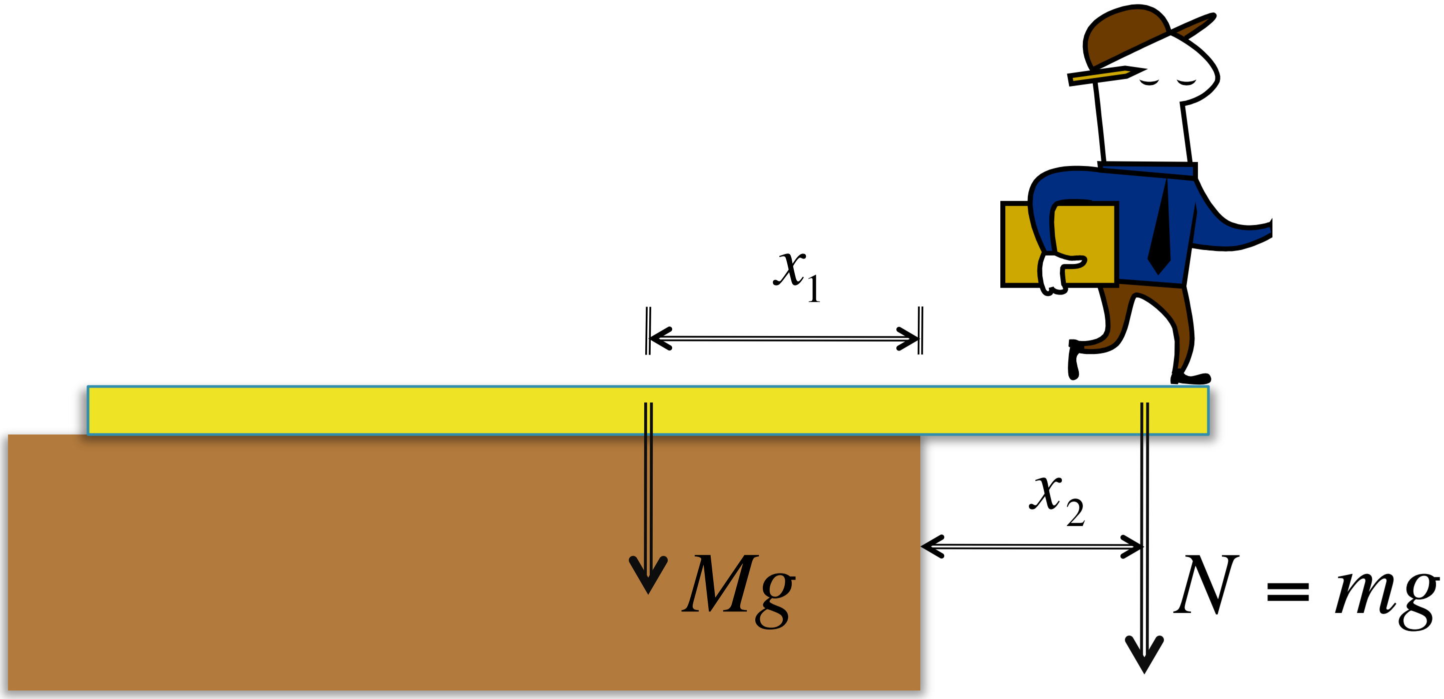
The skyhook alone won't balance on your finger, but when you put a belt on it, it does! This is all because adding the belt which curves under as it hangs actually moves the center of mass right under your finger!

Nutcracker



$$N = F\frac{a}{b}$$

"Walk the Plank"



$$Mgx_1 = mgx_2$$

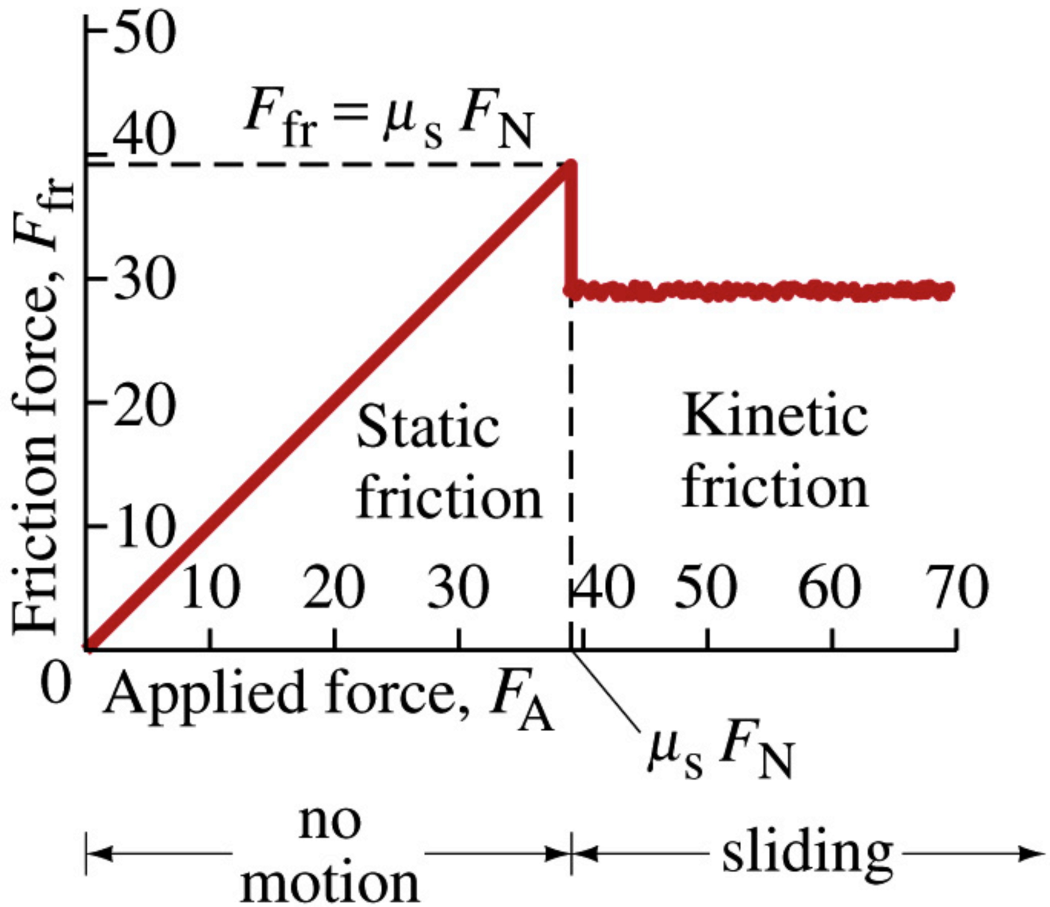
$$x_2 = \frac{M}{m} x_1$$

Inertia

If you pull the table cloth fast enough, the friction force between the cloth and the dinnerware will be very short-lived, so that the dinnerware will not have a chance to move before the force is gone.

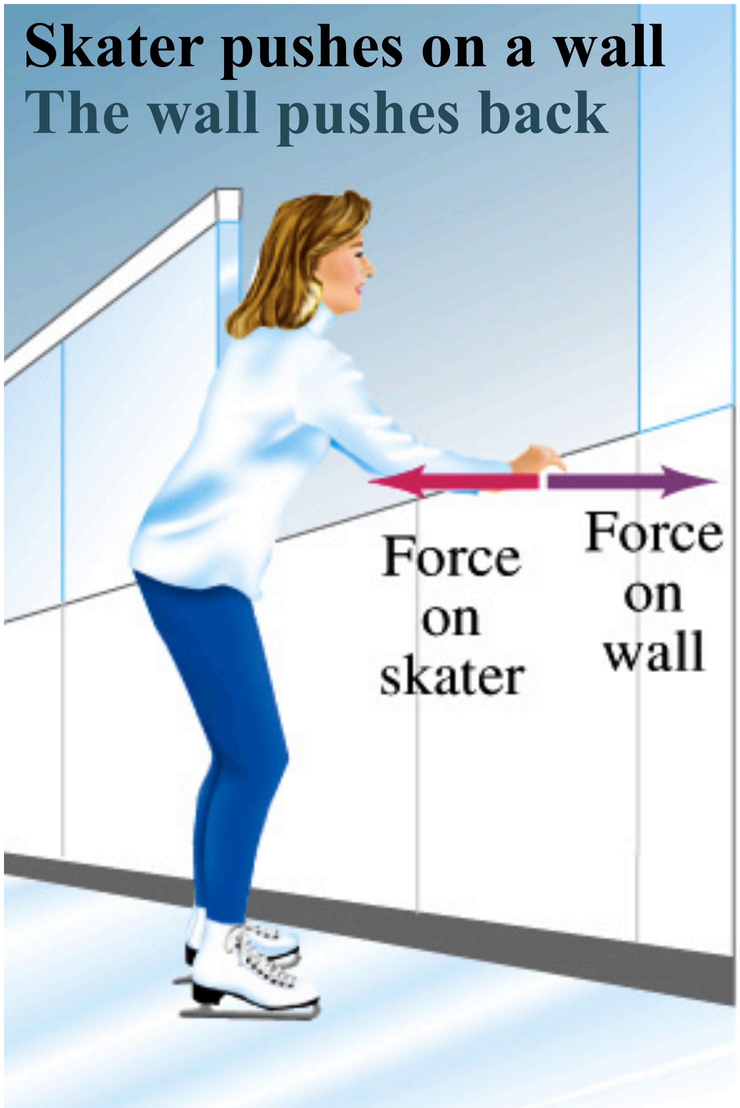
Quantitatively, impulse $F\Delta t$ of the friction force must be small.

Force of Friction with Phone Books



(from Giancoli)

Newton's Third Law with two spring scales



Equal and opposite force

Conservation of Momentum

- Basketball and Racquetball
- Skateboard with Leaf Blower
- Rotating Platform with Leaf Blower (angular momentum)

More with a Leaf Blower!

Bernoulli's principle

$$p + \rho g h + \frac{1}{2}\rho v^2 = Const$$

$$h = Const$$

Velocity $\uparrow$ $\downarrow$ **Pressure**

The Frisbee as an Airfoil

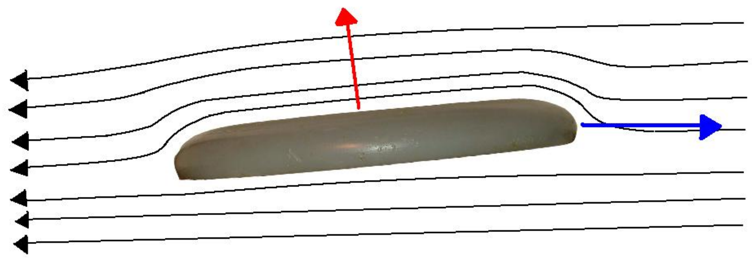
- According to Bernoulli's Eq,

  $p + \rho g h + \frac{1}{2}\rho v^2 = \text{Constant}$

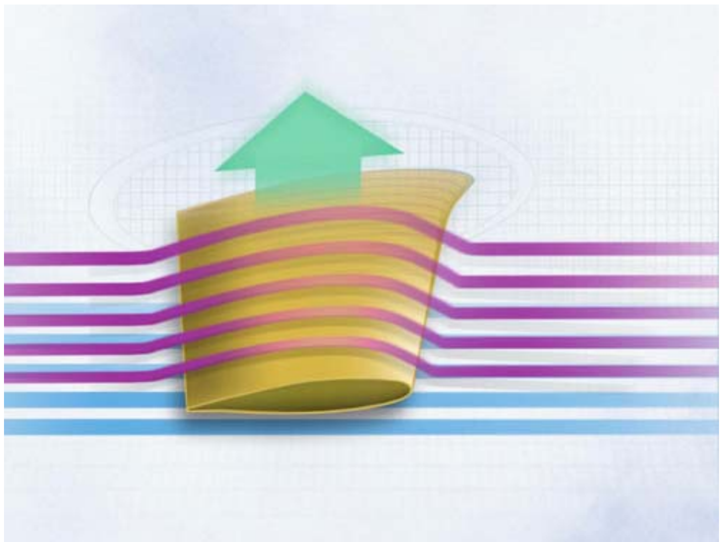
- The curved upper surface of the Frisbee forces the air above it to increase its velocity as compared with the air flowing underneath – much like an airplane wing

- Because $\rho g h$ is the same on the top and bottom of the Frisbee, the increased velocity of the air above the Frisbee must correspond to a lower air pressure

- The lower air pressure above the Frisbee provides a lift force that helps counteract gravity.



Frisbee



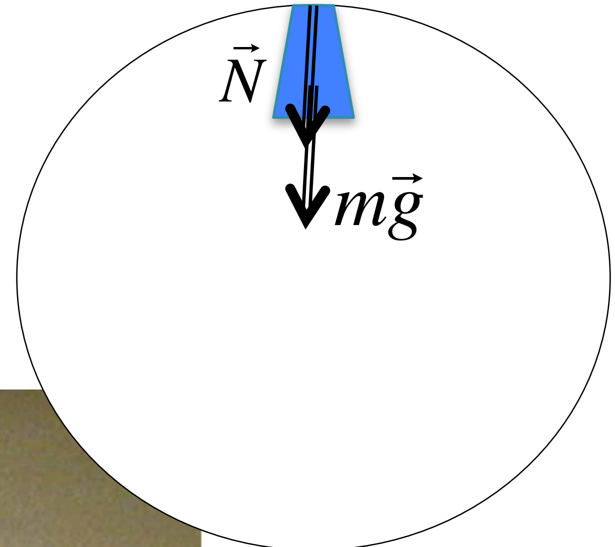
Airplane wing

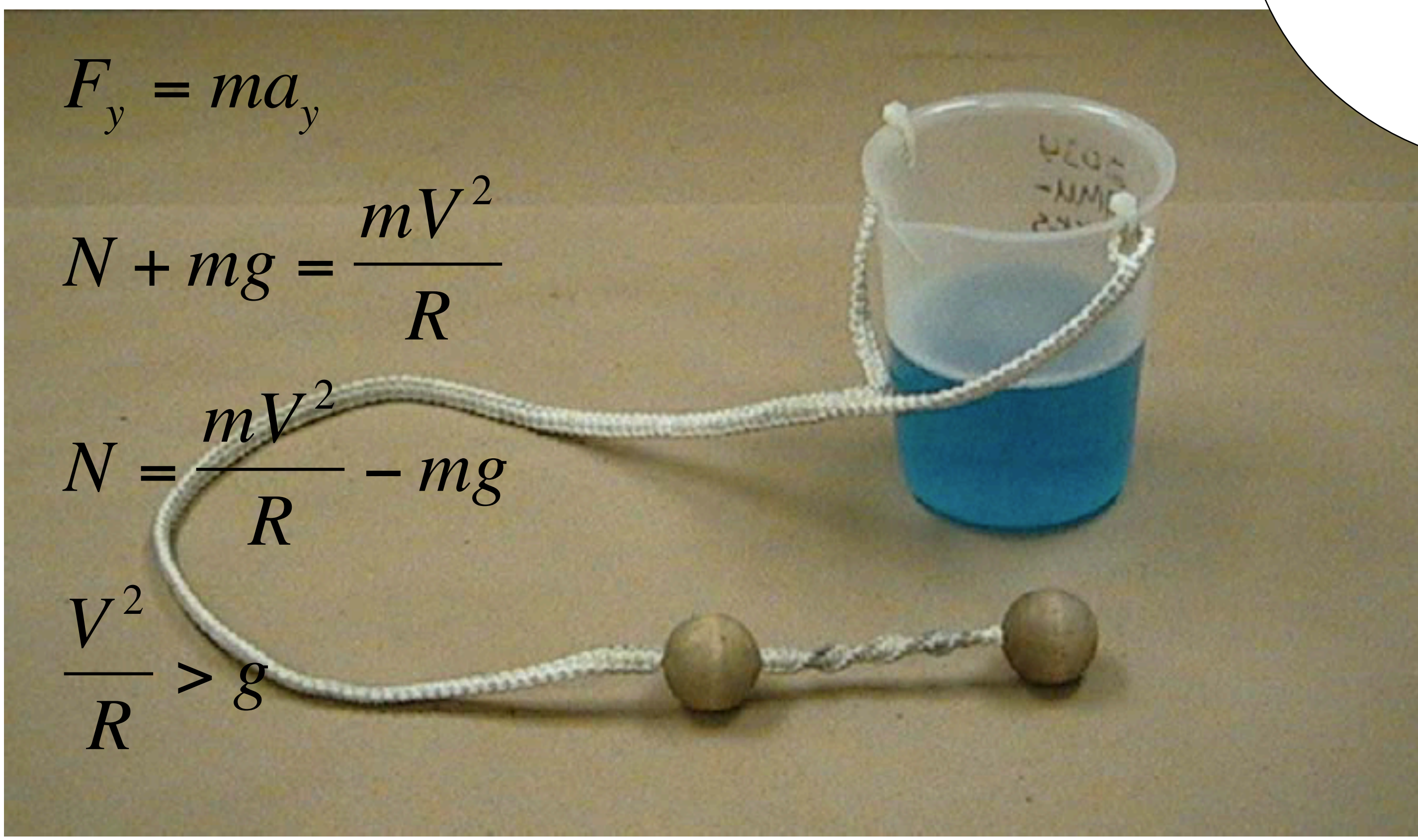
- **Leaf Blower and Flying Ball**
- **Leaf Blower, Broom, and Toilet Paper**

Eagle photo/Stuart Villanueva

Rotational Motion

Whirling Beaker of Water





$$F_y = ma_y$$

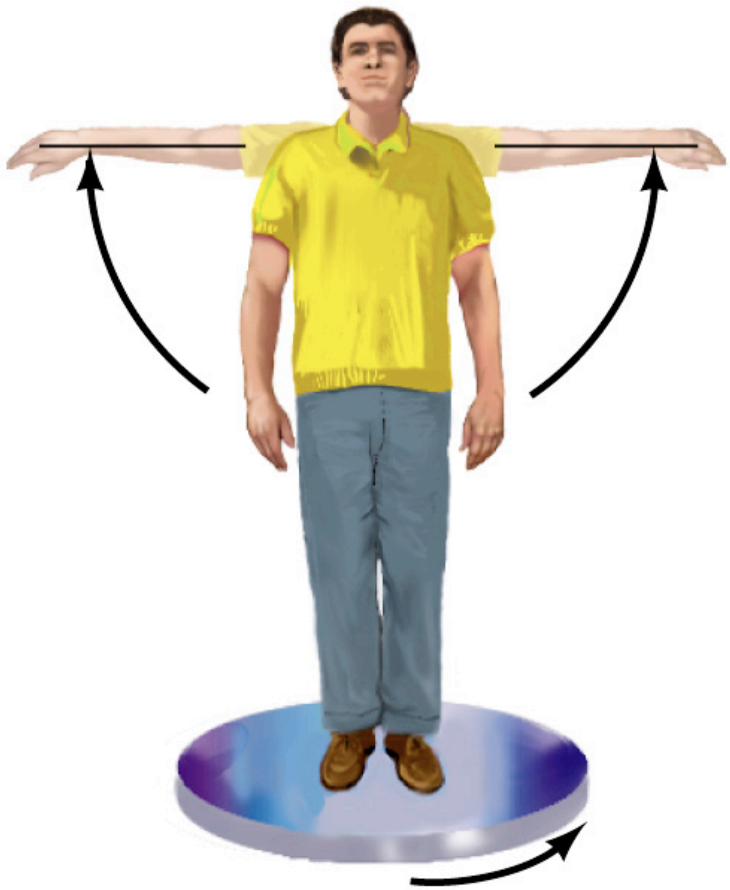
$$N + mg = \frac{mV^2}{R}$$

$$N = \frac{mV^2}{R} - mg$$

$$\frac{V^2}{R} > g$$

Rotation of Rigid Bodies

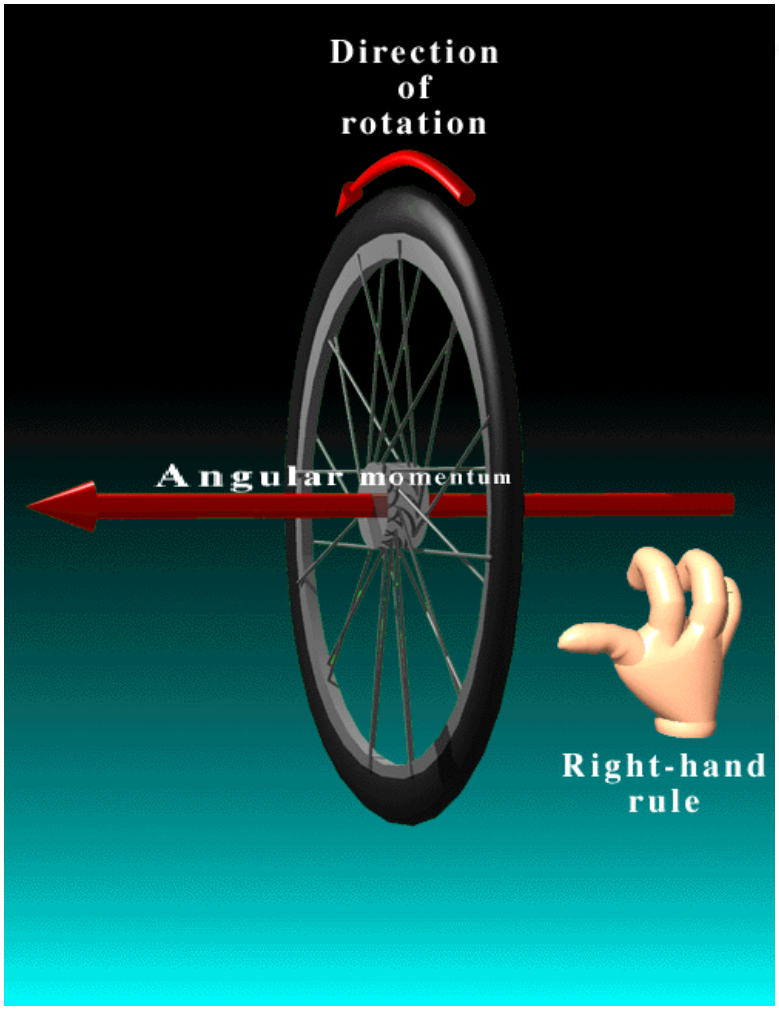
- **Cookie Cans with Magnets on Inclined Plane (moment of inertia)**
- **Rotating Platform with Weights and a Wheel (angular momentum)**
- **Eggs (hard-boiled and raw) on Inclined Plane**



L before = L after

$$I_a \omega_a = I_b \omega_b$$

Angular momentum



Moment of inertia

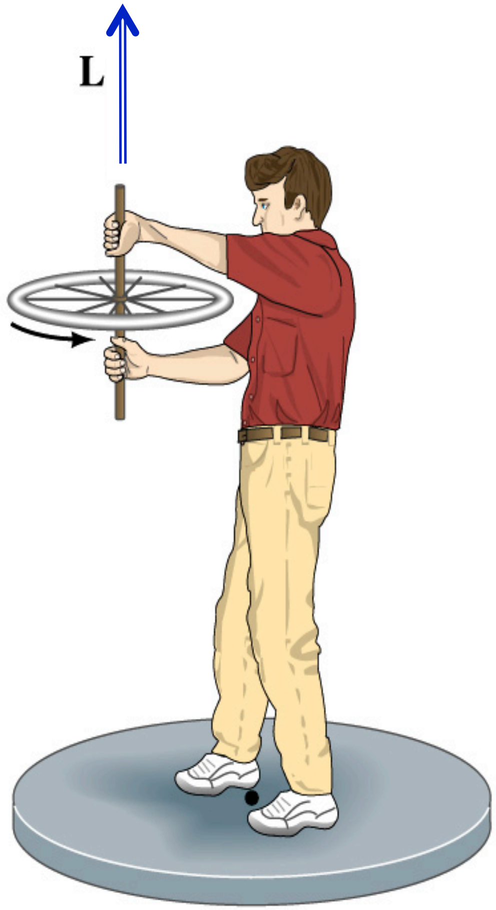
$$\vec{L} = I\vec{\omega}$$

Angular velocity

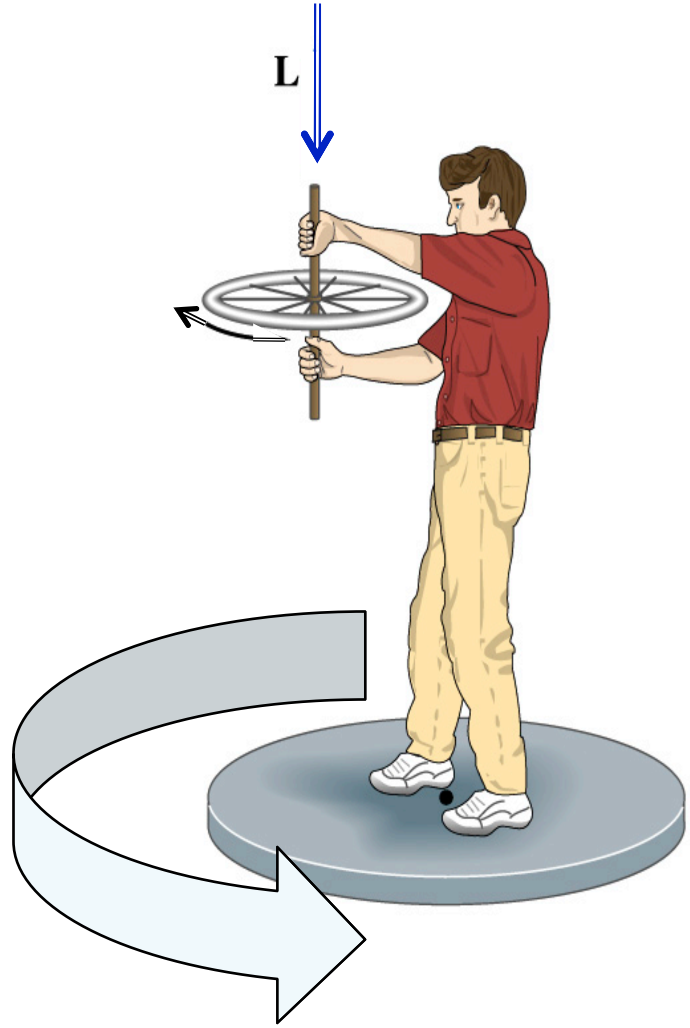
Vector along axis of rotation

Compare with momentum:

$$\vec{P} = m\vec{V}$$



$$L = I_{wheel}\omega$$



$$I_{wheel}\omega = (-I_{wheel} + I_{man} + I_{platform})\omega_{new}$$

What do freshman students mostly struggle with when they enter physics class?

1. **Vectors, vectors, and vectors!** How to work with vectors by means of *components* - basic trigonometry is inevitable.

2. **Derive a solution in a symbolic form** rather than "plug and chug" approach

Projectile Motion

$$x(t) = v_x(0)t + x(0)$$

$$v_x(t) = v_x(0)$$

$$y(t) = \frac{1}{2}a_y t^2 + v_y(0)t + y(0)$$

$$v_y(t) = a_y t + v_y(0)$$

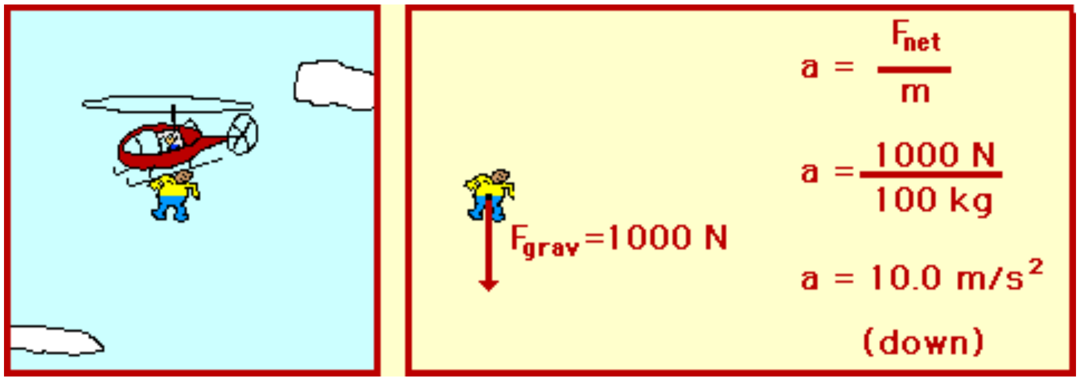
$$v_y^{\,2}(t_2) - v_y^{\,2}(t_1) = 2a_y(y(t_2) - y(t_1))$$

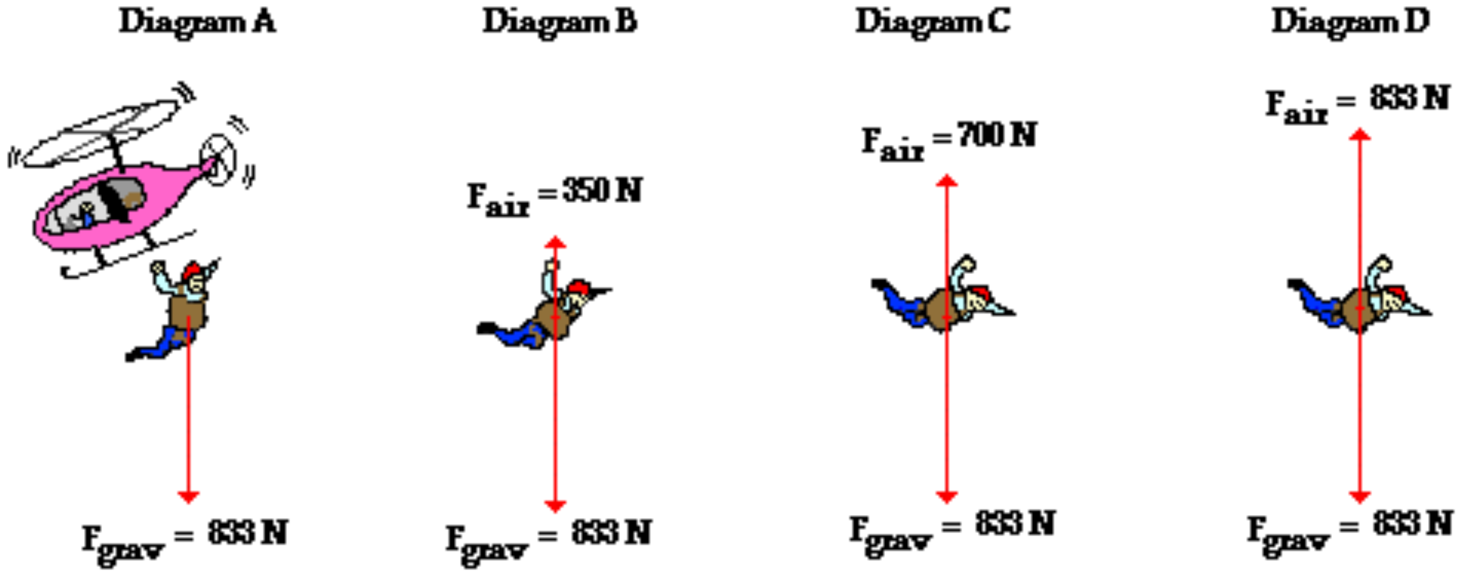
A cannon at the origin points up at an angle θ with the x axis. A shell is fired which leaves the barrel with a velocity of magnitude V_m.
How long is the shell in the air before it lands?

A cannon at height H points up at an angle θ with the x axis. A shell is fired which leaves the barrel with a velocity of magnitude V_m.
How long is the shell in the air before it lands?

Falling with air resistance

$$a = \frac{dv}{dt} = g - kv^2$$





Terminal Velocity with Coffee Filters

$$mg - F_r = ma$$

where F_r is the resistance force.

$$a = g - \frac{F_r}{m}$$

1. A penny and a quarter dropped from a ladder land at the same time (air resistance is negligible).
2. A coin dropped in a coffee filter from a ladder lands later than a coin without coffee filter (the terminal velocity is smaller for larger cross-section area).
3. A quarter dropped in a coffee filter will land faster than a penny in a coffee filter (the terminal velocity is larger for larger mass)
4. Two identical coins dropped in coffee filters of different diameters land at different times (the terminal velocity is smaller for larger cross-section area).

Resistance force: $F_r = \gamma A v^2$

A – area of the projectile

For a spherical projectile in air at STP: $\gamma = 0.25\ \mathrm{N} \times \mathrm{s}^2/\mathrm{m}^4$

Terminal velocity:

$$a = g - \frac{F_r}{m} = 0$$

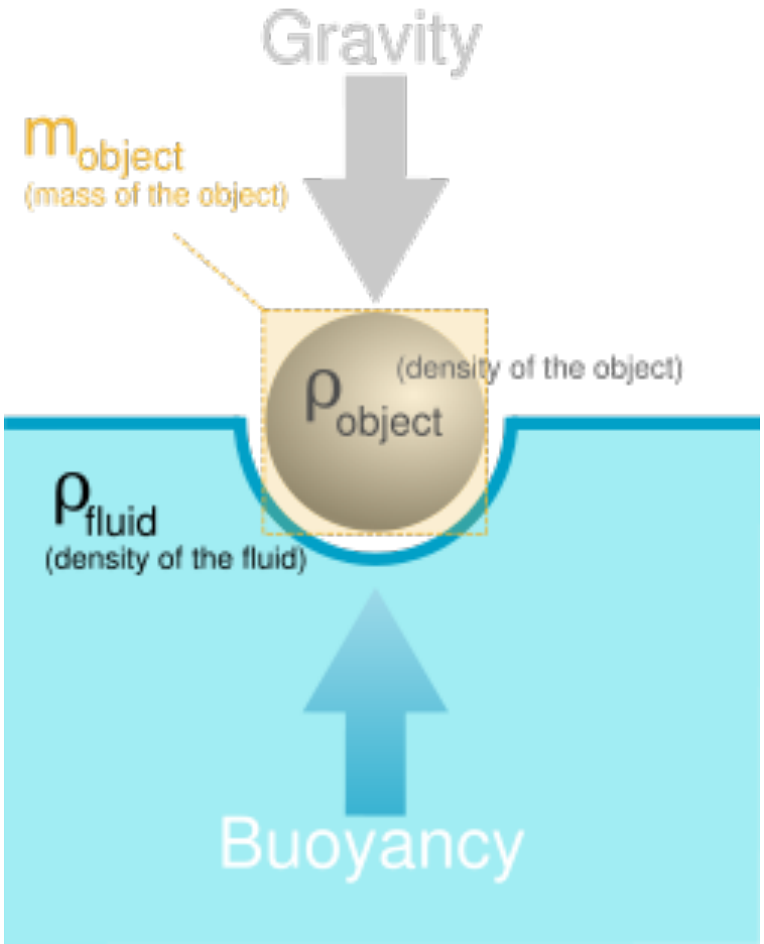
$$F_r = mg$$

$$\gamma A v^2 = mg$$

$$\boxed{v_T = \sqrt{\frac{mg}{\gamma A}}}$$

A 70-kg man with a parachute: $v_T \sim 5$ m/s
A 70-kg man without a parachute: $v_T \sim 70$ m/s

Buoyancy
(Magic Bubbles)



$$F = (\rho_{fluid} - \rho_{object})Vg$$

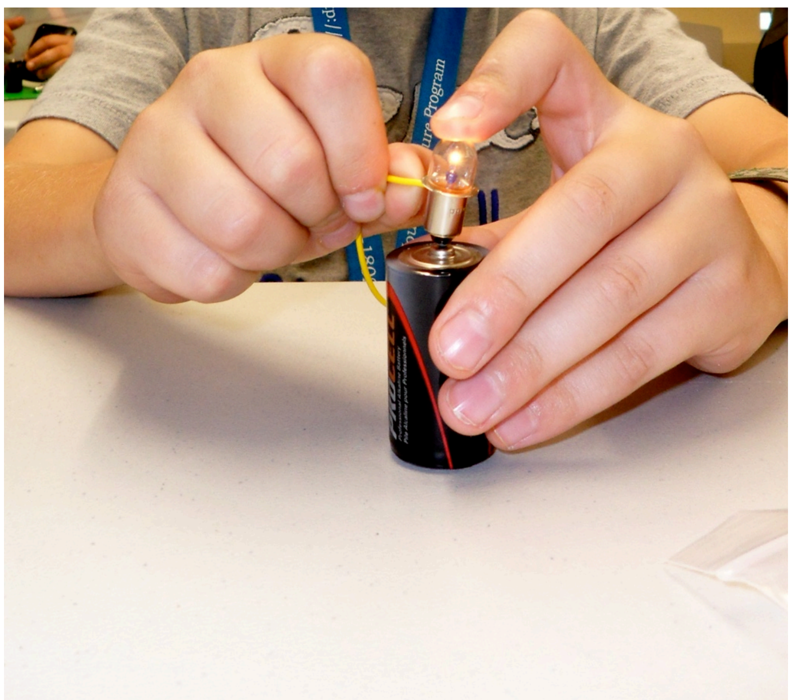
$$F = (\rho_{surrounding\ gas} - \rho_{object})Vg$$

When a body is completely or partially immersed in a fluid, the fluid exerts an upward force on the body equal to the weight of the fluid displaced by the body.

Can you make a light bulb work with a battery and a wire?

"Minds of Our Own"
by Dr. Matthew H. Schneps and Dr. Philip M. Sadler
Harvard-Smithsonian

TAMU Youth Adventure Program 2010

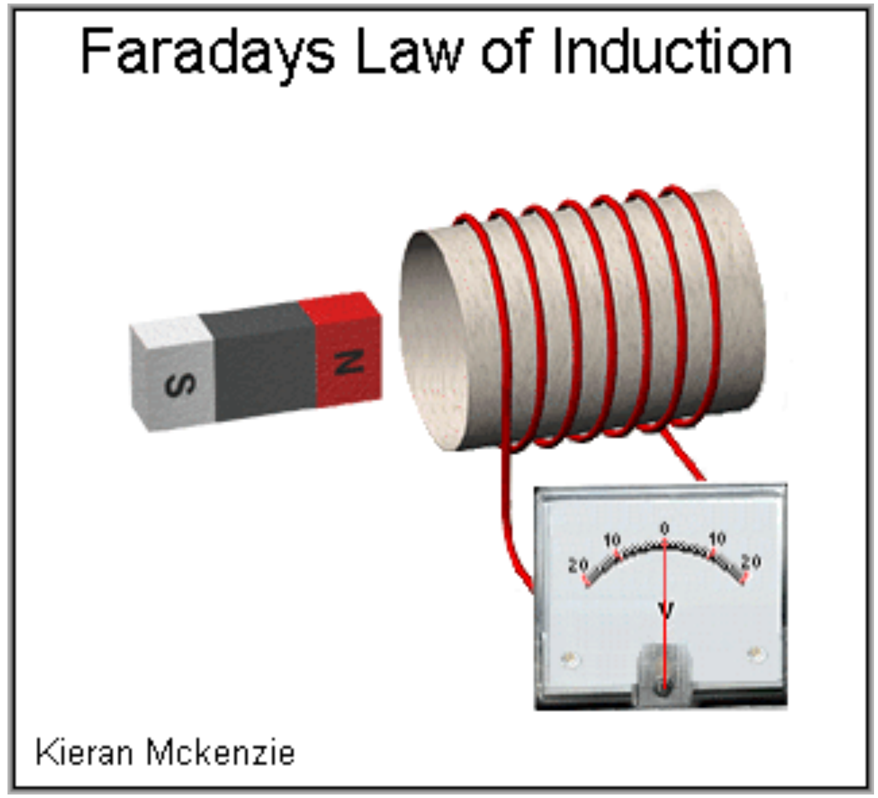


How can students graduate from prestigious schools like Harvard or MIT and not know even some of the most basic ideas in science taught in grade school?

Faraday's Law of Induction

•A time varying magnetic flux through a circuit will induce an EMF (voltage) in the circuit.

• Varying magnetic field is created as a bar magnet passes through the coil.



$$\oint \vec{E} \cdot d\vec{r} = -\frac{d\Phi_B}{dt}$$

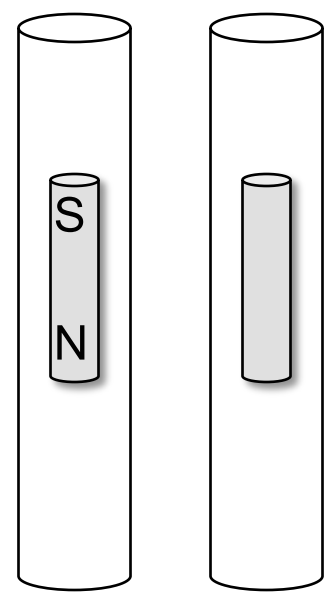
Lenz's Law

Which way will the current go?

Lenz's Law: if a current is induced by some change, the direction of the current is such that it opposes the change.

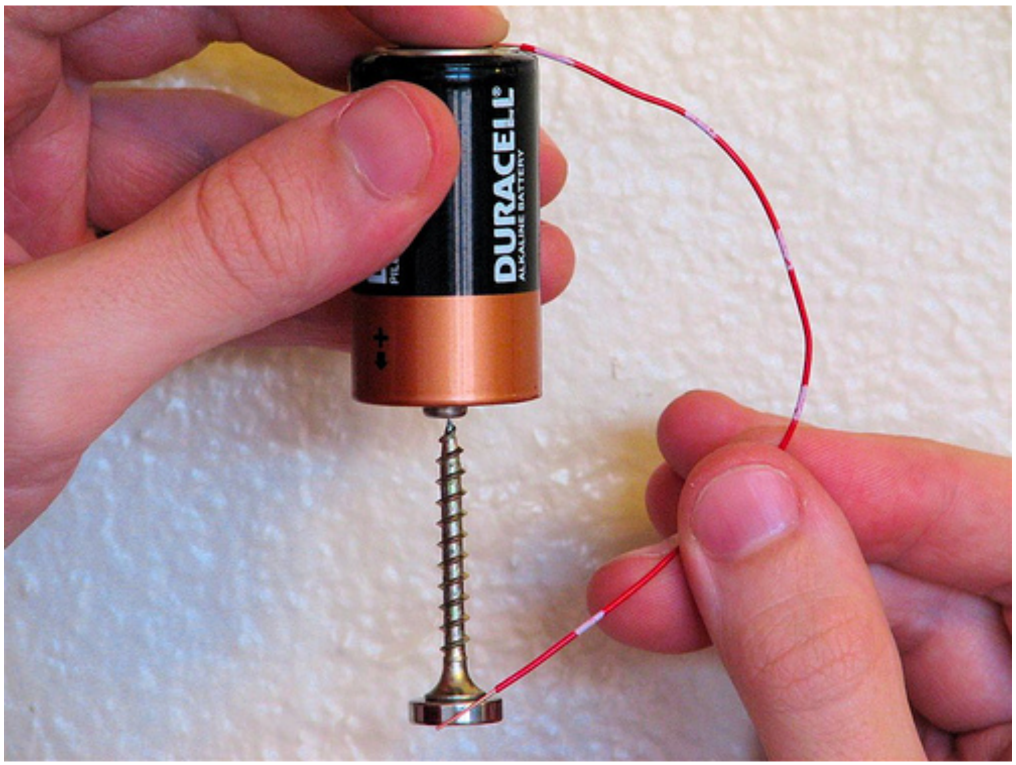
$$\oint \vec{E} \cdot d\vec{r} = -\frac{d\Phi_B}{dt}$$

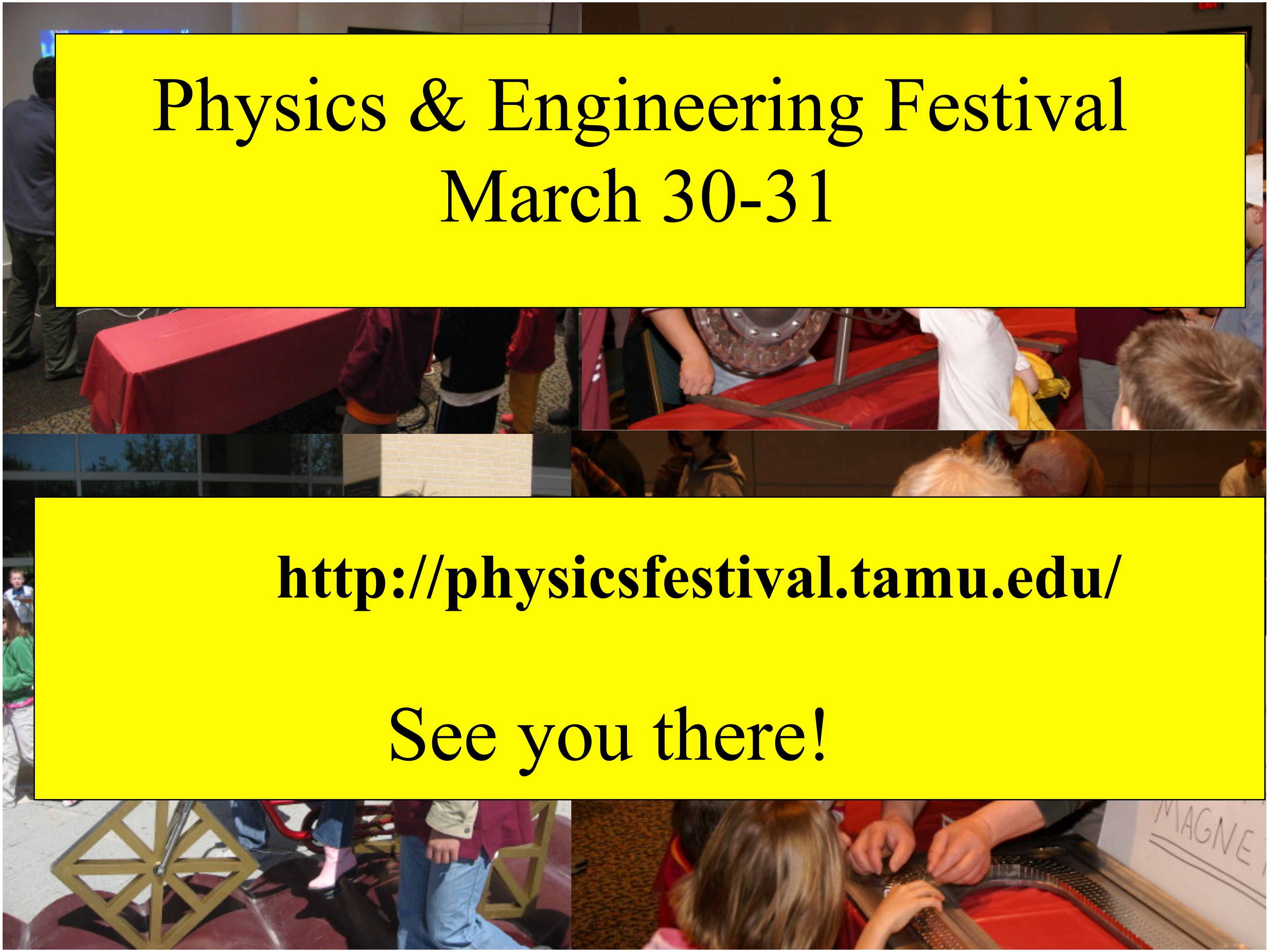
Experiment with a magnet falling in an aluminum pipe



Make your own MOTOR!

All you need is a battery, a nail, a small magnet, and a wire (foil works better)




Physics & Engineering Festival
March 30-31
http://physicsfestival.tamu.edu/
See you there!

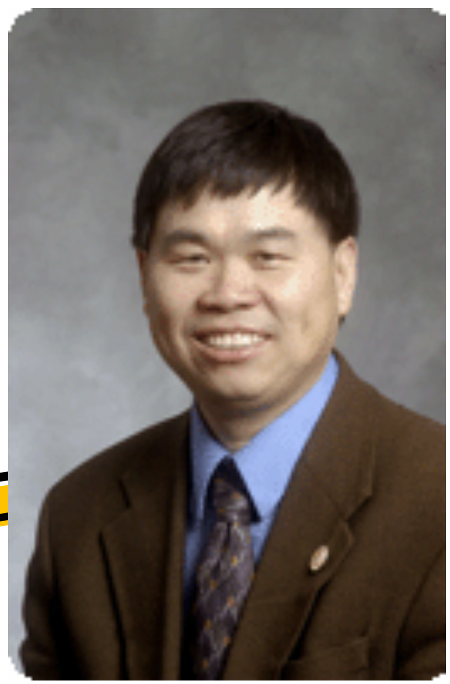
2012 Teacher Summit
Engineering in the Classroom

Carlos Montalvo
Foy H. Moody High School
Innovation Academy for Engineering, Environmental, and Marine Science
Corpus Christi ISD
Corpus Christi, Texas

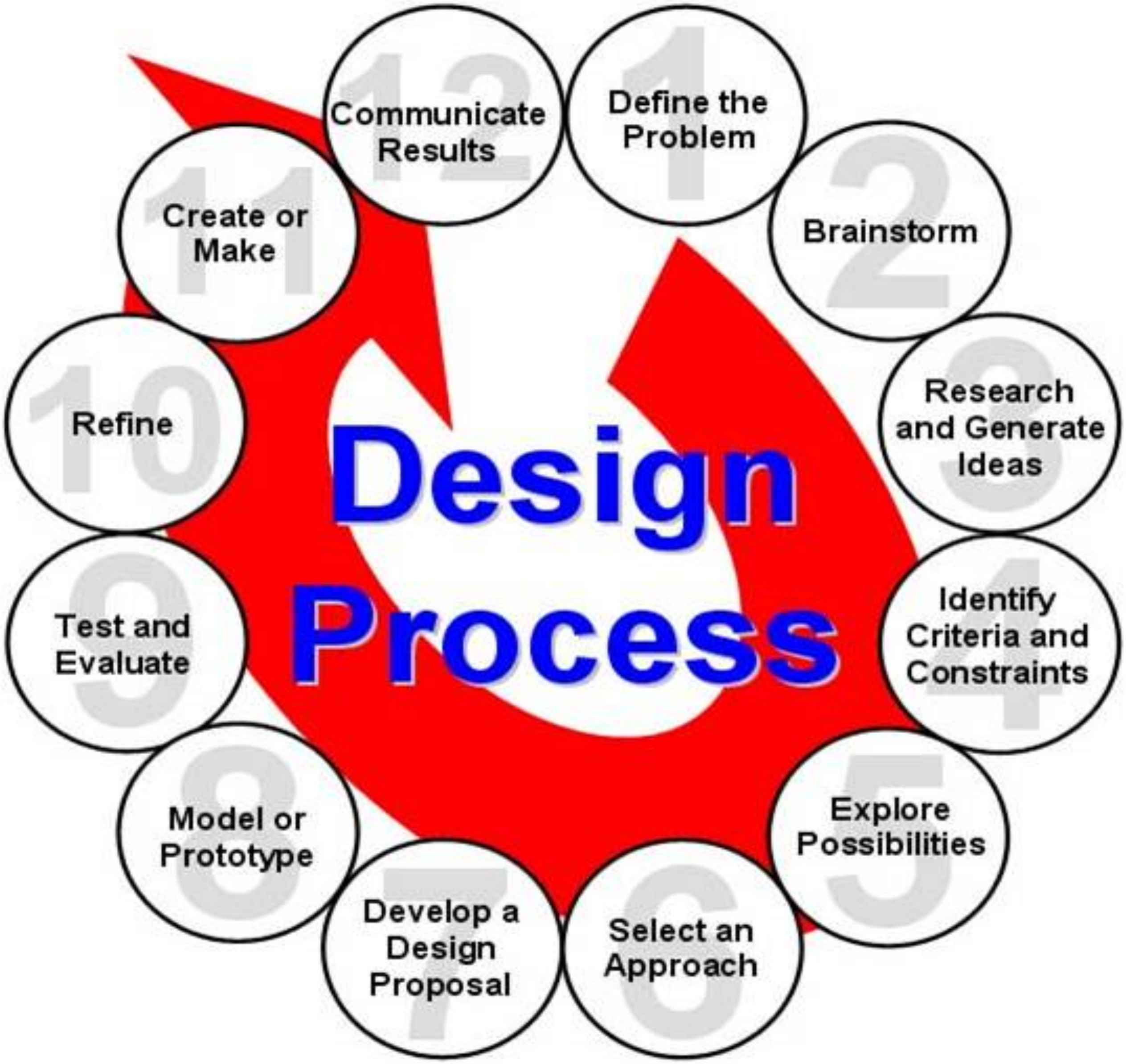
My E3 Experience

Summer Teacher Program at Texas A&M

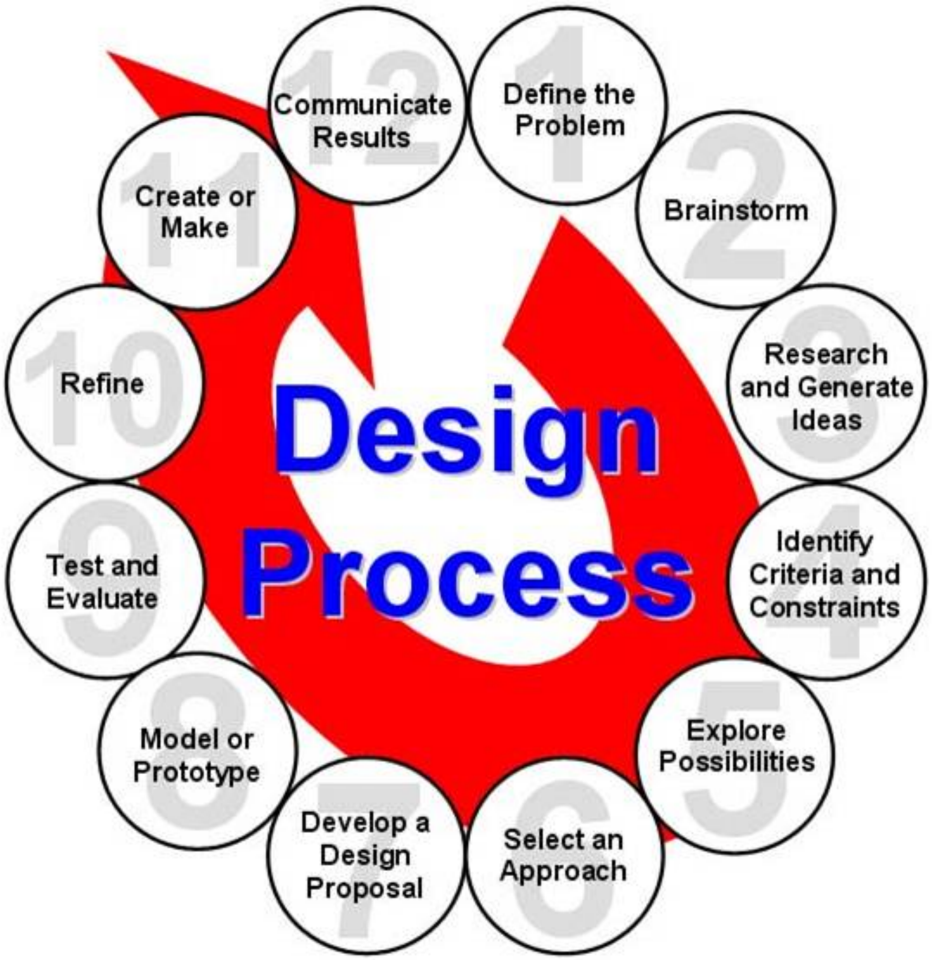
- Audrey Gonzalez and I were assigned Dr. Zhengdong Cheng
- Chemical Engineering

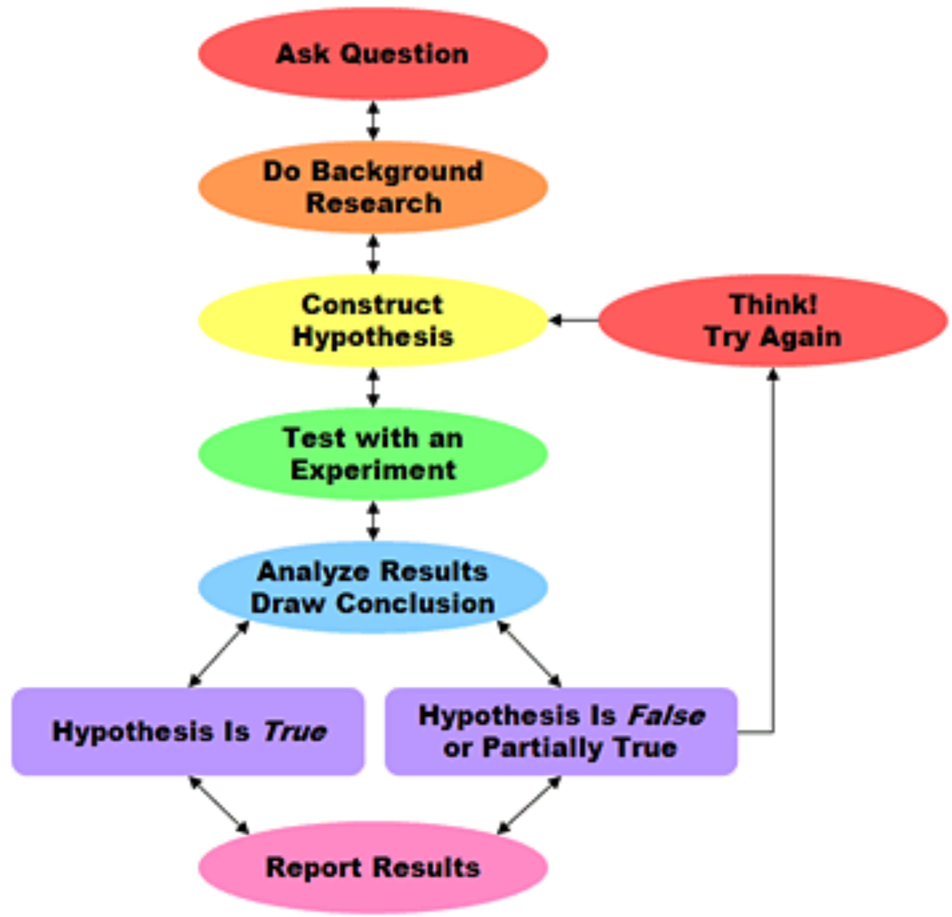


Engineering Design



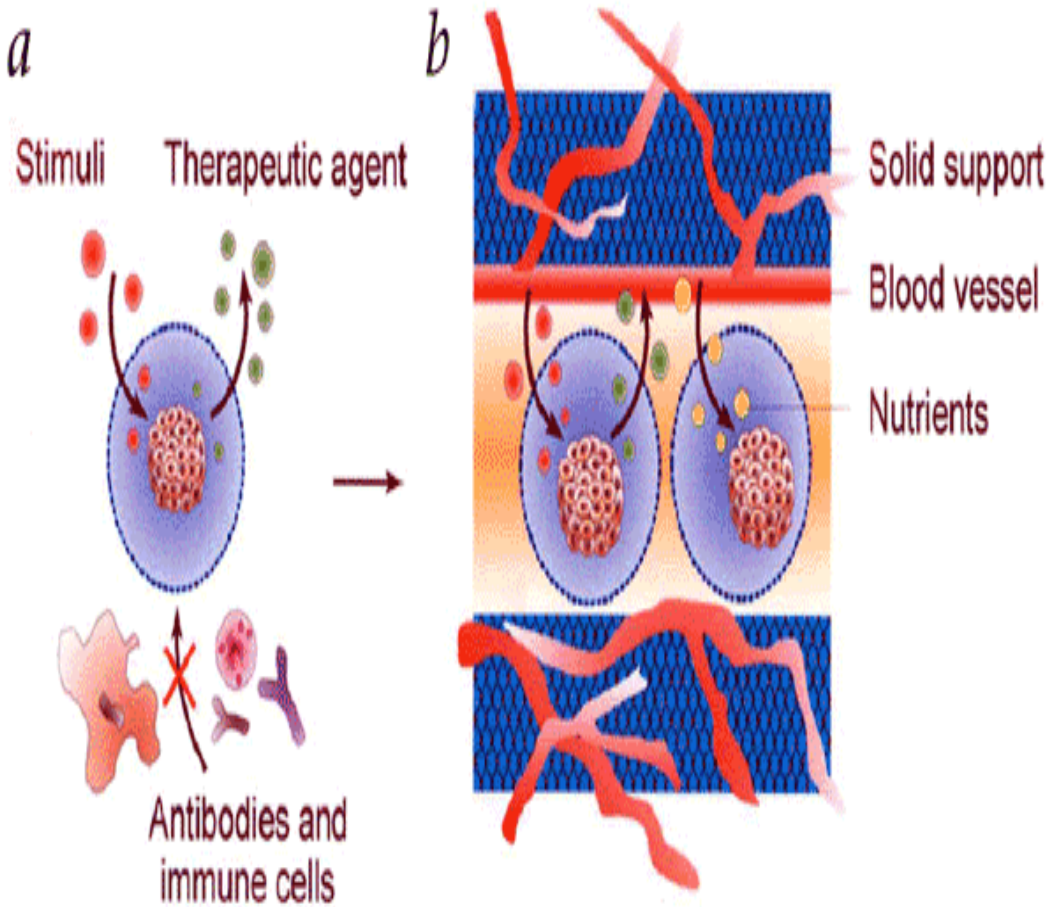
Engineering vs. Science





Aspects of Research

- **<u>Cell Encapsulation</u>**
  - Using microreactors to create a protective "bubble" over a cell for possible drug delivery

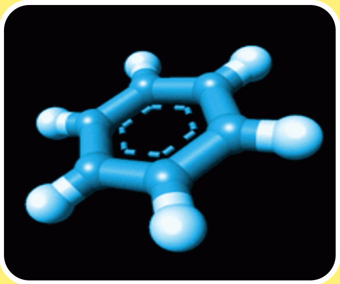


- Encapsulating cells of interest with therapeutic agent in a semi-permeable membrane
- Implant cell capsules into human
- Cells release therapeutic substance such as insulin for diabetics

Relevant Math/Science Concepts?

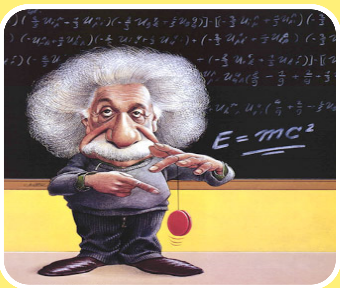
- What TEKS or concepts can you relate to this research?
  - Biology—Cells, membranes, biomolecules, biological systems and functions, homeostasis
  - Chemistry—Properties of water, properties of fluids (density), chemical/physical changes and properties, measurements
  - Physics—Measurements, motion (speed of medicine release), particle motion, fluid mechanics and motion,
  - Math—Functional relationships, interpreting data to create graphs, slope/rate of change, congruence and similarity of shapes

Chemistry



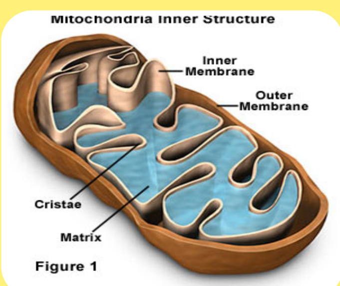
- using lab equipment and solving formulas
- properties of water and fluids (density, buoyancy, and viscosity)
- identify physical and chemical changes and properties
- Relation between atoms, elements, compounds, and mixtures

Physics



- manipulating physics equations such as motion, density, and buoyancy
- Solving simple algebraic equations
- graphing and interpreting data from graphs
- Forces and force diagrams

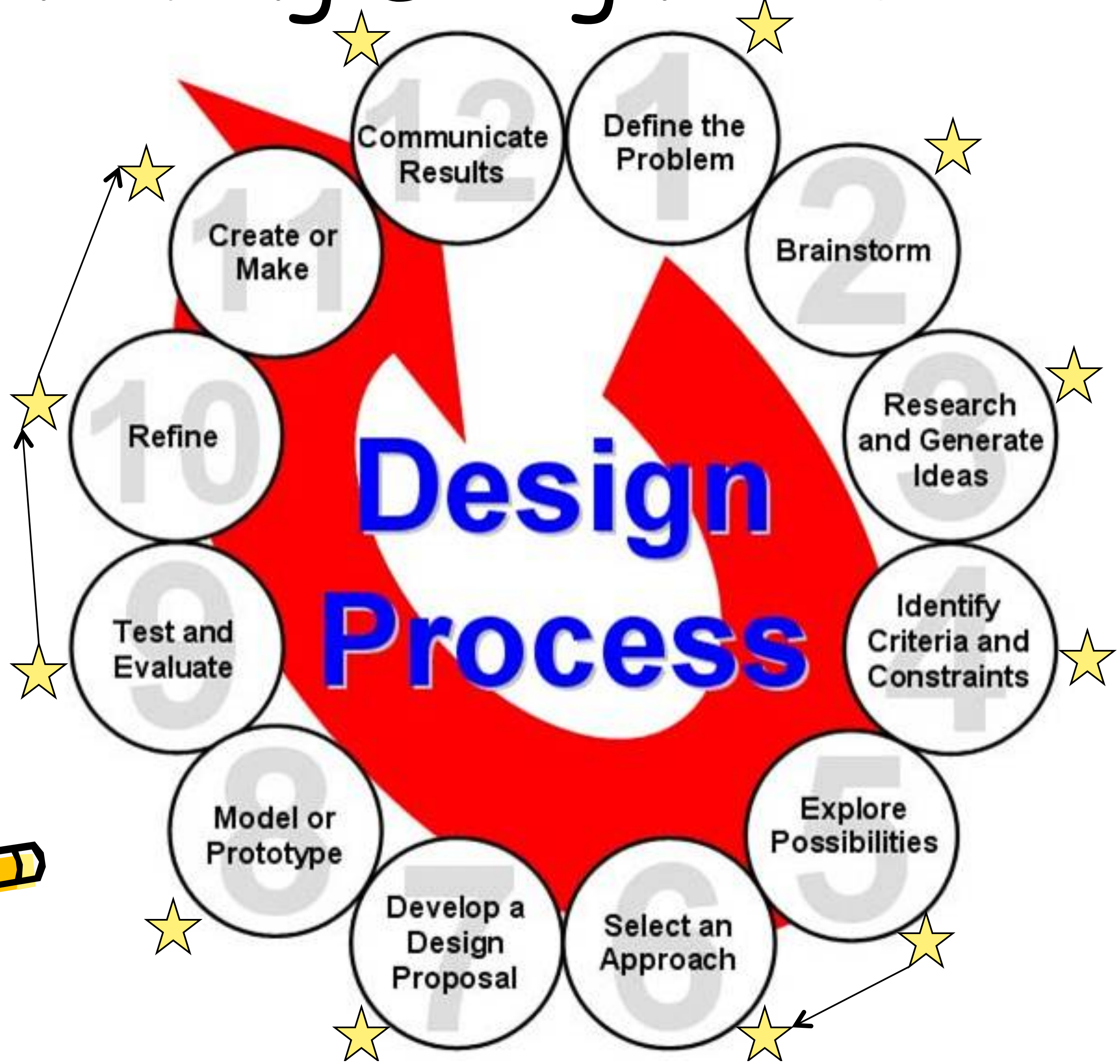
Biology



- biochemistry (cells, atoms, elements, compounds, mixtures).
- cell processes such as osmosis and diffusion
- properties of water (hydrophilic and hydrophobic).

Pre and post-test

Engineering Design Process

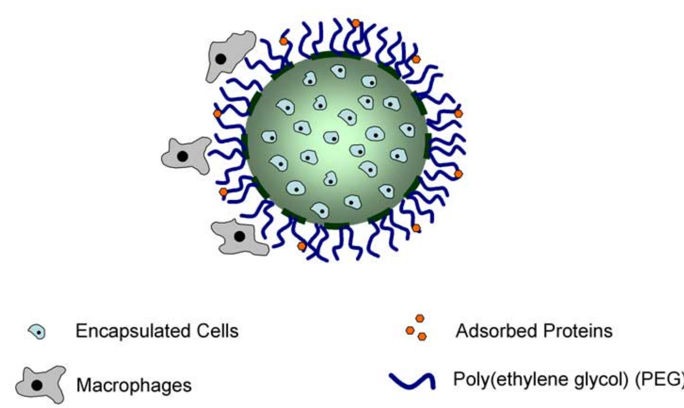


1. Define the Problem!

- **Proposal:** A local pharmaceutical company is looking for a new way to encapsulate a drug.

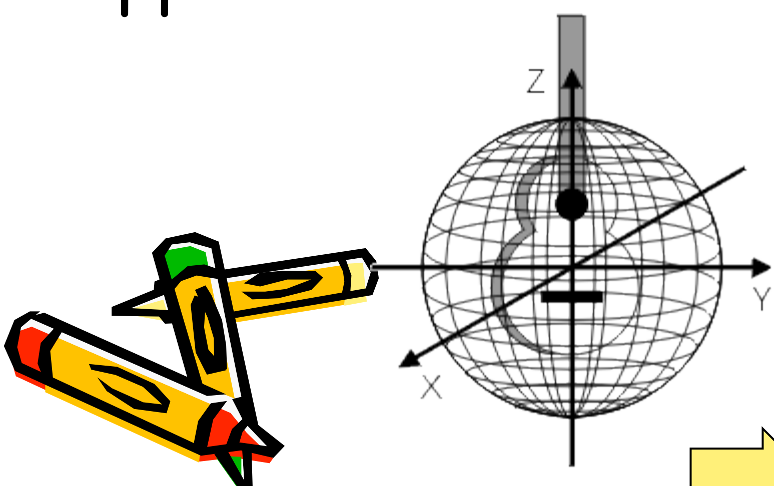
2.Brainstorm/Encapsulation Overview

- The actual encapsulation can be-
  1. protective of the medicine inside
  2. time released
  3. selectively-permeable



3. Research and Generate Ideas

- Students will be given **5 different semi-permeable materials** to test
- A design proposal will be submitted for approval



Research:

- **physical and chemical properties of membrane** - Do they affect semi-permeability or density? (Chemistry)
- **Bioencapsulations/ Immunosuppression of** (AP Biology)
- Advantages and disadvantages of **time released** (AP bio/ chemistry/physics)

4. Criteria and Constraints

- Team can only have one square foot of chosen membrane type
- Encapsulation must fit in 8cm x 8cm x 8cm cube
- TUMS has to be able to stay in encapsulation until released into water
- Any material for encapsulation skeleton can be used
- Must have a medicine release projection plot
- Must defend and "sell" design to local pharmacist

5. Explore Possibilities
6. Select an approach

Before building:

- **Time** that it takes for small measured amount of Tums to diffuse through each membrane
- Using **ratios** decide time for an entire packet of Tums quikpak to dissolve
- Based on research decide if **long or short diffusion** is better
- **Rank membranes and choose material(s)**

7. Develop a Design

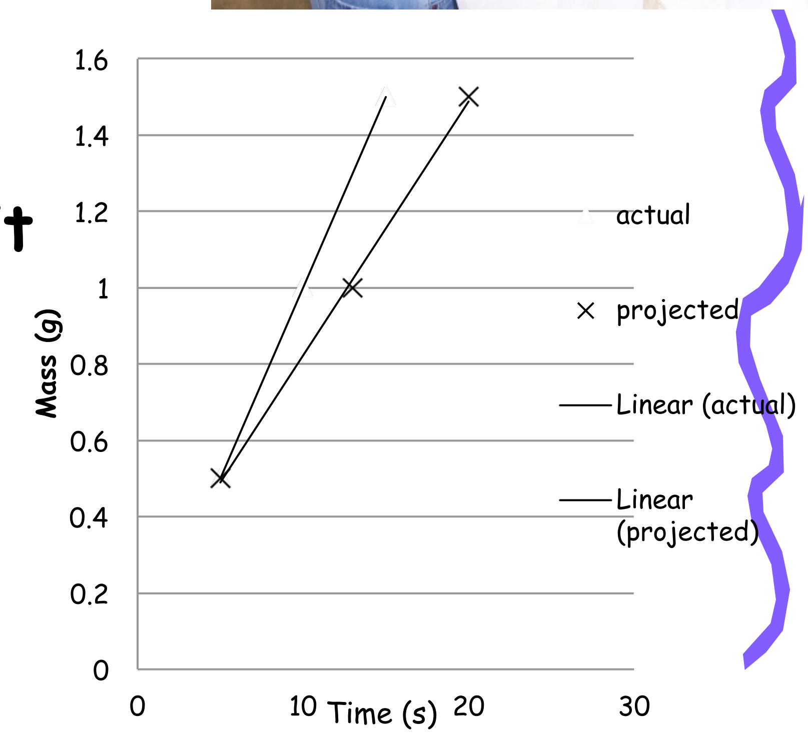
- Sketch on paper or use design program to create your encapsulation skeleton

8. Model or Prototype

9. Test and Evaluate 10. Refine 11. Create

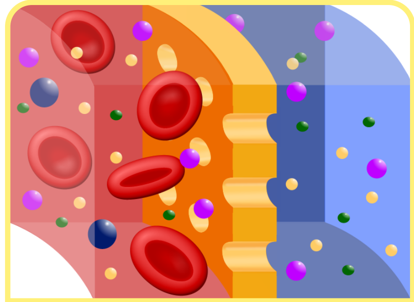
Testing of encapsulation:

- **Mass** before/after
- **Volume**
- **Density**: sink, float, or suspended in water
- Find **buoyant forces** (physics)
- Measure **mass released per unit time** (extrapolate at 2*t, 4*t, 6*t)
- Selectively permeable?



12. Communicate Results

- Groups must clearly and concisely defend their encapsulation product, design and material, to a local pharmaceutical rep



Semi-permeable

Protective covering

Time released

RUBRIC FOR GRADING

Design process:

plan is neat with clear measurements and labeling

Skeleton Design:
clear evidence of troubleshooting, why this material above others

Data Collection:
data taken several times in careful and reliable manner

Construction of materials:
materials used in a way that made them even better

Function:

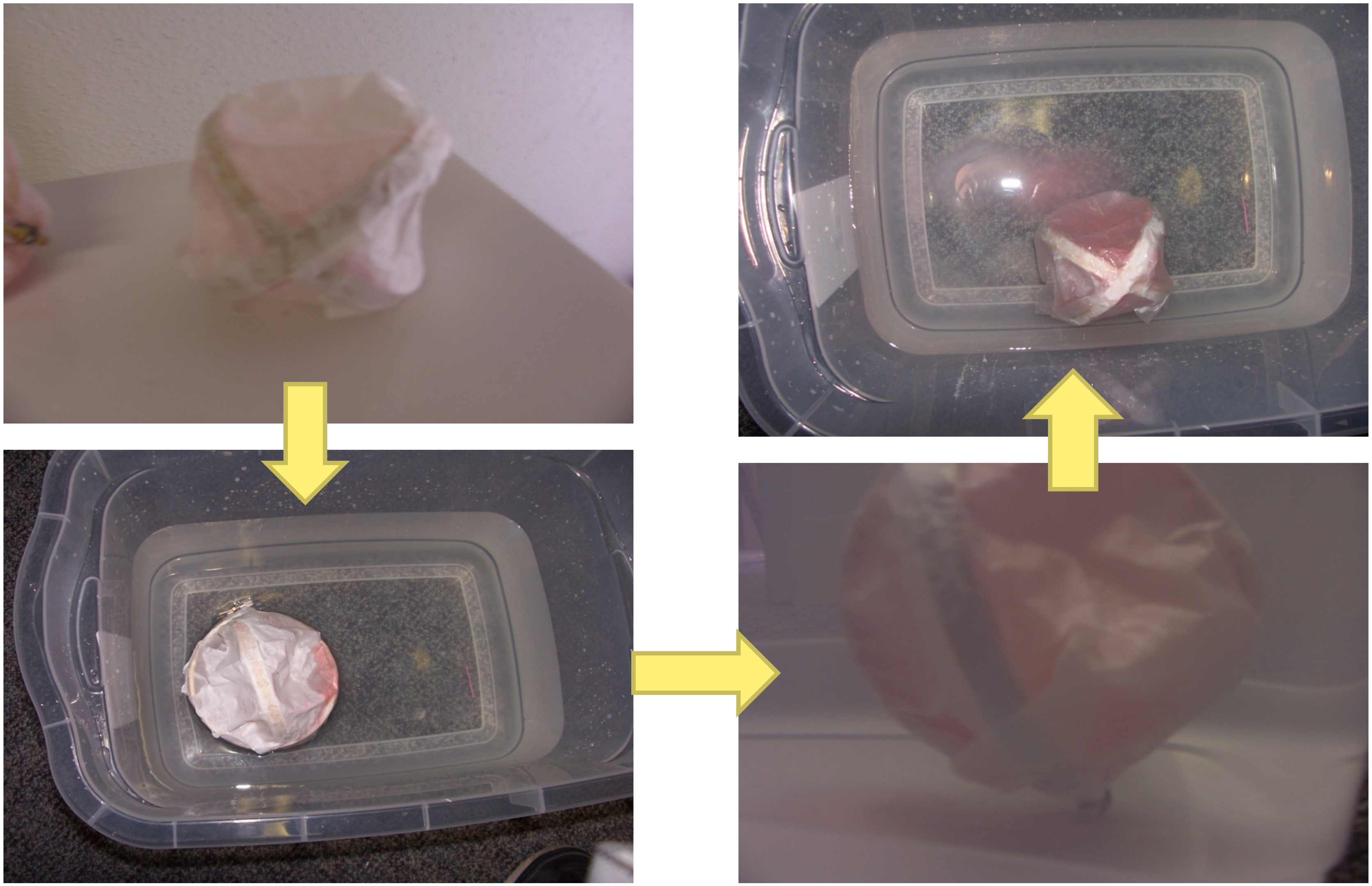
structure functions as an encapsulation should

Conclusion/Defense:
defense is clearly articulated and accurate info is given to defend model

Graph Analysis:

Graphs plotted correctly in mass

This encapsulation is made of a double layer of filter paper surrounding an embroidery hoop and is encapsulating a Tums quikpak.

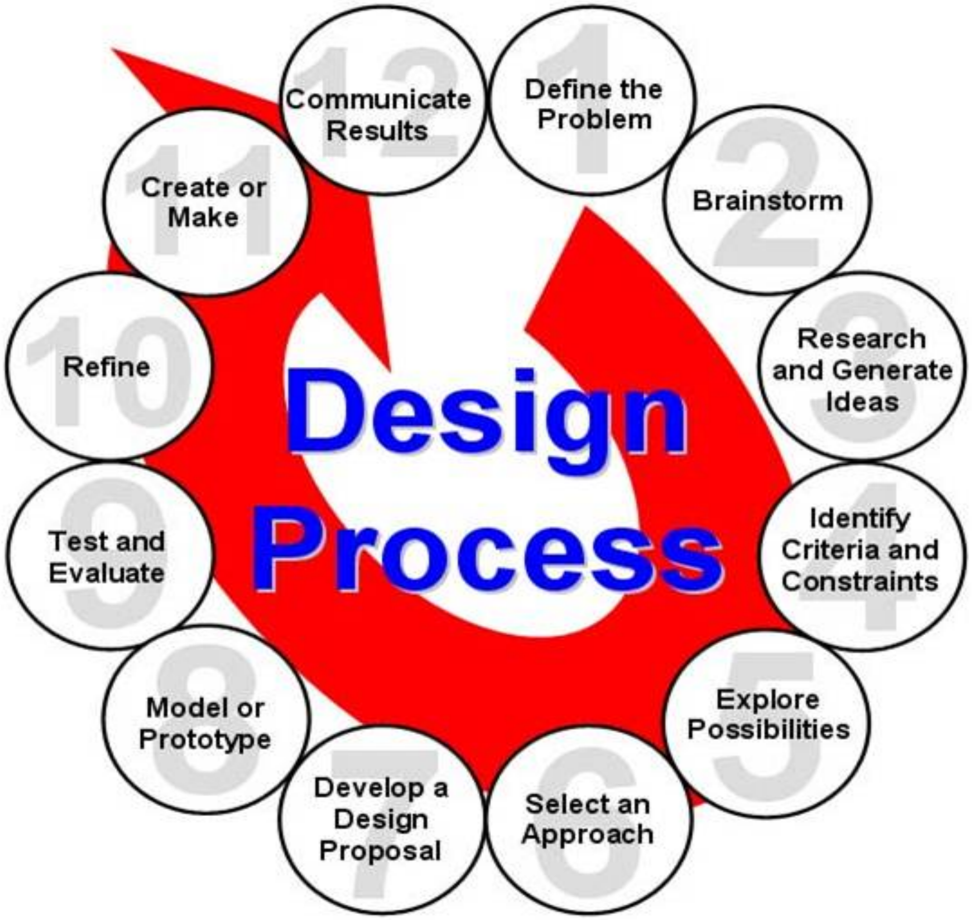


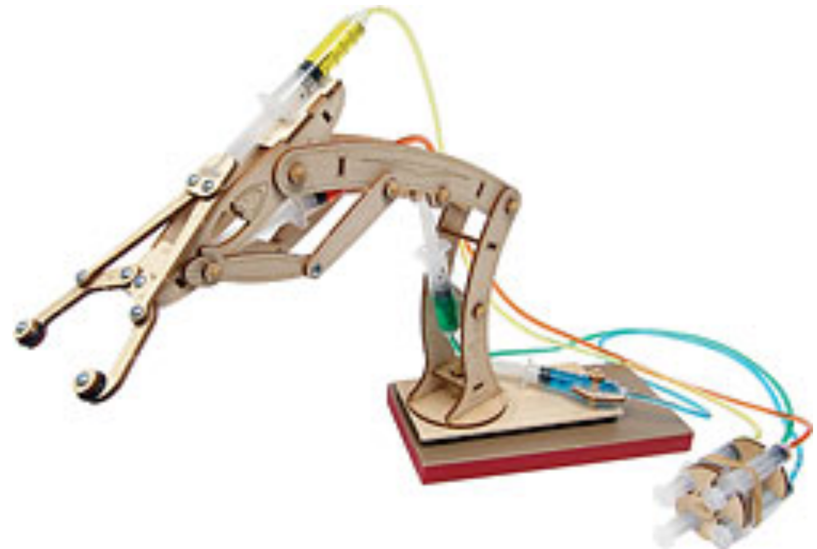
Time for Tums to diffuse out 3.53 min

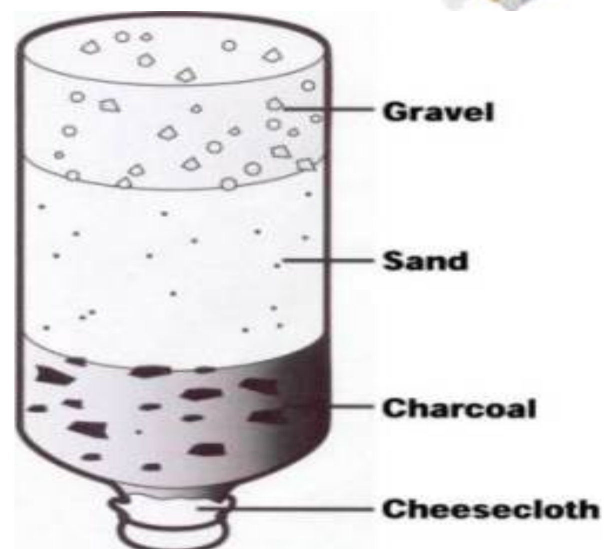
Can you design an encapsulation?

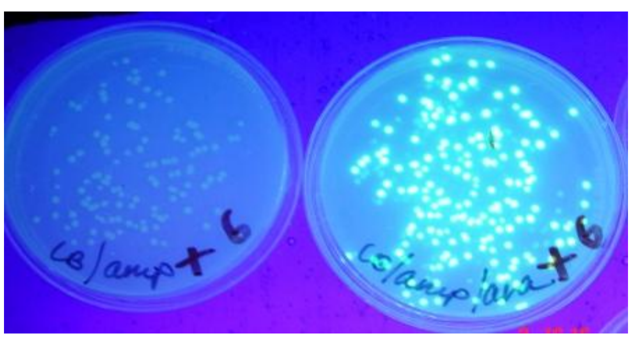
- Using the materials at your station try to design the encapsulation skeleton
- Test the membrane material with TUMS quikpak

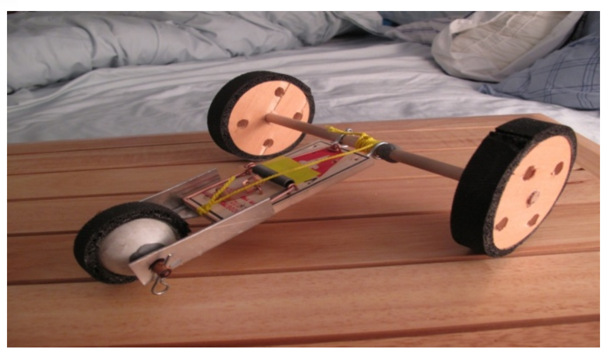
Other Ideas?


Design Process
Define the Problem
Brainstorm
Research and Generate Ideas
Identify Criteria and Constraints
Explore Possibilities
Select an Approach
Develop a Design Proposal
Model or Prototype
Test and Evaluate
Refine
Create or Make
Communicate Results




Gravel
Sand
Charcoal
Cheesecloth





Questions?

Carlos Montalvo

Carlos.Montalvo@ccisd.us

notcarlosm@hotmail.com

Encapsulation Project Rubric

Components	4 points	3 points	2points	1 points
Design Process	Students show evidence of use of the design process by documenting all aspects of project as well as sketches. Students have neat sketches with labels and have all data and evidence recorded. Students also show evidence of refining or redesigning after testing, if necessary.	Students show evidence of use of the design process throughout entire project but some things might not be clear. Student has sketches with labels.	Student uses the design process sparingly They might have evidence of use but not much is clear and no brainstorming of ideas is evident. Student does not have sketch of design.	Student shows very little to no use of the design process. Student does not have any sketches of encapsulation as well as no ideas written as evidence.
Data Gathering	Student creates their own data tables that have all appropriate data pertinent to the project including mass of TUMS before and after release, density of encapsulation, flow rate, etc.	Student creates their own data tables that have most of the appropriate data related to the project. Student may be missing one piece of data.	Student has data tables but most information may be missing or might not have the correct data.	Student may not have any data tables or has one with little to no useful information relevant to the project.
Encapsulation Skeleton Design	Encapsulation skeleton is within the 8cm by 8cm by 8cm constraints. Students show evidence of brainstorming of design as well as reason for choosing design. Skeleton is creatively and cleanly put together.	Skeleton fits within constraints and students show evidence of brainstorming but may not have a specific reason for choosing design. Skeleton may or may not be put together neatly.	Skeleton fits constraints but students does not show evidence of brainstorming and skeleton may not be put together cleanly.	Skeleton does not fit constraints, student shows no evidence of brainstorming or reason for design, and skeleton is not cleanly put together.
Use of Materials	Student uses appropriate materials and uses them in a creative way to enhance the project. Evidence of why materials were chosen is given.	Student uses appropriate materials in a creative way to enhance the project but some evidence of why materials were chosen might not be clear.	Student uses some materials hastily that do not enhance the project and/or hinder the project. Evidence of why materials were chosen might not be given.	Student does not use materials creatively and/or appropriately. No evidence of why materials were chosen is given.
Function of Encapsulation	Encapsulation functions extraordinarily well, holding medicine without pre-releasing, releases medicine when in water, does not break or come undone, and reinforces student's reasons for choosing materials.	Encapsulation functions very well. Does all functions except maybe one or does a function different than what student originally planned for it to do.	Encapsulation functions properly but may not correlate with student's expectations and almost functions totally opposite of students expectations.	Encapsulation does not function properly at all. Medicine is not contained inside, may not be released, skeleton breaks or falters during trials.
Analysis Graphs	Both graphs (projected and actual release) are plotted correctly in a mass vs. time graph with correct units, increments, labels.	Both graphs are plotted correctly but may be missing units, increments, or labels.	Both graphs are plotted but may not be clear and/or messy and do not have correct units and labels.	Both graphs are not plotted correctly. Very messy and does not have labels, units, and correct increments.
Conclusion and Defense	Engineering design process is thoroughly explained. Student explains advantages of their encapsulation vs. other students design. Student explains and justifies all qualities of encapsulation using data as justification.	Engineering design process is explained well and student explains advantages of their encapsulation but may not justify their reasoning with data.	Engineering design process is explained but may not be clear. Advantages are explained but may not be clear. No justification is given.	Engineering design process is not explained. Advantages are loosely discussed and no justification is given.

Encapsulation Project--Student Lab

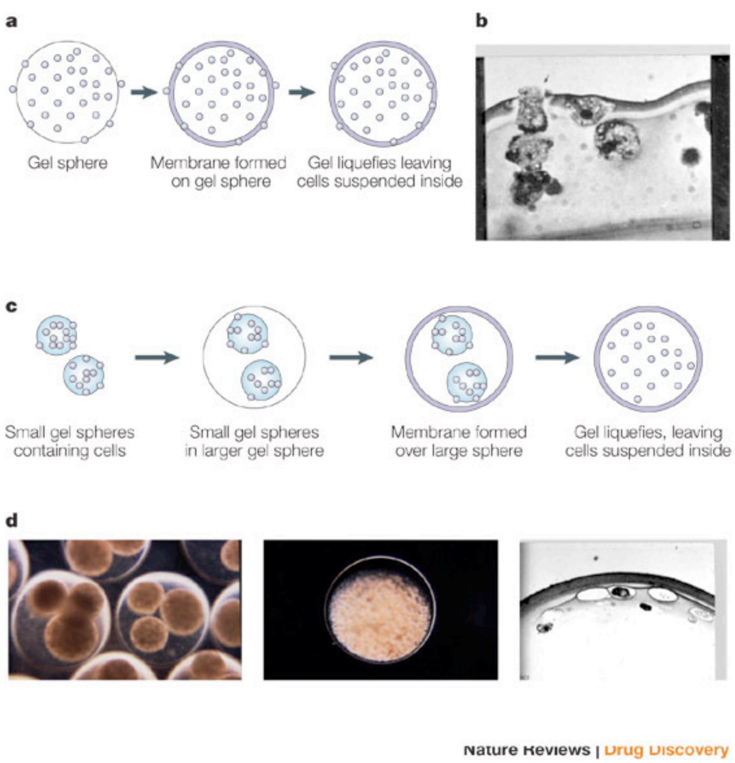
Carlos Montalvo—Engineering in the Classroom, 2012 TAMU Teacher Summit

Problem:

A local pharmaceutical company is searching for a new way to encapsulate a drug. The actual encapsulation must 1) be protective of the medicine inside, 2) have some sort method to time releasing the drug, and 3) have the physical and chemical characteristics that make it selectively permeable.

Background:

Cell encapsulation is the process by which transplanted cells are protected from rejection (by the body's immune system) by an artificial, semipermeable membrane, potentially allowing transplantation without the need for immunosuppression (taking down your defense system).[1] Cells are inserted into a gel like bubble and then the bubble is coated with a protective coating which can then be inserted into a foreign body. This type of process can be used for insulin delivery in diabetic patients at specific sites in the body. This makes medicine more specific to a particular disease or symptom as opposed to blanketing the entire body.



[1] *Nature Medicine*. http://www.nature.com/nm/journal/v9/n1/abs/nm0103-104.html

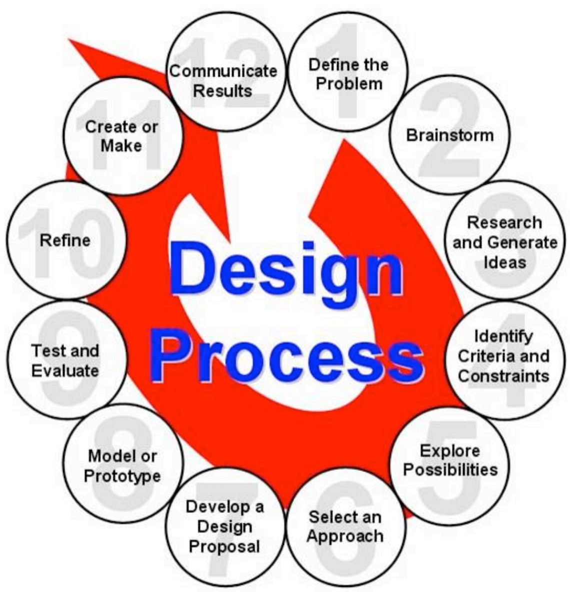
Objective:

Each team will need to design a cell encapsulation, test their encapsulation, and pitch their encapsulation design to a local pharmaceutical representative. Each team will need to address (defend) the advantages to their particular design using the knowledge based on their research of physical and chemical properties of the materials used and data measured.

Materials:

Teacher Provided	**Student Provided**	**Lab Only Equipment**
Nylon	Embroidery loops	Triple beam balance
Pantyhose	Wiffle balls	Plastic container
Fiberglass	Popsicle sticks	Water
Burlap	Dowels	TUMS quikpak
Coffee filter	Balsa wood	Pepper
Water	Straws	Graduated cylinder
	Toothpicks	Ruler
	Other creative materials	Stapler
		Tape
		Glue

Procedures: (TEAMS MUST USE AND DOCUMENT THE ENGINEERING DESIGN PROCESS DURING ENTIRE EXPERIMENT)



SEMIPERMEABLE MEMBRANE SELECTION

1. Each team will be given samples of the five materials to be used as semipermeable membranes (nylon, pantyhose, fiberglass, burlap, and coffee filter paper).
2. In class, each team will test the five membrane samples for durability, speed of medicine release, and semi-permeability using their own methods of testing such as density, ability to release medicine, etc.

3. Based on the team's choice (more semi-permeable versus time release; or durability versus semi-permeable, etc) the team will choose one membrane material and obtain one square foot of that material to be used for the encapsulation.

ENCAPSULATION SKELETON CREATION

1. Each team will design the encapsulation skeleton with a drawing or sketch or using the AutoCAD Inventor program, if available.
2. Once design is made, team will collect any material they feel necessary in order to make their skeleton.
3. Total encapsulation must fit within an 8cm x 8cm x 8cm cube.
4. Triple beam balances and rulers will be provided so that students can test the density of their encapsulation.
5. Glue, tape, staplers will be provided by teacher.

ENCAPSULATION TESTING

1. Teams will draw at random the order which they will test their design.
2. Teams must leave an opening in encapsulation so that TUMS may be put into encapsulation. One packet of TUMS will be put in right before testing.
3. After sealing encapsulation, team will place encapsulation in pepper/water pool and time begins.
4. Teams are responsible for documenting testing by taking pictures, video, etc.
5. Each encapsulation will sit in water for 2 minutes. After two minutes the mass of TUMS remaining in encapsulation will be measured.

ENCAPSULATION DEFENSE

1. Day after testing is complete, teams will create a PowerPoint presentation showing their engineering design process, advantages of their encapsulation, graph of testing results, and photos/videos of process and testing.
2. Teams will present their defense to local pharmaceutical representatives the next day in class.
3. Teams must dress professional.

Data:

All data tables must be created by teams and include mass, volume, and density of materials and overall encapsulation, as well as mass release and timing data.

Analysis:

Plot two graphs of your projected TUMS release (from prior testing) and actual TUMS release (experiment day) in a mass vs. time graph.

Conclusion (DEFENSE):

Explain your engineering design process including all brainstorming ideas, Inventor sketches, reason for choosing membrane, etc. Be sure to explain your initial advantages to design (materials used, size, etc) before testing as well as justification of advantages and any new advantages based on testing. Rank your design qualities of durability, semi-permeability, and time-release function as high priority, medium priority, and low priority and explain the benefits of your high priority quality. Be prepared to answer any questions about your design process, design, testing, and/or justifications.

Encapsulation Project—Teacher Edition
Carlos Montalvo—Engineering in the Classroom, 2012TAMU Teacher Summit

Problem:

A new method of delivering medicine to patients needs to be created; an encapsulation that has a semipermeable membrane that allows medicine to be delivered to specific parts of the body.

Background (Possible topics covered):

Chemistry—chemical and physical properties/changes, density, buoyancy, viscosity, properties of water, pH, heterogeneous mixtures (colloids), scientific method

Physics—density, speed, velocity, thermodynamic systems (affecting rate of diffusion), rate/force of elasticity, flow rates

Biology—cellular processes, osmosis, diffusion (active/passive transport), biomolecules, cell transport, microorganisms and health of an organism

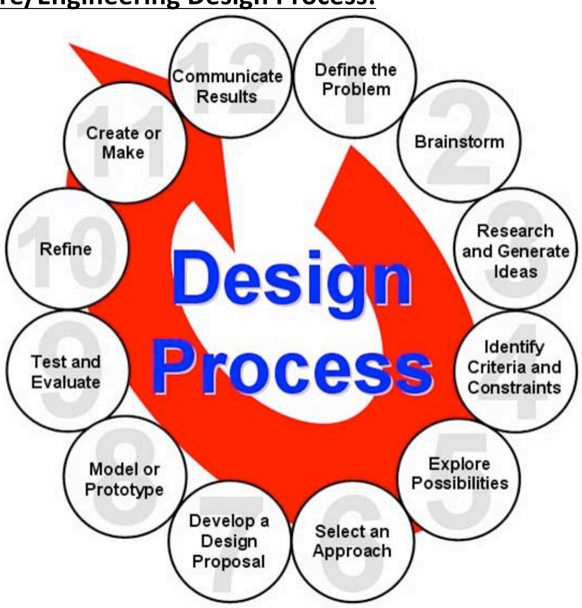
Objective:

Design a cell encapsulation, test it, and pitch the design to a local pharmaceutical representative. Each team will address the advantages of their design and discuss its characteristics of flexibility, semipermeability, density, etc.

Materials: (Student list is completely optional and open for the student to be creative with their design)

Teacher Provided	Student Provided	Lab Only Equipment
Nylon	Embroidery loops	Triple beam balance
Pantyhose	Wiffle balls	Plastic container
Fiberglass	Popsicle sticks	Water
Burlap	Dowels	TUMS quikpak
Coffee filter	Balsa wood	Pepper
Water	Straws	Graduated Cylinder
	Toothpicks	Ruler
	Other creative materials	Stapler
		Tape
		Glue

Procedure/Engineering Design Process:



1. Have students test a small sample of each membrane for density, permeability, strength, etc by practicing placing medicine in the samples and seeing how much they release in water as well as if they float and/or fall apart when in water.
2. Have students design their encapsulation skeleton using a material of their choice. Students can use any material as long as encapsulation fits in an 8cm by 8cm by 8cm cube. Have students design their skeleton by drawing or on a sketch computer program, if available (such as AutoCAD Inventor, SketchUp, SolidWorks, etc).
3. Have students draw at random the order in which they will test their design. Teams will leave an opening for the TUMS to be placed into their encapsulation before sealing completely.
4. Have students create a powerpoint explaining the advantages and disadvantages of their design to a local pharmacist and/or pharmaceutical sales representative.

Data:

Have students create their own data tables for mass, volume, density, time for release, and any other data that you feel necessary.

Analysis:

Have students create two graphs (Projected TUMS release and Actual TUMS release—mass vs. time). Projections will be based on student testing and actual will be based on experiment day. Recording the amount of TUMS started with and TUMS remaining in encapsulation at end will give you data to create graphs.

Conclusion:

Have students explain their design process and defend their ideas and justify why their encapsulation is the best.

EXTENSIONS:

- Focus on more aspects of membrane such as defense (pepper is optional to illustrate the body's defense system possibly attacking the cell encapsulation; if pepper travels into encapsulation)
- Focus on time and flow rates and determine that actual length for each encapsulation to completely empty
- Use pH meters to determine the amount of TUMS in water by the change of pH
- Coteach with a math teacher and have students use higher level math equations
- Present to other local people (Doctors, parents, hospital staff, etc)

SHRINKING THE PROJECT:

- Give students only one material and base project mainly on their encapsulation design
- Do not have students present to local representatives
- Provide students with specific materials to make the encapsulation skeleton (for example only a waffle ball or embroidery loops)
- Provide students with density, rate data for each semipermeable material to eliminate student testing

Teacher Summit 2012

TEXAS A&M UNIVERSITY

Admissions & Profile of STEM Students

Dr. Robin Autenrieth
Senior Associate Dean
Dwight Look College of Engineering

Dr. Tim Scott
Associate Dean
College of Science

Teacher Summit
January 27, 2012

Office of Admissions

TEXAS A&M UNIVERSITY

December 1 Scholarship Deadline

Important Freshman Deadlines

January 15 Application Deadline

Admissions | Future Students | Family | HS Guidance Counselors | Visit Us

Google Texas A&M GO

Admissions » Freshman » Getting In » Ways to be Admitted

FRESHMAN

GETTING IN

1. State of Texas Uniform Admission Policy
2. Ways to be Admitted
   - Top 10% Admits
   - Academic Admits
   - Review Admits
   - Other Pathways
3. High School Courses
4. Tips for Applying
5. Required Documents
6. Deadlines
7. Notification of Admissions Decision

WHY AGGIELAND

VISIT US

ONLINE TOOLS

Ways to be Admitted

TOP 10% ADMITS

» more

ACADEMIC ADMITS

» more

REVIEW ADMITS

» more

OTHER PATHWAYS

- Attend TAMU Galveston (TAMUG)
- Participate in Texas A&M's Program for System Admission (PSA)
- Apply as Transfer Student
- Transfer Articulation Program (TAP)

Application Opening Date : August 1

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TAMU Admission Requirements

Top 10% Admits – Applicants qualify for Top 10% Admission, if:
they attend a recognized public or private high school in Texas, and rank in the top 10% of their graduating class, and meet the State of Texas Uniform Admission Policy, and ensure all required credentials are received by the freshman closing date.

Academic Admits – Applicants qualify for automatic admission, if:
they are ranked in the top quarter of their graduating class, and achieve a ***combined SAT Math and SAT Critical Reading score of at least 1300*** with a test score of ***at least 600 in each of these components***; or achieve a ***composite ACT score of at least 30*** with a test score of ***at least 27 in ACT Math and ACT English***. Students must take the writing component of the SAT and/or ACT in order for the test score to be considered, and have successfully taken all recommended coursework, and meet the State of Texas Uniform Admissions Policy, and ensure all required credentials are received by the freshman closing date.

Review Admits
Holistic assessment of the complete application

In addition, the College of Engineering requires a minimum score of 550 in SAT MATH (24 in ACT MATH)

College of Engineering

TEXAS A&M UNIVERSITY

More than **11,000** undergraduate and graduate students

- **Second largest engineering school** in the nation based on enrollment

Highly Ranked Programs

- Overall Undergraduate Program Ranked #9 (public)
  - Seven undergraduate programs ranked in the top 10
- Overall Graduate Program Ranked #7 (public)
  - Seven graduate programs ranked in the top 10.

Research Level 1 Institution

- **$ 248.4 Million** in Engineering Research Expenditures

College of Engineering
Profile of Incoming Freshman - Fall 2011

TEXAS A&M UNIVERSITY

1634 students (first-time-in-college)
Male 79% Female: 21%
71.1% (W), 12.4%(H), 2.5% (AA), 14% (O)

64% ranked at the top 10% of their high schools
96% ranked at the top 25% of their high schools
98% enroll with at least 12 Student Credit Hours

18.8% First Generation

Average MATH SAT --- 666
Average Verbal SAT--- 609

College of Engineering
Profile of Graduating Student

2010 May COE Graduation

649 BS Graduates

- 53.1% graduated in top 10% of their high schools
- 1259 Average composite SAT (math+verbal)
- 41.4% changed their major once
- 10.5% started in non-engineering majors
- 51.5% of May 2010 graduates completed their degree within 4 years

Graduation Rates (Six-year Data)

2004 Cohort	52.5%
2005 Cohort	55.2%

College of Science

~3,200 undergraduate and graduate students
(Biology accounts for 2/3 of undergrads; fourth-largest major on campus)

Teach 20% of university's total semester credit hours (1 of every 5 classroom hours taken by 49,000+ Aggies)

Highly Ranked Graduate Programs

Chemistry: 8th public, 19th overall (*U.S. News & World Report*)

Mathematics: 14th public, 25th overall (National Research Council)

Physics: 20th public, 40th overall (*U.S. News & World Report*)

Statistics: 3rd public, 12th overall (*U.S. News)*; 10th overall (NRC)

Research Level 1 Institution

~$67 million annually in sponsored research projects

College of Science
Profile of Incoming Fall 2011 Freshman

797 students (First-Time-In-College)

Male 54.5% Female: 45.5%

57% (W), 25.8%(H), 2.9% (AA), 14.2% (O)

- **67.8% ranked at the top 10%**
- **94.5 ranked at the top 25% of their high schools**
- **99% enroll with at least 12 Student Credit Hours**

29.7% First Generation

Average MATH SAT 623
Average Reading SAT 583

College of Science
Profile of Graduating Students

- Average SAT = 1227 (1208-1246)
- Average Math SAT = 630 (621-639)
- Average Verbal SAT = 597 (585-609)

- Percentile in High School Graduating Class = Top 9% (90-93)

- Freshmen College of Science Students Who Graduate from the College of Science = 34%

Texas A&M Claims Spot #2 in Top Recruiter Rankings – *Wall Street Journal* - 9/13/2010

TEXAS A&M UNIVERSITY

Big state schools Pennsylvania State University, **Texas A&M University** and University of Illinois at Urbana-Champaign were the top three picks among recruiters surveyed. Wall Street Journal. 9/13/2010

PATHS TO PROFESSIONS | SEPTEMBER 13, 2010

Penn State Tops Recruiter Rankings

Companies Favor Big State Schools With One-Stop Shopping for Graduates With Necessary Skills

By TERI EVANS

State universities have become the favorite of companies recruiting new hires because their big student populations and focus on teaching practical skills gives the companies more bang for their recruiting buck.

Under pressure to cut costs and streamline their hiring efforts, recruiting managers find it's more efficient to focus on fewer large schools and forge deeper relationships with them, according to a Wall Street Journal survey of top corporate recruiters whose companies last year hired 43,000 new graduates. Big state schools Pennsylvania State University, Texas A&M University and University of Illinois at Urbana-Champaign were the top three picks among recruiters surveyed.

Recruiters say graduates of top public universities are often among the most prepared and well-rounded academically, and companies have found they fit well into their corporate cultures and over time have the best track record in their firms.

Employers also like schools where they can form partnerships that allow them to work with professors and their students, giving them an inside track when it comes time to make offers for internships and jobs.

Corporate budget constraints also play a role. Recruiter salaries, travel expenses, advertising

Internet

Texas A&M Ranks 21st for ‘Best Values’ Public College National Rankings: 2011-2012

TEXAS A&M UNIVERSITY

Texas A&M University moves up in *Kiplinger*’s annual listing of **“best values” among the nation’s top 100 public colleges**, now **ranking 21st — and top in Texas**. The widely circulated personal finance magazine’s rankings are based on a combination of academic quality and affordability.

It is **one of only three Texas universities to be included on the list this year,** followed by the University of Texas at Austin and the University of Texas at Dallas.

SCIENCE
TEXAS A&M UNIVERSITY

Analee Mattice

SENIOR MICROBIOLOGY MAJOR

STEM Teacher Summit

January 27, 2012

Scholarships in Science Technology, Engineering and Mathematics DUE-0728685
Louis Stokes Alliance for Minority Participation HRD-0703290

LSAMP
LOUIS STOKES ALLIANCE
FOR MINORITY PARTICIPATION
THE TEXAS A&M UNIVERSITY SYSTEM

Judson High School - Converse, TX
Class of 2008

- PreAP - Algebra 1, Geometry, Algebra 2, Biology and Chemistry
- AP – Physics
- IB – Anatomy and Physiology
- Others – Pre-Calculus, Medical Terminology*and Pharmacology*
- Distinguished program graduate ***but not*** top 10%
- Junior Reserve Officer Training Corps (JROTC)
- Health Occupations Students of America (HOSA)
- Completed Certified Nurses Aide Certification*
- Interests in health, medicine, and biological sciences

Palo Alto College – San Antonio, TX
Attended 2008-2010

ALAMO COLLEGES
PALO ALTO COLLEGE

- Financial Considerations
- Began in Nursing
- Transitioned to Biology
- Recommended for S-STEM Program
  - NSF funded Scholarship Program between Palo Alto and TAMU
  - Funds 2+2 Programs in Science and 2+3 in Engineering

Texas A&M University Class of 2012 - Whoop!

- 2+2 is possible!
- Transfer Shock is real
- Career Plans Change
- Learning Communities
  - S-STEM Cohort
  - Undergraduate Resea
    LSAMP
  - TAMU Society for
    Conservation Biology

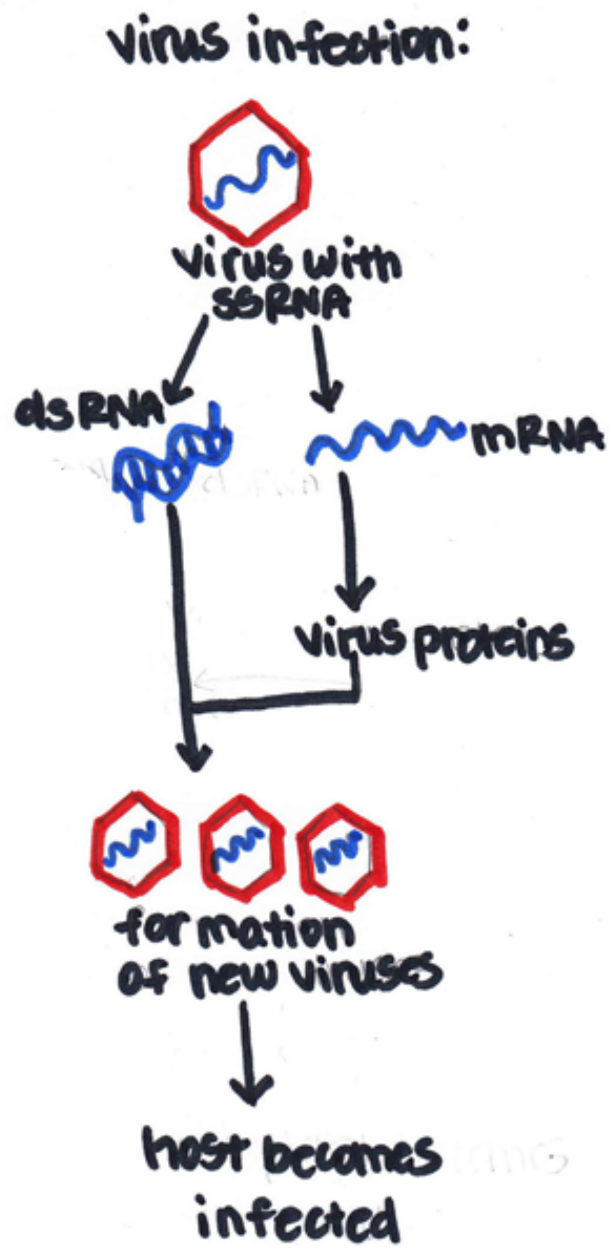
Research Experience

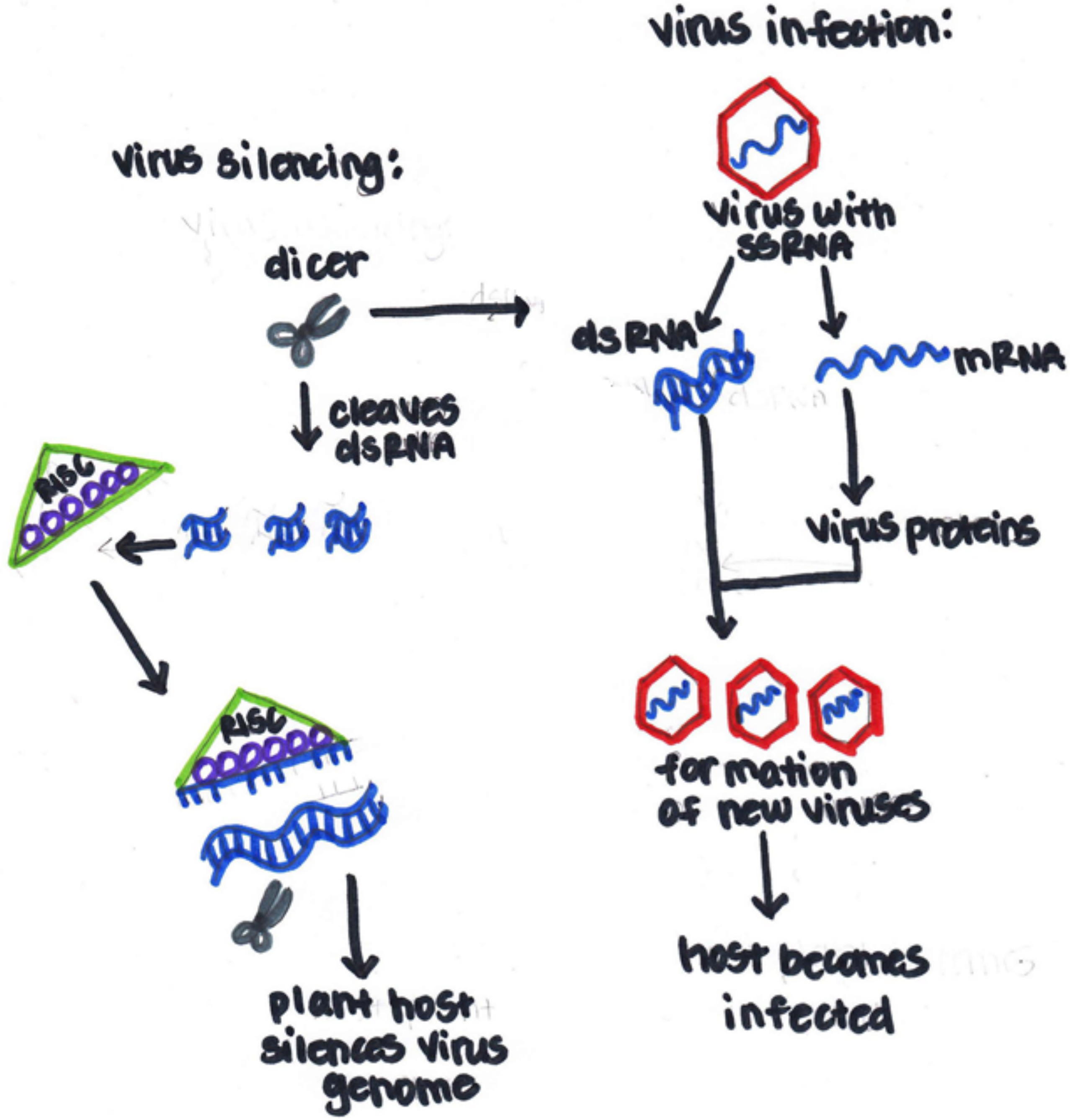
ATM | SCIENCE
TEXAS A&M UNIVERSITY

- Began Spring 2011 as paid student laboratory worker
- In the Fall of 2011, began independent research with guidance and mentoring of a graduate student
- Research Focus - Molecular Genetics of Virus and Plant Host Interactions
- USDA Funded

Research Objective:

Which Argonaute components of the RNA Induced Silencing Complex (RISC) are involved in antiviral silencing in *Nicotiana benthamiana?*


virus infection:
virus with ssRNA
dsRNA
mRNA
virus proteins
formation of new viruses
host becomes infected



virus infection:
virus with ssRNA
dsRNA
mRNA
virus proteins
formation of new viruses
host becomes infected
virus silencing:
dicer
cleaves dsRNA
RISC
RISC
plant host silences virus genome

What's Next

- Benefits of a Research One Education
  - Ability to take specialized and unique classes
  - Networking with professors and companies
  - Gaining valuable experience in laboratory skills
- Masters Program in Environmental Sciences
- Career in Environmental Testing or Remediation

Preparing High School Students for College

- Applying knowledge to real life situations
- Critical thinking problems to move beyond rote memorization
- Experiments using real life data to master collection and analysis
- Never underestimate the power of encouragement

Thanks and Gig'em!

TEXAS A&M ENGINEERING

Ryan Rihani

Senior Biomedical Engineering Student

MICHAEL E.
DEBAKEY INSTITUTE
TEXAS A&M UNIVERSITY

High School Profile

Northland Christian School Houston, Tx

Classes I Took:

- Mathematics: Algebra I & II, Geometry, Pre-Cal, AP Calculus AB
- Sciences: Biology, Chemistry, Physics, AP Biology, AP Chemistry
- AP Computer Science (Java)
- Dual Credit World History
- Dual Credit Economics
- AP Studio Art
- AP English I & II

Came into Texas A&M University with 25 hours

High School Profile

- Graduated Valedictorian in a 60 person class
- Participated in Robotics Team
- Lettered in Football, Basketball, & Track/Field
- Scariest part was knowing that excelling in a 60-person class could not reflect how I would do with 40,000 people at A&M.
- Craig Brown helped with my confidence.

NORTHLAND Christian School

College- Freshman Year

Classes:

- College classes are different from High School
  - Much faster paced
  - More independence
  - Tests are harder, the teachers tougher, stakes higher

- Physics in Engineering
  - Mechanics-focused first semester (from kinetics to harmonics)
  - Electronics & Optics-focused second semester

- Calculus in Engineering
  - Covered my entire year-long AP Calculus course in one month

College- Experiences Outside the Classroom

- Biomedical Engineer working towards a career in medicine
  - Three years of research
  - Michael E. DeBakey Institute
  - Modeling pulmonary flow
  - Volunteering at Urgent Care
  - Summer Program Manager

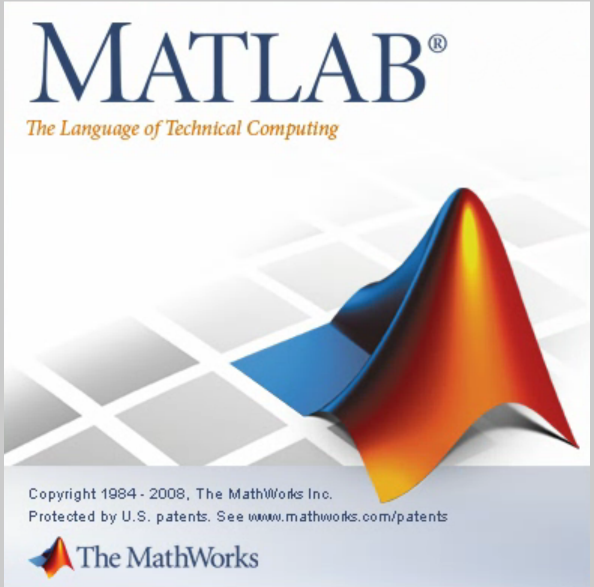
- Spent 2009 winter break in Germany
- Effects of a role model

Why Biomedical Engr?

- Reason I chose BMEN & Engineering
  - Mr. Craig Brown
  - Love of two subject areas drove me to indecision, which was ok in this case
  - How it will make me a better doctor
- How study abroad in Germany, France, & Austria helped me decide on medicine over engineering
  - Open heart surgery

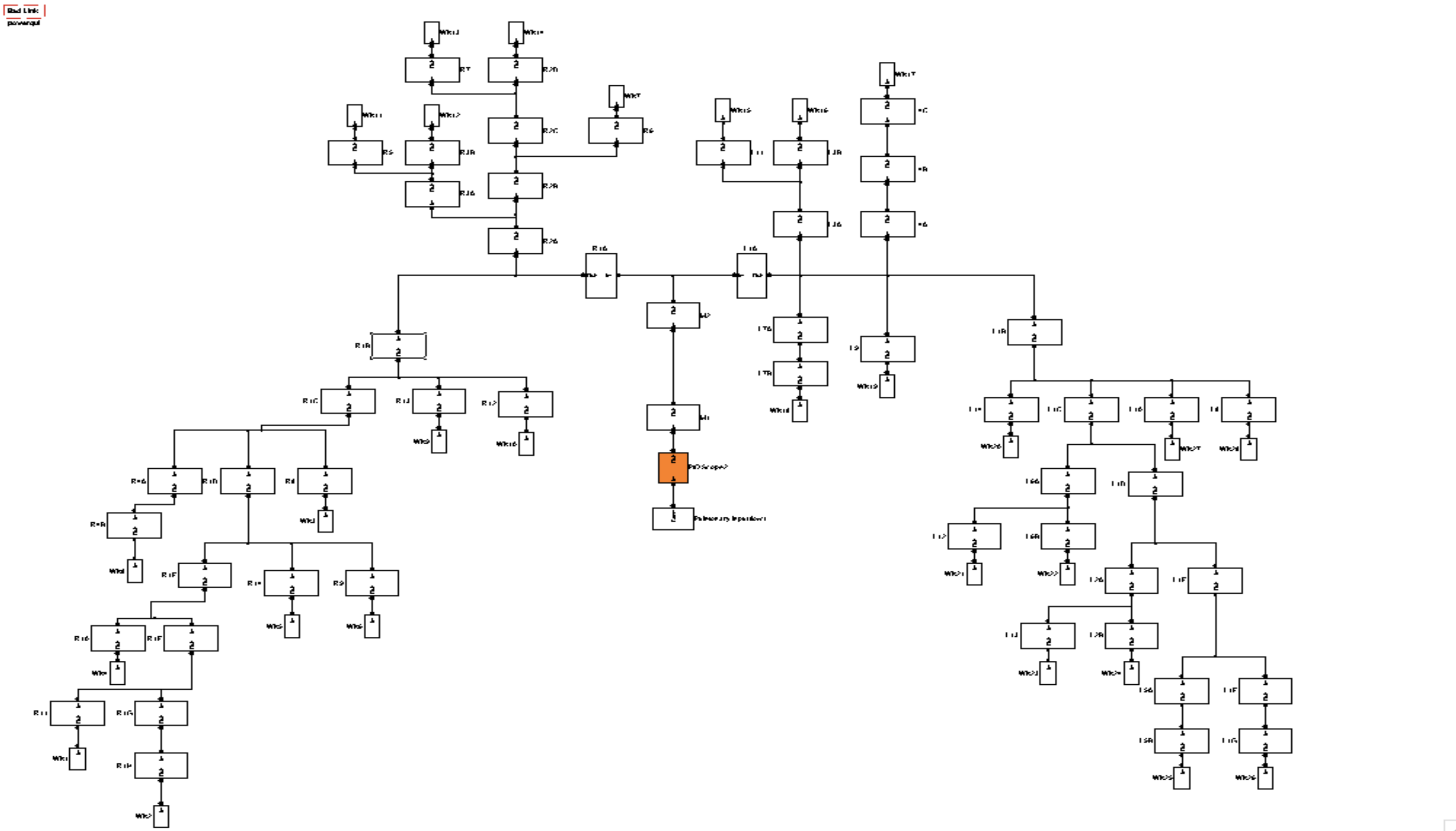
Career Path

- Reason I chose my area of research
  - Matlab (how high school experience affected this)
  - Focus on Medicine
- I have found that when someone loves what they are studying, it is much easier to excel



- Always wanted to be a doctor
- Took opportunities to make sure I love this as much as I think I do
- Effects of a role model

College Career



How to help your students excel

- Find out what they love!
- Cover material at a faster pace to help them get ready for college

- Physics:
  - Vector understanding/knowledge
  - Coordinate axes besides cartesian
  - Circular motion, angular momentum
  - Harmonics

- Calculus
  - Integration
  - Application of concepts
  - Focus on general concepts

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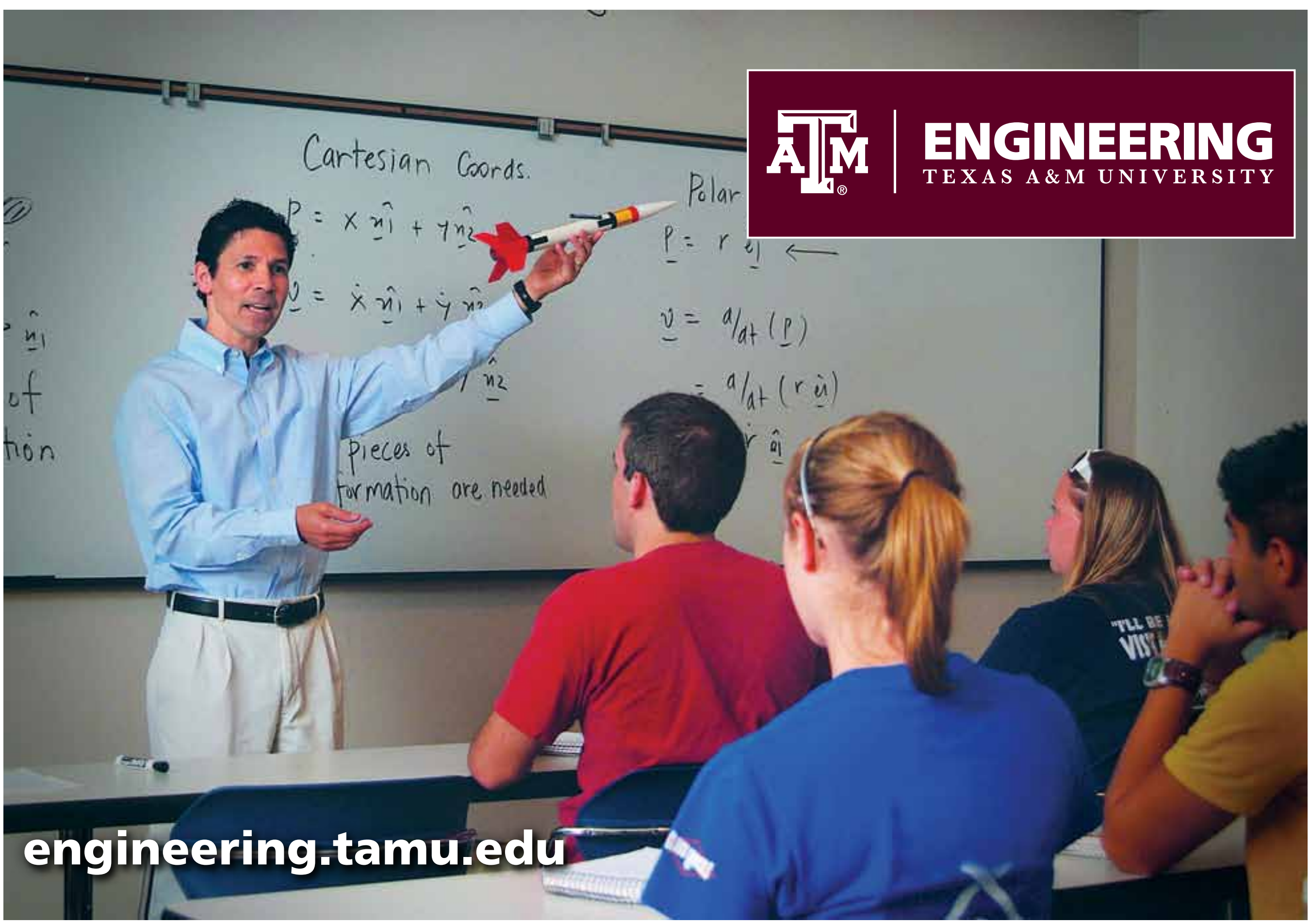
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For More Information

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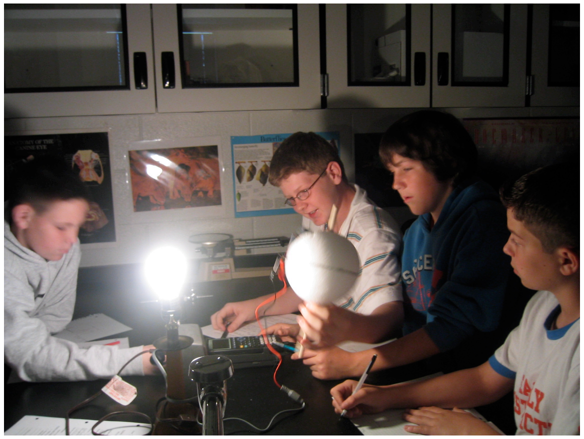
University Studies Program for Secondary Science Teaching



Secondary Science Teaching

Introduction

Texas A&M's University Studies degree is an innovative interdisciplinary degree with an area of concentration and two associated minors in science and education. The degree serves students

• who are in good academic standing (GPA of 2.5 or better);
• who specifically seek a broad interdisciplinary combination of coursework that is unavailable through existing degree programs; and
• who desire to teach sciences in grades 8 through 12.

The objective of this University Studies degree is to provide students highly qualified in science and mathematics who are interested in a career in secondary science teaching with the broad interdisciplinary academic degree and associated experiences that will prepare them for this career choice.

This program is designed to prepare students to receive the secondary science composite certification. The degree program is a collaboration of the College of Science, the College of Geosciences and the College of Education and Human Development.

Core Curriculum		
Social Sciences INST 322 or SOCI 317	Humanities English Literature	MATH 151/152 or 171/172
Communications COMM 203		

Core Body of Knowledge 36 Hours		
ATMO 201/202	ASTR 101/102	BIOL 111/112
CHEM 101/102 or 111/112	GEOL 101 or GEOG 203	PHYS 201/202

Minor 1: Science Specialization
Biology: BIOL 301 or 304 or 328 or 453; BIOL 318 or 319 or VTPP 323; BIOL 335, 357 or WFSC 420, 440; GENE 302
Chemistry: CHEM 315/318 or 316/317, 362, 383, 415
Geosciences: GEOL 301, 306–310, 312, 352, 410, 420; GEOG 331, 335, 360, 370; OCNG 401

Program

Students complete a set of required **Core Curriculum** classes supporting the degree as well as 36 hours in a concentration (**Core Body of Knowledge**) of science courses. In addition, students select a minor elective track of either **Biology**, **Chemistry** or **Geosciences** which is taken in addition to an associated minor specialization in Teacher Education.

Minor 2: Teaching Specialization
INST 310 or TEED 302, INST 322, TEFB 322 or 323, TEFB 324, TEFB 406, RDNG 460 and 465, and Student Teaching