



Rensselaer

Department Of Electrical, Computer, & Systems Engineering



# Electrical Engineering Computer & Systems Engineering Electric Power Engineering

## Curricular & Career Information

Electrical Engineering

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# What Is?

From Wikipedia:

[Computer engineering](#) deals with the design of [computers](#) and [computer systems](#). This may involve the design of new [hardware](#), the design of [PDAs](#) or the use of computers to control an [industrial plant](#). Computer engineers may also work on a system's [software](#). However, the design of complex software systems is often the domain of [software engineering](#), which is usually considered a separate discipline. [Desktop computers](#) represent a tiny fraction of the devices a computer engineer might work on, as computer-like architectures are now found in a range of devices including [video game consoles](#) and [DVD players](#).

both. Power engineers may also work on systems that do not connect to the grid, called *off-grid* power systems, which in some cases are preferable to on-grid systems.

# Wide Variety of Opportunities

- Consider the diversity of topics covered by divisions of our professional society – The IEEE.
- Not addressed by the IEEE – jobs in the finance industry, which has been a growing sector in recent years



(366,000 Members)

- Aerospace and Electronic Systems Society
- Antennas and Propagation Society (9,000 Members)
- Broadcast Technology Society
- Circuits and Systems Society (16,000 Members)
- Communications Society (50,000 Members)
- Components Packaging, and Manufacturing Technology Society
- Computer Society (88,000 Members)
- Consumer Electronics Society
- Control Systems Society (10,000 Members)
- Council on Super Conductivity
- Dielectrics and Electrical Insulation Society
- Education Society

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# IEEE

- Electromagnetic Compatibility Society
- [Electron Devices Society \(13,000 Members\)](#)
- Engineering Management Society
- Engineering in Medicine and Biology Society
- Geoscience & Remote Sensing Society
- Industrial Electronics Society
- Industry Applications Society
- Information Theory Society
- Intelligent Transportation Systems Council
- Instrumentation and Measurement Society
- [Lasers & Electro-Optics Society \(9,000 Members\)](#)
- Magnetics Society
- [Microwave Theory and Techniques Society \(12,000 Members\)](#)
- Nuclear and Plasma Sciences Society
- Neural Networks Council

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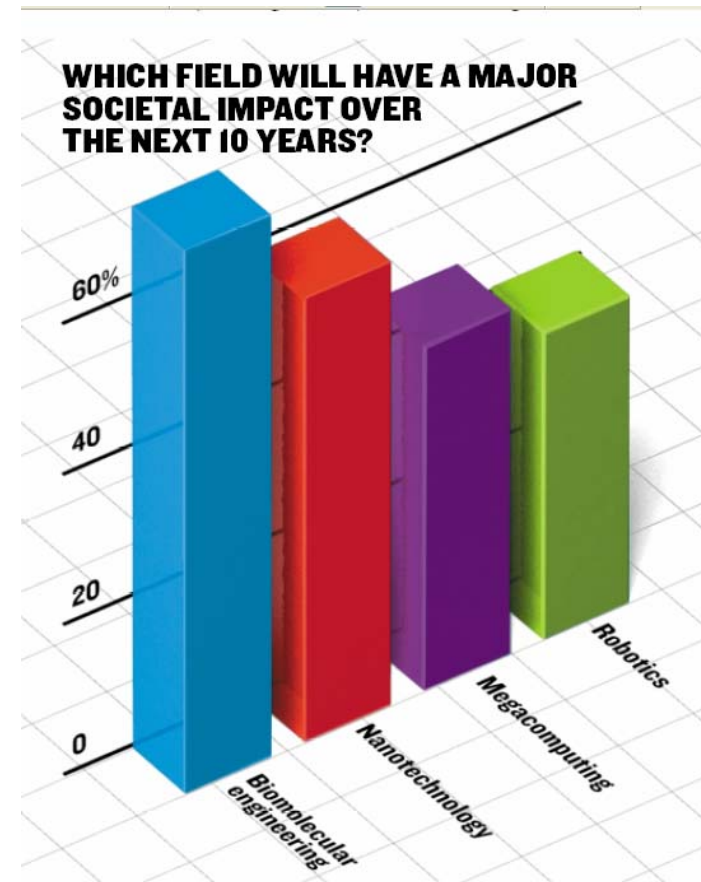
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# IEEE

- Oceanic Engineering Society
- Power Electronics Society
- [Power Engineering Society \(22,000 Members\)](#)
- Professional Communication Society
- Reliability Society
- Robotics & Automation Society
- Sensors Council
- [Signal Processing Society \(18,000 Members\)](#)
- Society on Social Implications of Technology
- [Solid-State Circuits Society \(14,000 Members\)](#)
- Systems, Man, and Cybernetics Society
- Ultrasonics, Ferroelectrics, and Frequency Control Society
- Vehicular Technology Society

# Where EE Jobs Are – IEEE Spectrum 1/04

- Power
- Communications
- Semiconductors
- Transportation
- Computers
- Bioengineering



Dream Jobs (as presented in the IEEE Spectrum) are not typical but the skills they require are representative.

It should always be your goal to have fun and get paid well.



# EE CSE EPE Dream Jobs (2006)



**ENJOYING THE RIDE:** For Manni Wong, having fun is part of the job.

**MANNI WONG: Serious Fun**

## Manni Wong (M)

**AGE:** 46.

**WHAT SHE DOES:** Designs electronics and control systems for rides and attractions at Disney parks worldwide.

**FOR WHOM:** Walt Disney Imagineering.

**WHERE SHE DOES IT:** Glendale, Calif.

**FUN FACTORS:** Has worked and lived in Paris and Hong Kong while building attractions for Disney theme parks; gets to ride Space Mountain with the lights on.

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# EE CSE EPE Dream Jobs (2006)

## Wade Bortz (M)

**AGE:** 32.

**WHAT HE DOES:** Designs, installs, and troubleshoots infrasonic arrays used to monitor the Comprehensive Nuclear Test-Ban Treaty.

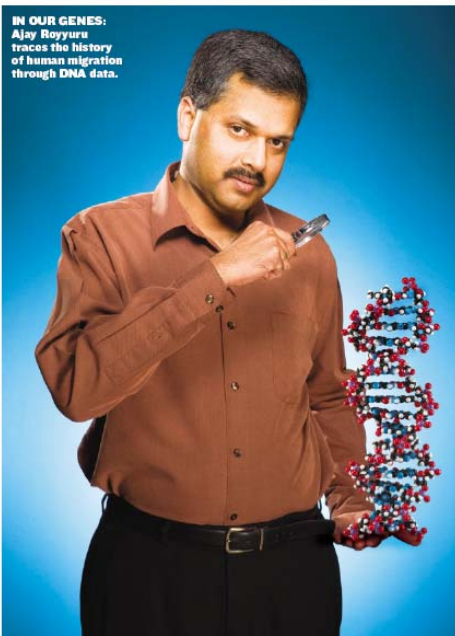
**FOR WHOM:** Infrasound Laboratory, University of Hawaii, Kailua-Kona.

**WHERE HE DOES IT:** Various installations across the South Pacific and Indian oceans.

**FUN FACTORS:** Travels to remote destinations like Tahiti and Palau—and has the freedom to pursue his hobby, kiteboarding, both on the road and back home.



**ISLAND HOPPER:** Wade Bortz crisscrosses the Pacific installing acoustic arrays.



**IN OUR GENES:** Ajay Royyuru traces the history of human migration through DNA data.

## Ajay Royyuru (M)

**AGE:** 41.

**WHAT HE DOES:** Manages a computational biology lab and runs the computing research for the Genographic Project, a five-year effort to map human migration, from its origins to the present, using clues in human DNA.

**FOR WHOM:** IBM Corp.

**WHERE HE DOES IT:** IBM's Thomas J. Watson Research Center, in Yorktown Heights, N.Y.

**FUN FACTOR:** His computational algorithms could tell us where we all came from and how we got here.

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# EE CSE EPE Dream Jobs (2006)



## Grant Imahara (M)

**AGE:** 35.

**WHAT HE DOES:** Builder for the Discovery Channel's "MythBusters."

**WHERE HE DOES IT:** San Francisco.

**FUN FACTORS:** Enjoys working on the eclectic "MythBusters" set, which features a motorized surfboard, a row of first-class airplane seats, and a larger-than-life rubber cast of a human rear end.

# EE CSE EPE Dream Jobs (2006)



## Martin Cooper

**AGE:** 38.

**WHAT HE DOES:** Works with lasers and three-dimensional scanners to restore and replicate priceless artwork.

**FOR WHOM:** The Conservation Centre of the National Museums Liverpool, England.

**FUN FACTORS:** Makes the world prettier one artifact at a time. Has few deadlines, an actual 40-hour week that leaves time for family, varying challenges with each job, and beautiful, art-filled surroundings.

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# EE CSE EPE Dream Jobs (2006)

## Jim Benya (M)

**AGE:** 55.

**WHAT HE DOES:** Designs energy-efficient lighting systems for commercial, public, and residential projects.

**FOR WHOM:** Benya Lighting.

**WHERE HE DOES IT:** California's Yosemite National Park; Maui, Hawaii; California wine country.

**FUN FACTORS:** Lighting design "involves a wonderful mix of art and science, amazing clients, travel—and an opportunity to make a difference."



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# EE CSE EPE Dream Jobs (2006)



**BUSHMAN:**  
Louis Liebenberg  
on the trail in  
South Africa's  
Kruger National  
Park.

## Louis Liebenberg

**AGE:** 45.

**WHAT HE DOES:** Runs a software company that offers an animal-tracking program for handheld devices; trains and evaluates animal trackers.

**FOR WHOM:** CyberTracker Software Ltd.

**WHERE HE DOES IT:** Noordhoek, Cape Town, South Africa, and in game parks and reserves all over the world.

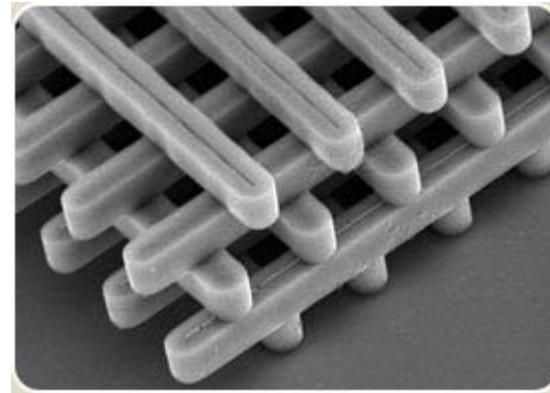
**FUN FACTORS:** Tracks exotic animals, evaluates state-of-the-art handhelds, sleeps and dines free of charge in the world's most exclusive game reserves.

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# Some Interesting Application Areas

# Smart Lighting

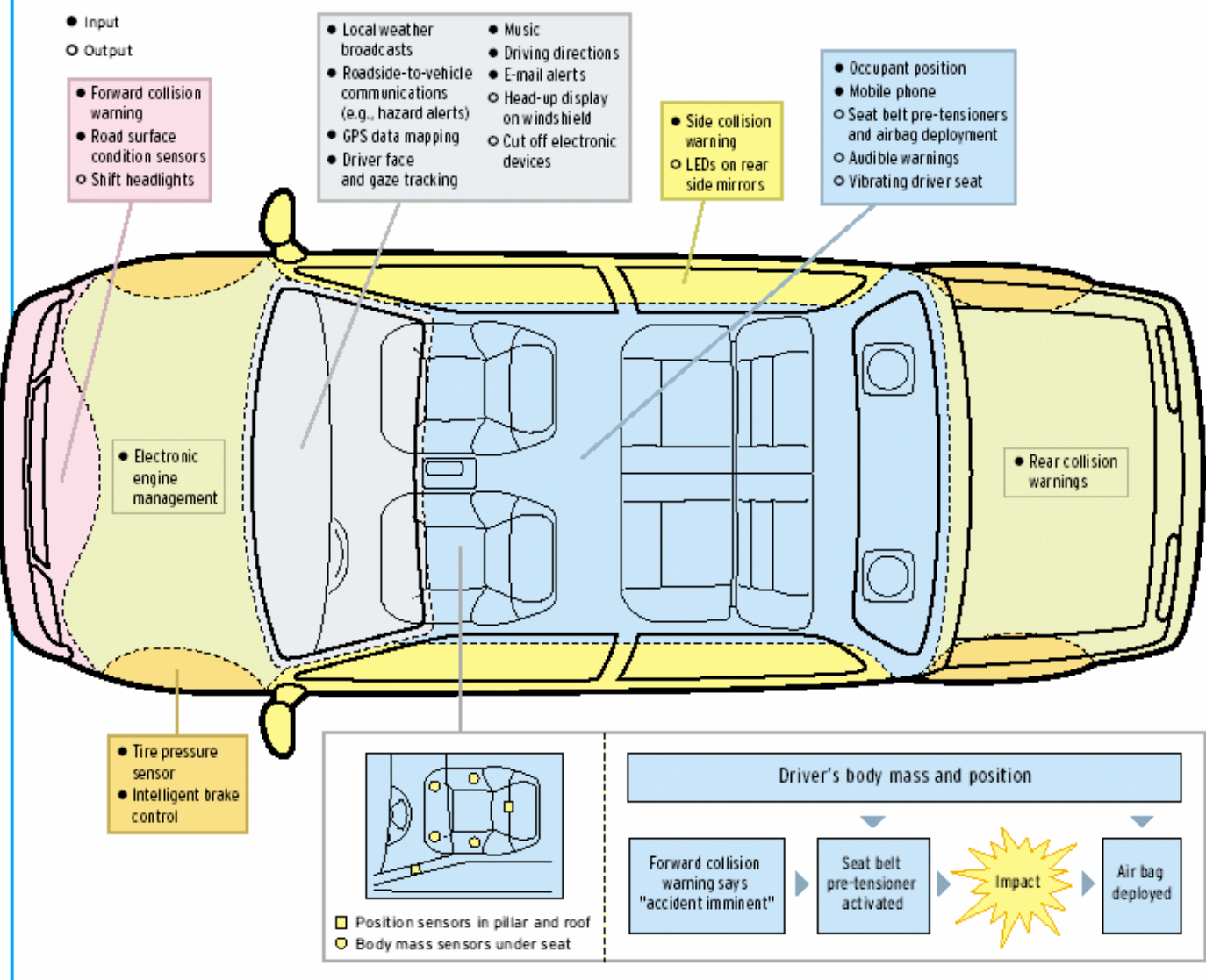


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smart lighting



# Smarter Cars

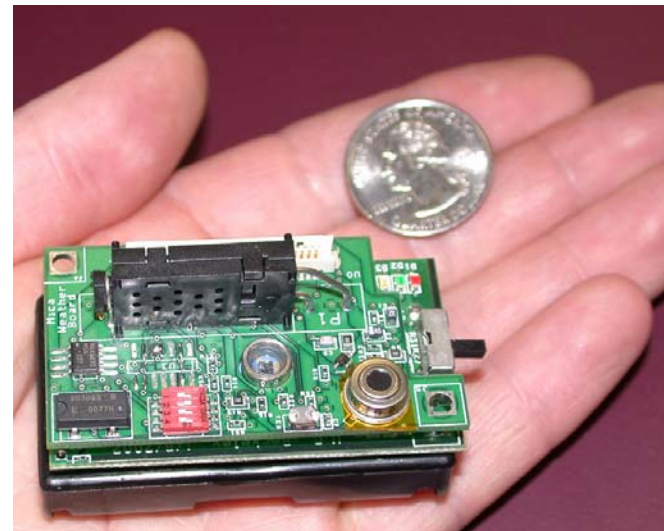
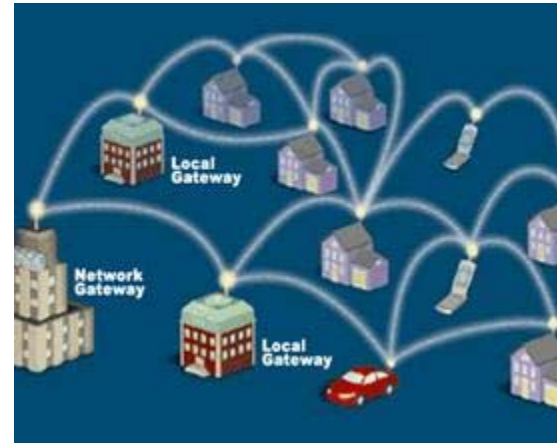
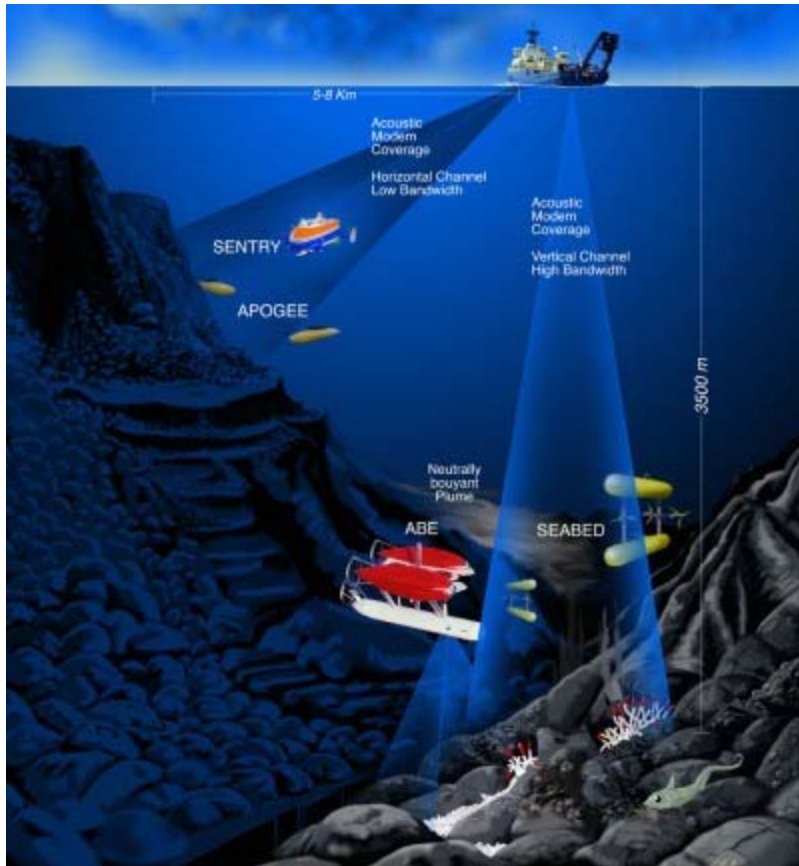


# Robotic Surgery



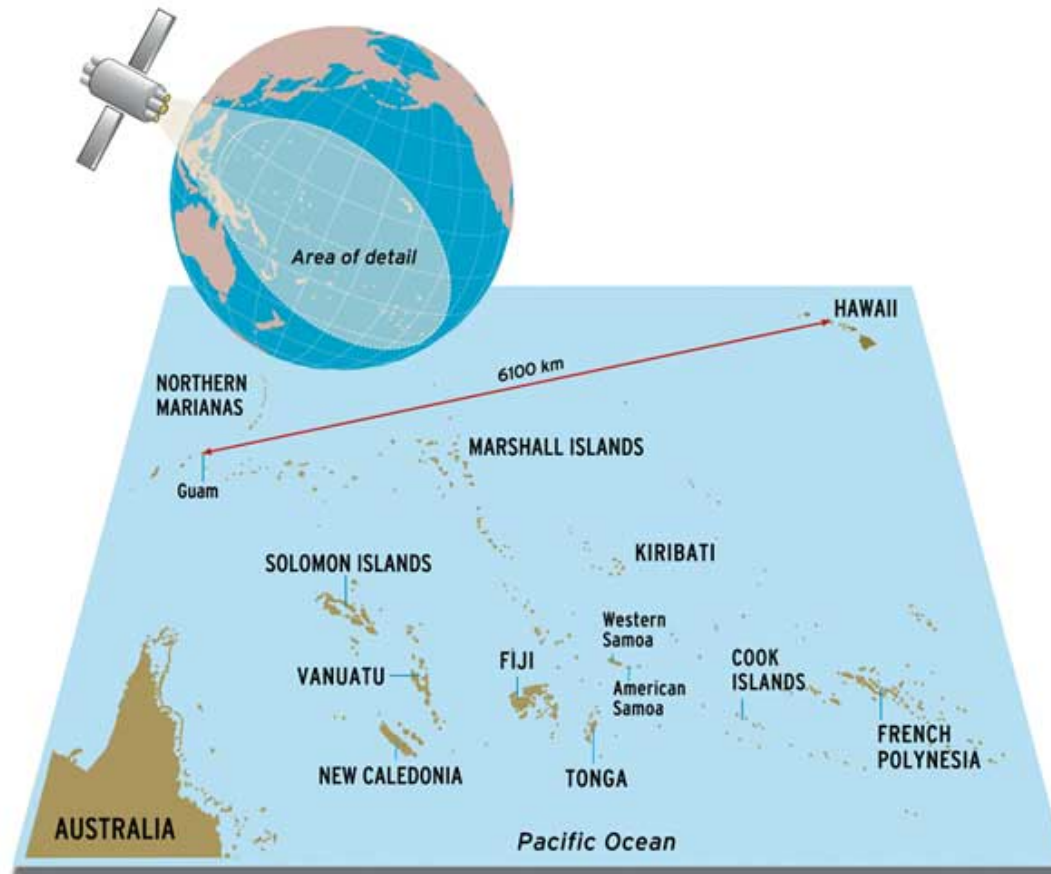
- A doctor in New York removing a woman's gallbladder in France.

# Sensor Networks



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# Telemedicine Hub



- Retired satellites have new uses

# Climate Changes

**● Losing Our Cool**

By now the increase in carbon dioxide in the atmosphere is definitely measurable, as data collected on Mauna Loa in Hawaii shows. Scientists point to the melting ice fields in Greenland, the bleaching of coral reefs in Australia, and shrinking glaciers and ice fields in Chile and Greenland as evidence of global warming that has already occurred. As it continues, global warming is also expected to intensify weather extremes, like droughts and floods.

Walrus may be at risk as the sea ice where they rest retreats from the coastal waters where they feed.

The ice sheet over Greenland is thinning around its edges. Blue indicates the greatest loss of ice.

More extreme weather, like this flooding in China, is expected.

Warmer ocean water causes coral bleaching, a sign of damage to coral reefs.

There is a concern that the melting of glaciers, like this one in Chile, could cause a catastrophic rise in sea level.

**Changing Atmospheric composition: CO<sub>2</sub>**

Parts per million

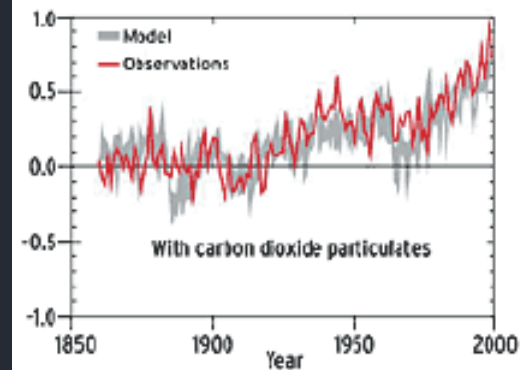
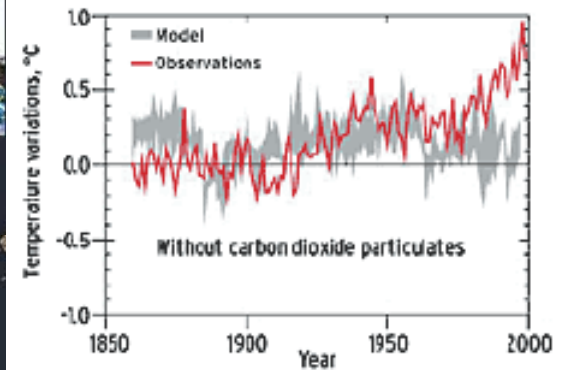
370  
360  
350  
340  
330  
320  
310

1958 '62 '66 '70 '74 '78 '82 '86 '90 '94 '98

Data source: Scripps Institute of Oceanography; data analysis: CH2L

The amount of carbon dioxide in the atmosphere has climbed steadily since regular measurements first began in 1958 at Mauna Loa, Hawaii. The red line tracks monthly measurements, the blue line is a yearly average.

Photo credits: top row: Picture Desk International, NASA/Reuters, KRT; bottom row: Picture Desk International, Greenpeace/Reuters

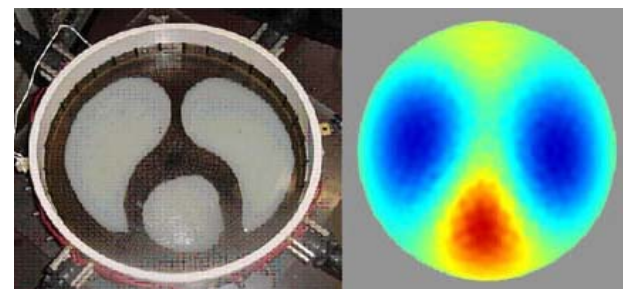
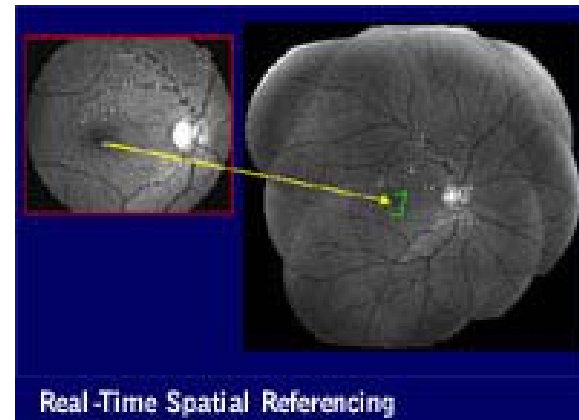
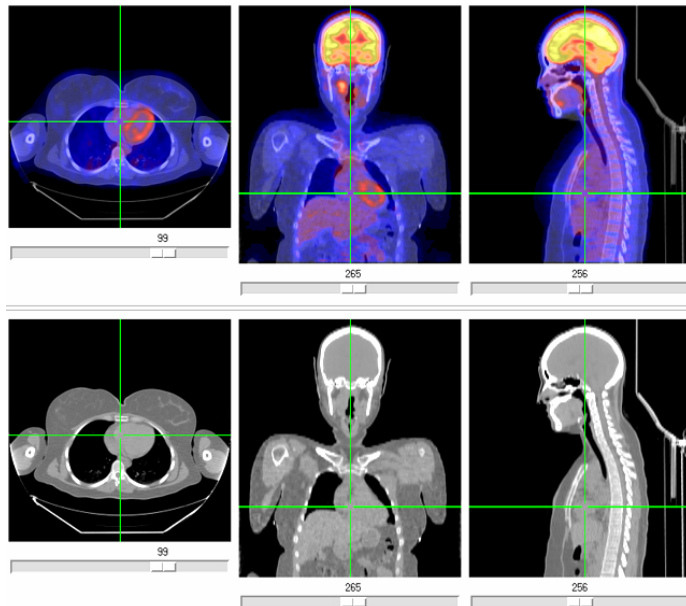


## Development of Accurate Modeling Tools

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# Medical Imaging

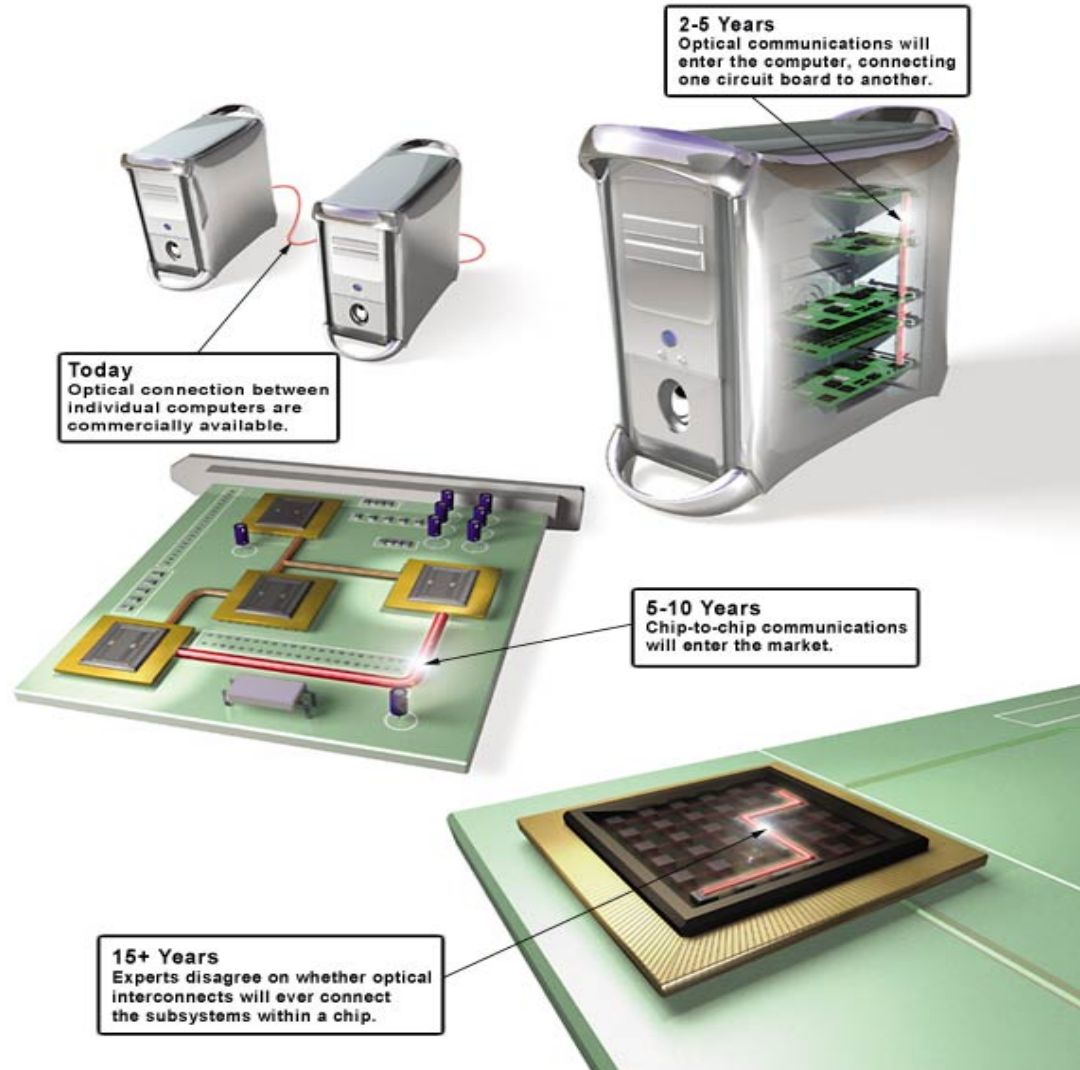


# Fuel Cell Power



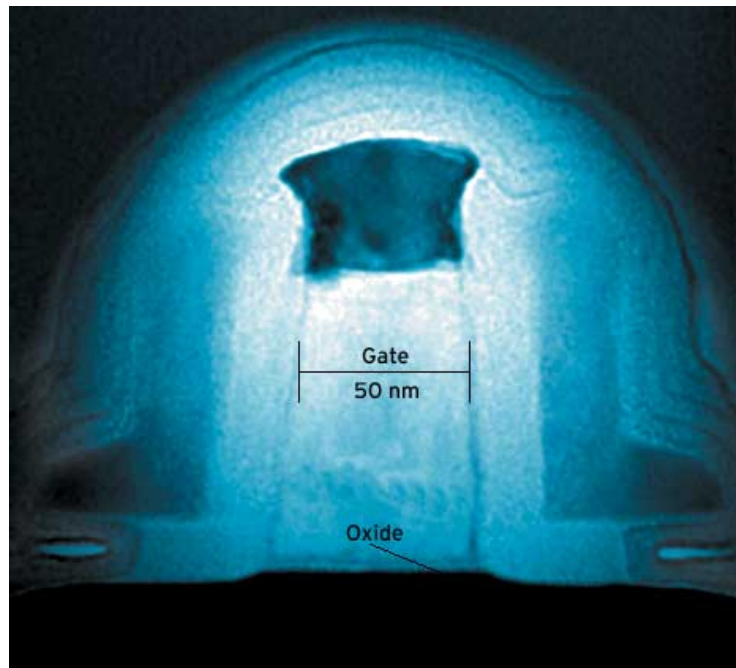
- Toyota Fuel Cell Hybrid Vehicle

# Linking With Light

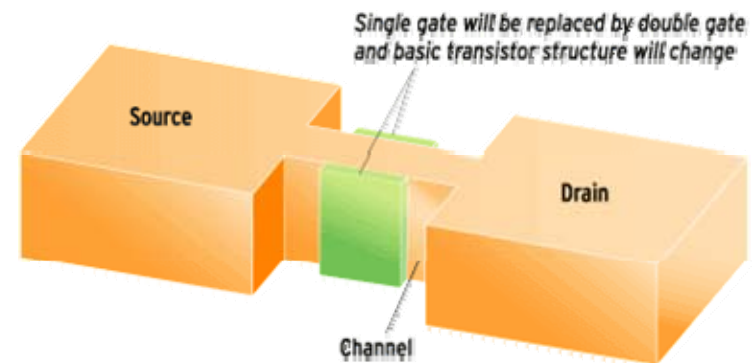
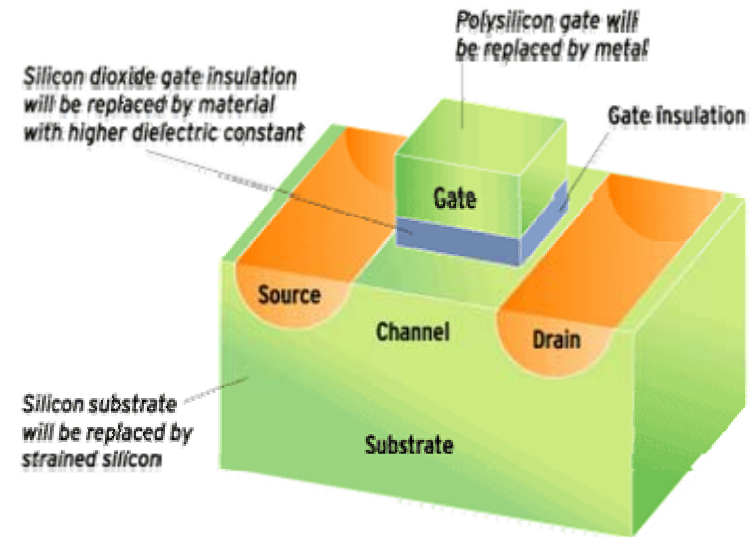




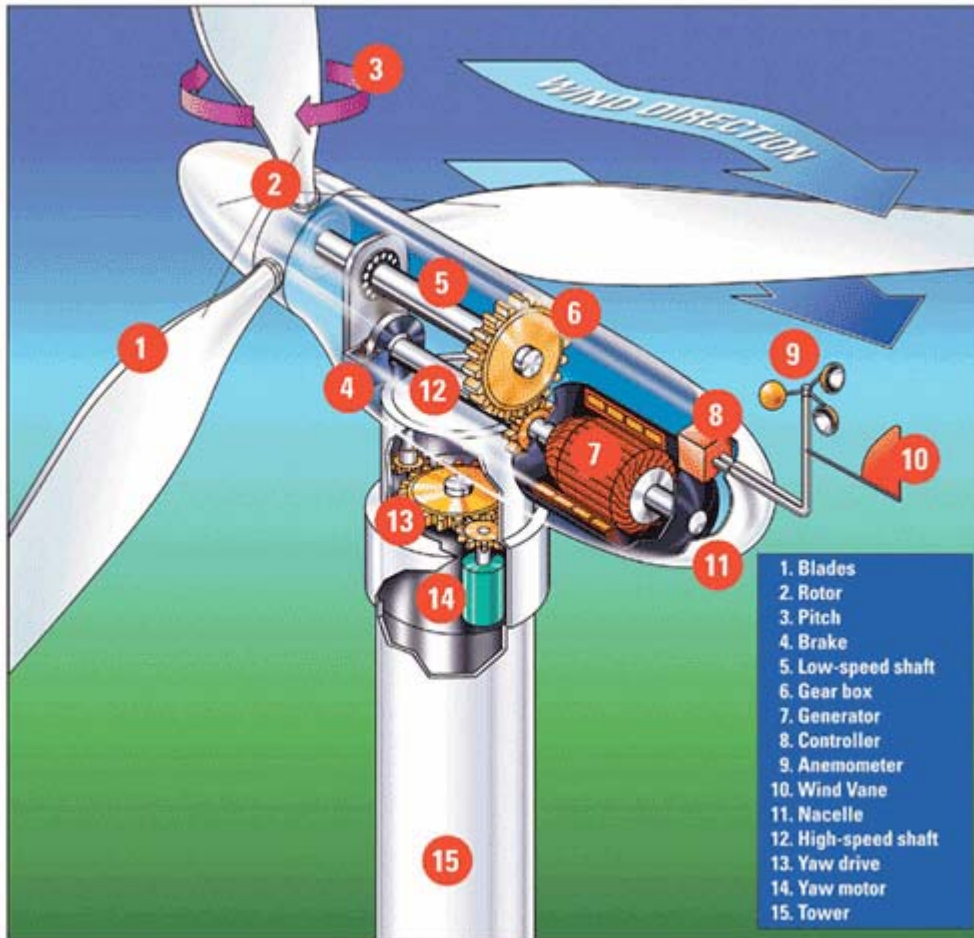
# The Shrinking Transistor



- Intel Transistor



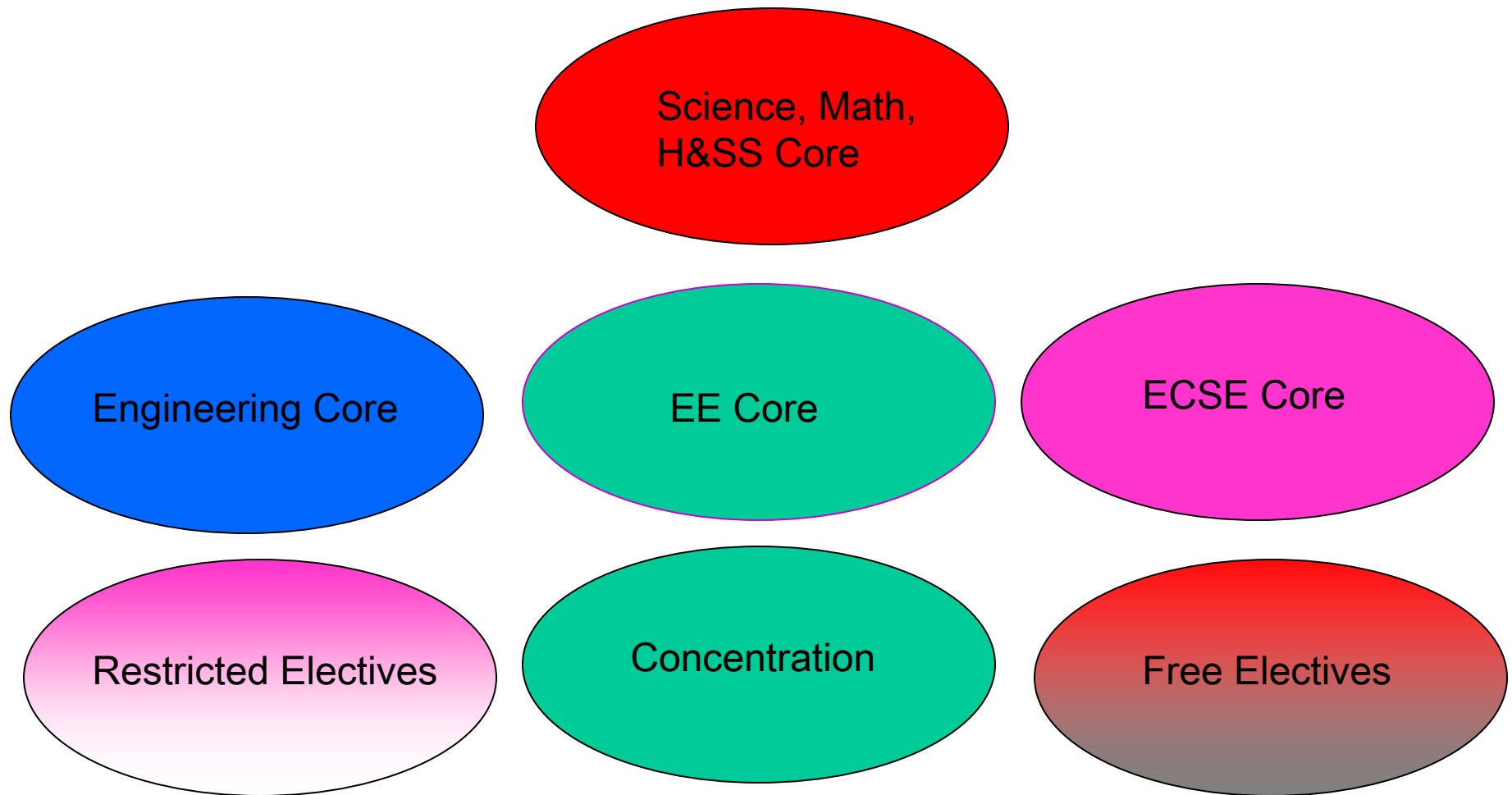
# Wind Power



# ECSE Degrees

- Electrical Engineering
- Computer and Systems Engineering
- Electric Power Engineering
- Popular Dual Degrees
  - EE/CSE Dual Degree
  - EE/EPE Dual Degree
  - CSE/CS Dual Degree
  - EE/Applied Physics Dual Degree

# Electrical Engineering



# Electrical Engineering

Courses Not Generally Taken by Other Majors: Computer Science I, Multivariable Calculus, Multidisciplinary Elective (Materials Science for Engineers, Engineering Dynamics, Thermal Fluids I, Strength of Materials – all of which are parts of other programs). First three terms are standard except for Computer Science I.

- Chem I
- Calculus I&II
- Differential Eqns
- Physics I&II
- **CS I (1<sup>st</sup> Year)**
- H&SS (5) + PD II
- **Multivariable Calculus (3<sup>rd</sup> Year)**
- IEA
- IEE (or Processes)
- EG&CAD
- IED
- Embedded Control
- PD I&III
- **Multidisciplinary Elective (3<sup>rd</sup> Year)**

# Electrical Engineering



ECSE Core

- Electric Circuits
- Computer Components and Operations
- Signals & Systems
- Probability for Engr. Applications



EE Core

- Intro to Electronics
- Fields and Waves I
- Microelectronics Technology

# Electrical Engineering

## Concentration

- Automatic Controls
- Comm & Info Proc
- Computer Hardware
- Electromagnetics
- Electronic Circuits
- Power Electronics
- Electric Power
- Manufacturing or Entrepreneurship
- Microelectronics
- Individualized

## Specified Electives

- Lab Elective
  - Adv Manufacturing
  - VLSI Design
  - Electric Power
  - Experimental Networking
  - Computer Applications
  - Computer Hardware
- Design Elective
  - Will soon be ECSE Design for All EE & CSE Students

# Electrical Engineering



## Restricted Electives

- Any ECSE or EPOW
- Used to satisfy concentration
- Can also include one ENGR course



## Free Electives

- Any course at all
- Usually used up for dual degrees
- Most students take additional technical courses



# ECSE Electives

- 296x: Sensing and Imaging
- 4040: Digital Electronics
- 4060: Communication Circuits
- 4080: Semiconductor Power Electronics
- 4160: Fields & Waves II
- 4250: IC Processes and Design
- 4290: Electronic Packaging
- 4320: Plasma Engineering

# ECSE Electives

- 4440: Control Systems Engineering
- 4490: Fundamentals of Robotics
- 4510: Discrete Time Systems
- 4520: Communication Systems
- 4630: Lasers and Optical Systems
- 4640: Optical Communications & Integrated Optics
- 4670: Computer Communications Networks
- 4710: Interactive Computer Aided Design

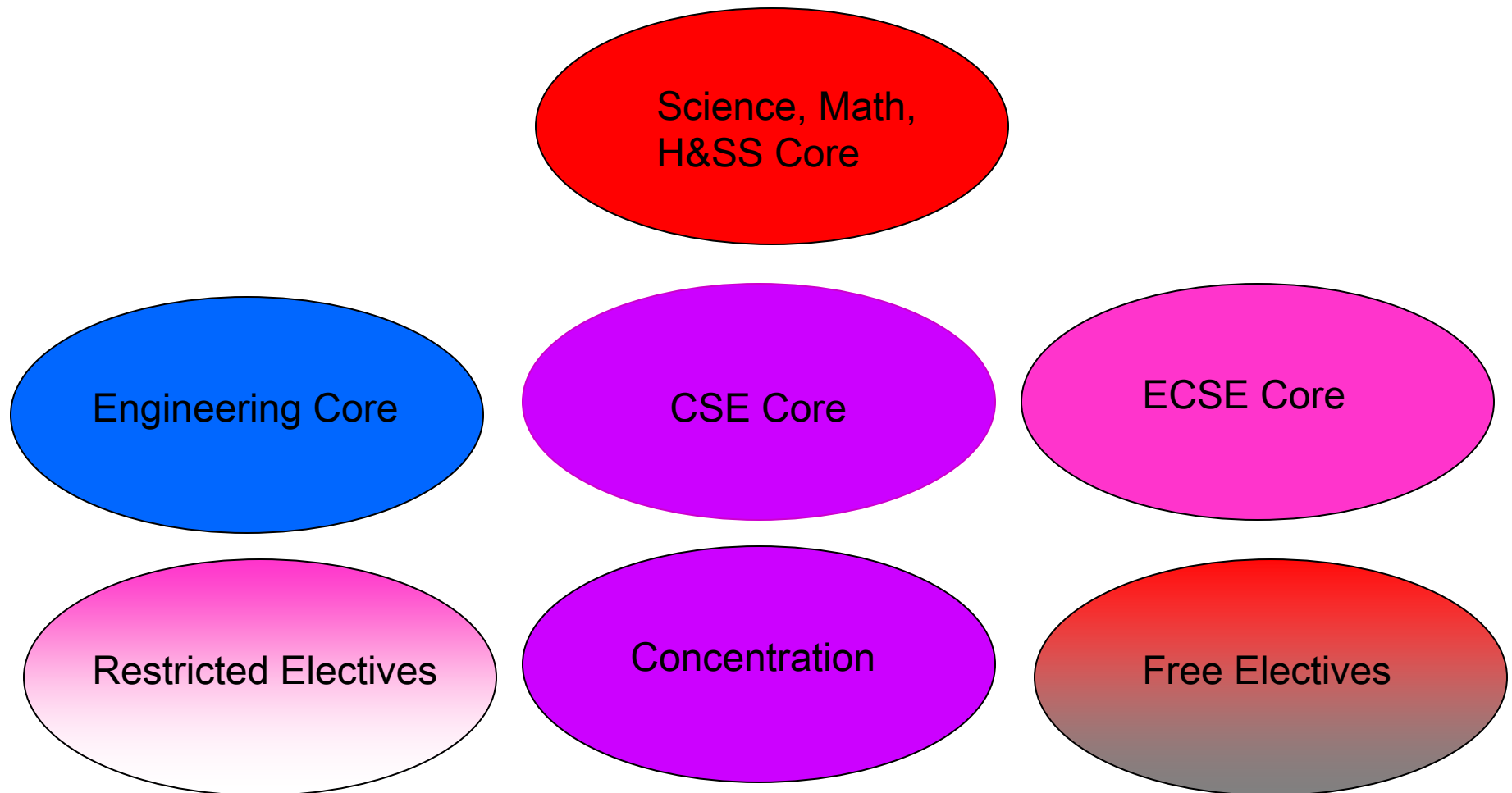
# ECSE Electives

- 4720: Solid State Physics
- 4540: Voice & Image Processing
- 4750: Computer Graphics (CSE Software Elective)
- 496x: Advanced Electronic Circuits
- 496x: Subsurface Imaging
- 496x: Digital Comm. Engineering
- 496x: Distributed Systems & Sensors
- 496x: Integrated Sensors

# ECSE Electives

- 496x: Mixed Signal Circuit Design
- 496x: VLSI Architectures for Signal Processing and Communications
- 6770: Software Engineering I

# Computer and Systems Engineering



# Computer and Systems Engineering

Courses Not Generally Taken by Other Majors: Computer Science I &II, Discrete Structures, Data Structures & Algorithms, Multidisciplinary Elective (Materials Science for Engineers, Engineering Dynamics, Thermal Fluids I, Strength of Materials – all of which are parts of other programs).

- Chem Princ for Engr
- Calculus I&II
- Differential Eqns.
- Physics I&II
- **CS I&II (1<sup>st</sup> Year)**
- **Data Structures & Alg.(2<sup>nd</sup> Year)**
- H&SS (5) + PD II
- **Discrete Structures (1<sup>st</sup> Year)**
- IEA
- IEE
- EG&CAD
- IED
- Embedded Control
- PD I&III
- **Multidisciplinary Elective (3<sup>rd</sup> Year)**

# Computer and Systems Engineering



ECSE Core

- Electric Circuits
- Computer Components and Operations
- Signals & Systems
- Probability for Engr. Applications



CSE Core

- Computer Architecture, Networks and Operating Systems
- Software Engineering Elective

# Computer and Systems Engineering

## Concentration

- Automatic Controls
- Comm & Info Proc
- Computer Hardware
- Computer Systems
- Manufacturing or Entrepreneurship
- Individualized

## Specified Electives

- Software Engineering Elective
  - Experimental Networking
  - Computer Graphics
  - Software Eng. I or Software Design & Doc
  - Intro. Graphical Interfaces
- Design Elective
  - Now ECSE Design for all EE & CSE Majors



# Computer and Systems Engineering



## Restricted Electives

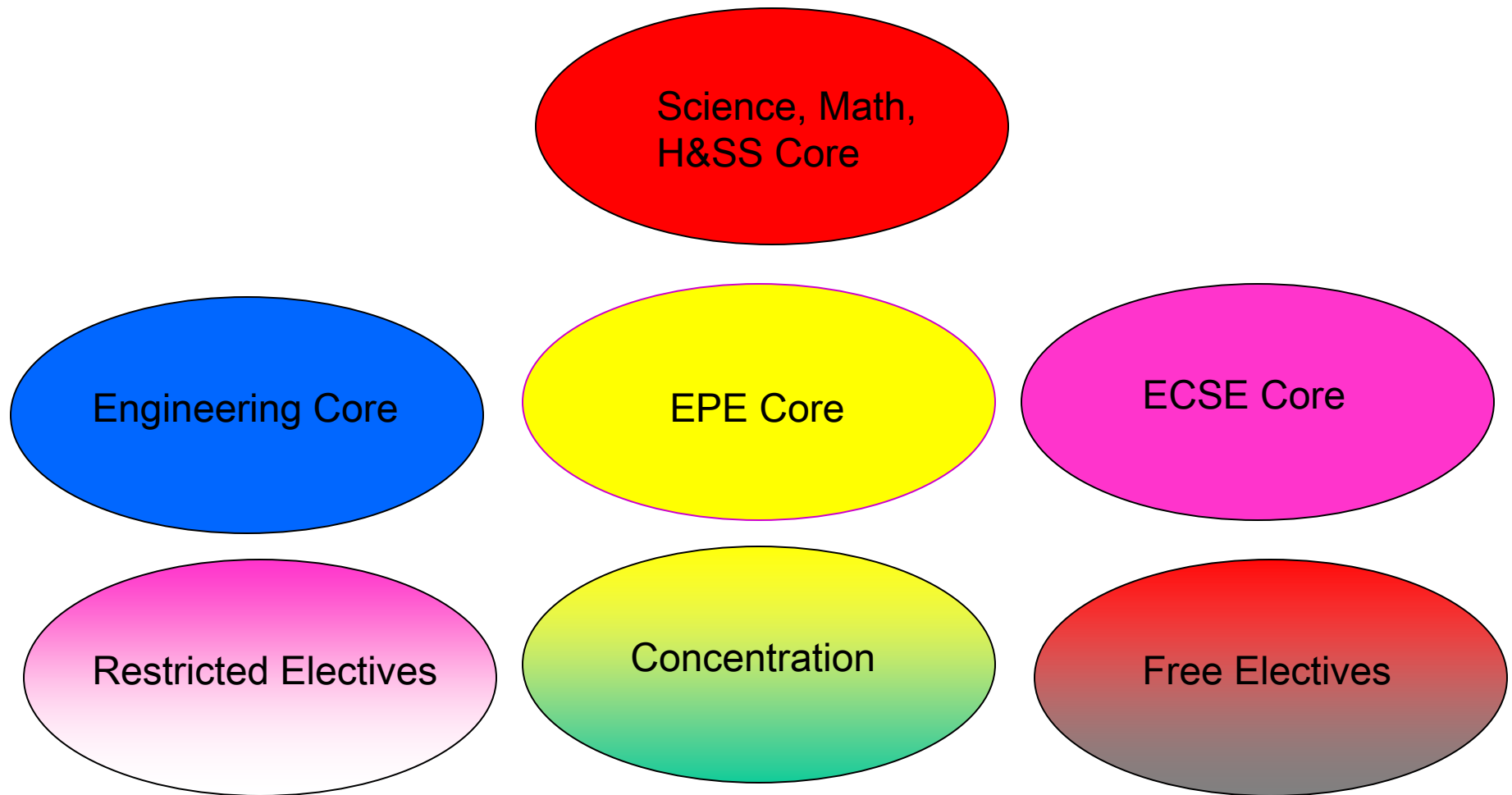
- Any ECSE or CSCI
- Used to satisfy concentration
- Can also include one ENGR course



## Free Electives

- Any course at all
- Usually used up for dual degrees
- Most students take additional technical courses

# Electric Power Engineering



# Electric Power Engineering



Science, Math,  
H&SS Core



Engineering Core

- Chem Princ for Engr
- Materials Sci for Engr
- Calculus I&II
- Differential Eqns
- Physics I&II
- C Prog. For Engineers
- H&SS (5) + PD II
- IEA
- Engr. Proc. Or IEE
- EG&CAD
- IED
- MAU
- Modeling & Control of Dynamic Systems
- Embedded Control
- PD I&III
- Thermal & Fluids Engr I

# Electric Power Engineering



ECSE Core

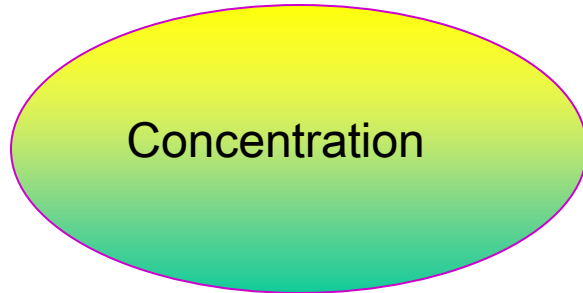
- Electric Circuits
- Fields & Waves I
- Signals & Systems
- Intro to Electronics



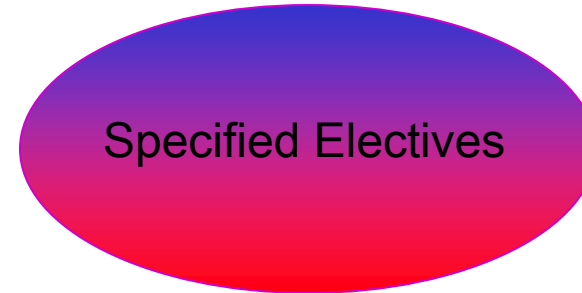
EPE Core

- Power Engineering Fundamentals
- Electromechanics
- Semiconductor Power Electronics
- EPE Lab
- EPE Design

# Electric Power Engineering



- Not required for EPE degree
- Optional Concentration in Power Electronics Systems -- Includes courses from EPOW, ECSE, & MANE



- Technical Electives – any 2 courses in Engineering or Science above the 2000 level

# Electric Power Engineering



Free Electives

- Any course at all
- Usually used up for dual degrees
- Most students take additional technical courses
- See undergrad handbook

# Dual Degrees

- EE/CSE – Includes only the CSE concentrations (137 credits)
- CSE/CSYS – Includes all CSE concentrations (137 credits)
- EE/EPE – Includes only the Power Electronics concentration (131 credits)
- EE/Applied Physics – Includes only the Microelectronics concentration (132 credits)

# ECSE Studios

- ECSE Courses make extensive use of studio facilities
  - Circuit Studio (eg Circuits)
  - Instrumentation Studio (eg Sensing & Imaging, Fields & Waves I)
  - Embedded Control (LITEC) Studio (eg Circuits)
  - Control Studio
  - Computer Studio (eg VLSI Design)



# Should we change the classroom?



## Studio Classrooms

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# Current Lab Instrumentation Set

Scope

Power Supply  
Function  
Generator  
Multimeter

CPU



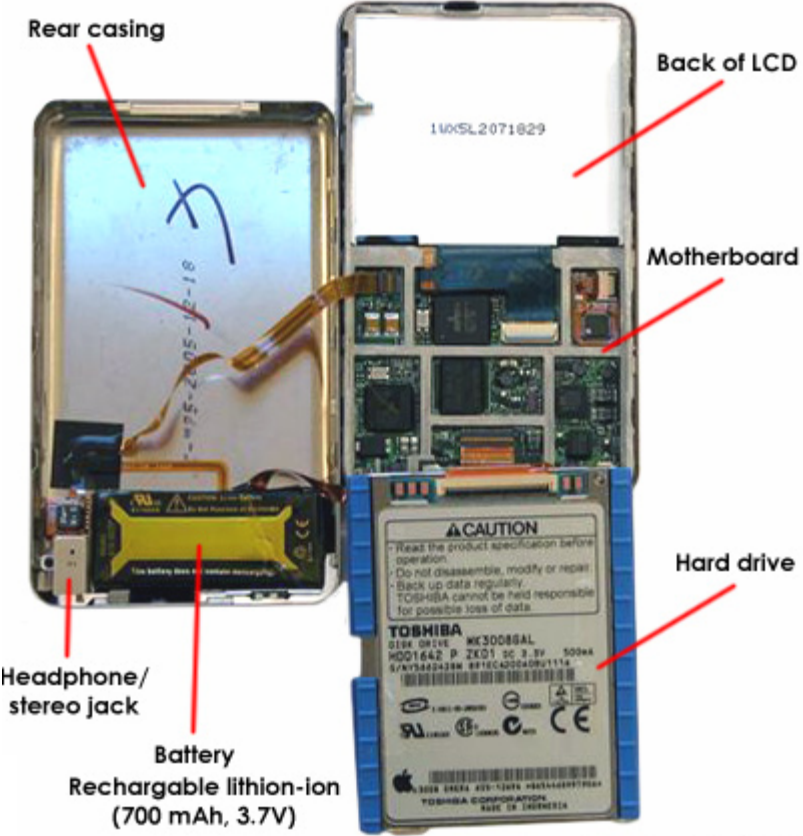
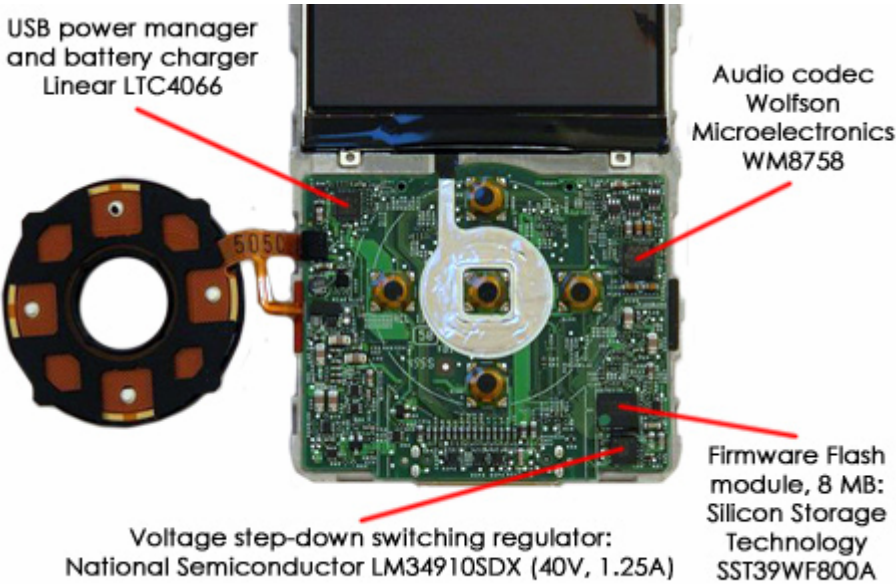
## So what if ... ?

*We could enable students to perform experiments **anyplace** at **anytime**...*

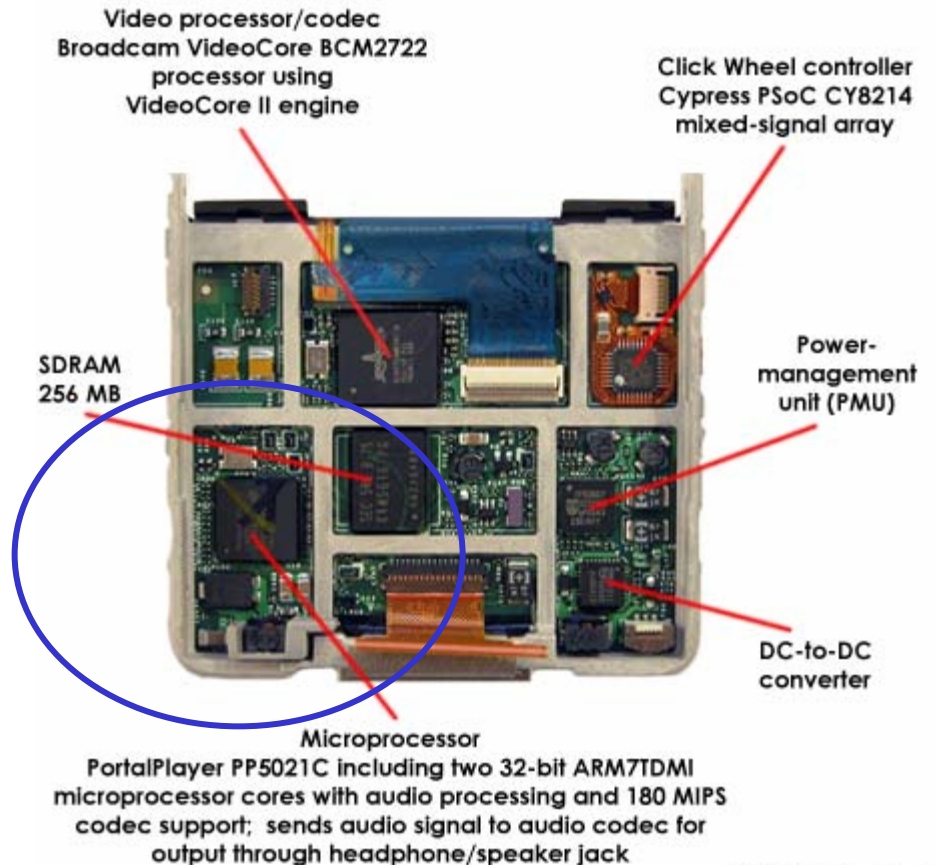
- Dormitory room
- Student Union
- Library
- Campus meeting rooms
- Etc.

# Look to Devices Like the iPod for Inspiration in How to Bring the Power of Electrical & Computer Engineering to Education

Information from How Stuff Works – An Amazing Website Created by Marshall Brain who has an EE Degree from RPI



# iPod



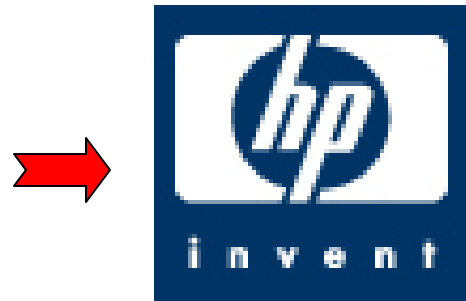
©2006 HowStuffWorks

Why not use embedded intelligence to enhance the educational experience of EE, CSE, & EPE students?

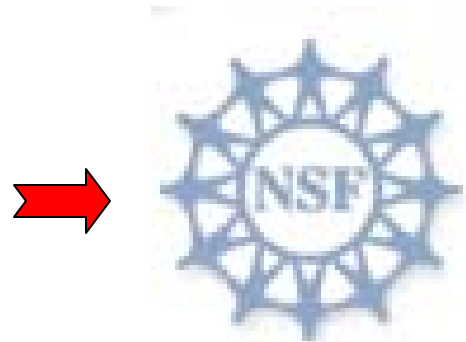
Most Exciting New Products Have Embedded Intelligence (Computers)

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# The Mobile Studio was born...



Instrumentation Card  
Designed Here to  
Augment Student  
Laptops with a Full  
Set of Instruments

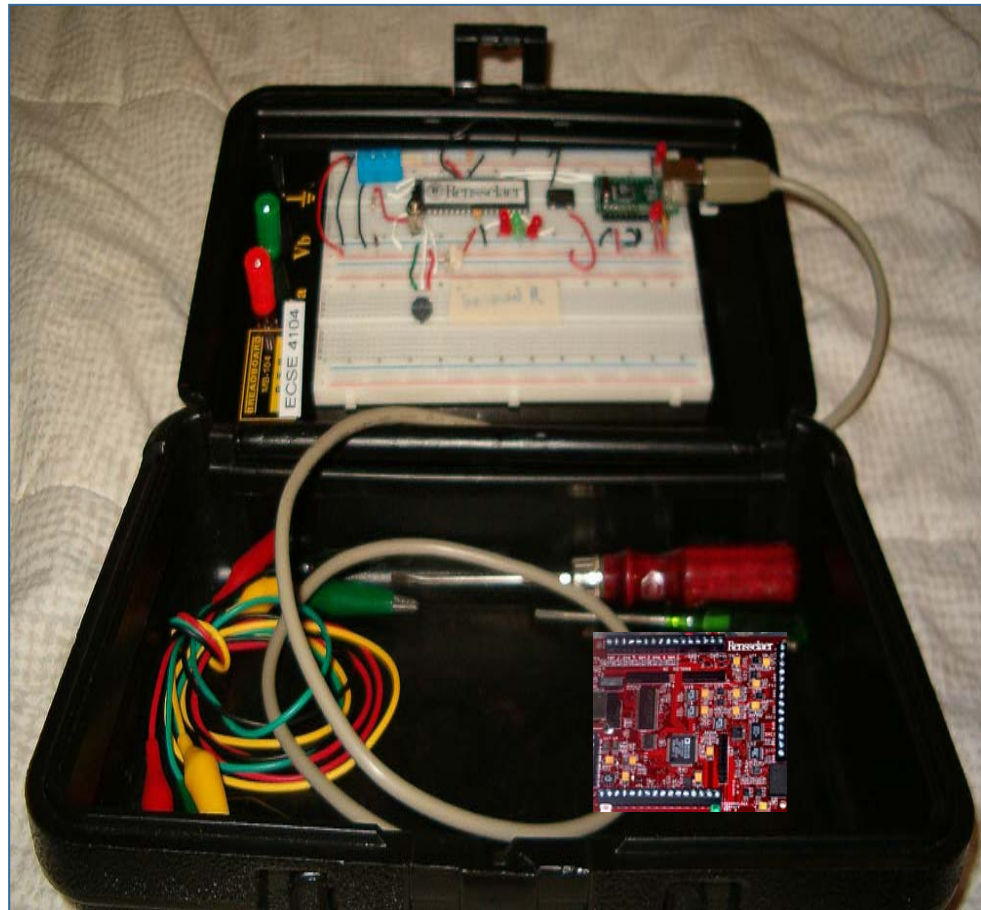
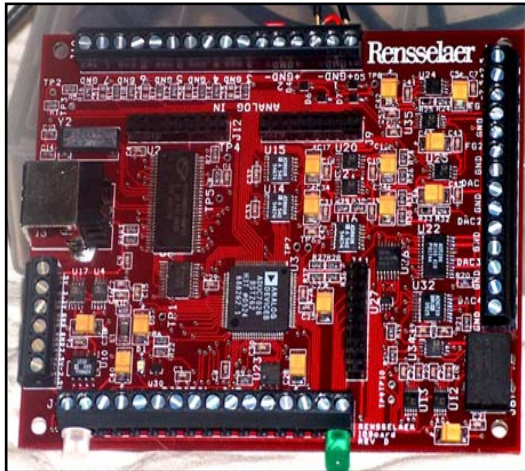


Early Version

Work Supported by

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# New Instrumentation Hardware

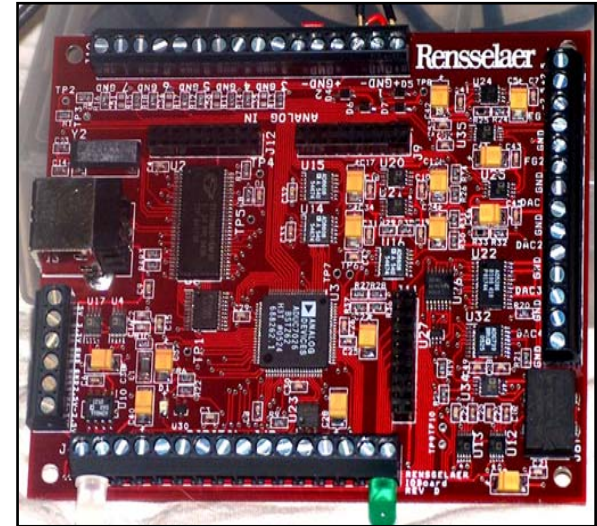


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Version 3 ... Faster Version 4 in Production

## Current Board Specifications

- 8 A/D inputs, which can be configured as:
  - 2 channel scope
  - DVM
- 4 D/A outputs
- 16 Digital outputs/inputs (software configurable)
- +/-2.5v, 3.3v, 5v Power supplies (*capable of delivering ~ 500mA*)
- 2 Independent Function Generators

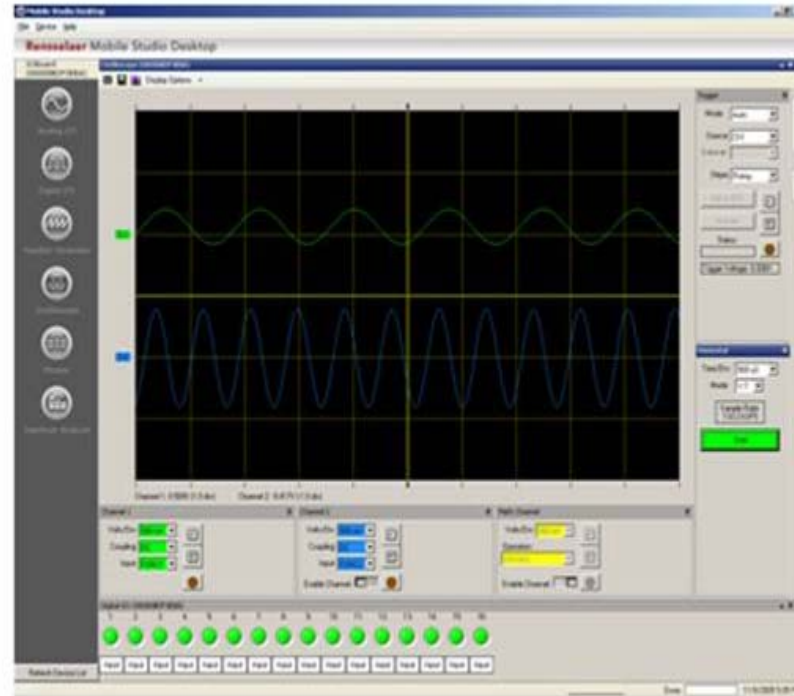


~ \$100





Version 2



PC Interface Software

The design of this system, like most electronics these days, is a combination of analog & digital circuitry and programmable components (in this case a microcontroller, in the case of version 4 a DSP chip). Thus, this project is as much software as hardware.

# Average Starting Salary for 2005 Graduates\*

## School of Engineering

	BS in Engineering	<u>2005</u>
Aeronautical		\$53,290
Biomedical		56,500
Chemical		55,542
Civil		47,284
Computer and Systems		56,248
Environmental		Not Available
Electrical/Electric Power		56,243
Industrial and Management		51,636
Mechanical		50,905
Materials		51,150
Nuclear/Eng Phys		56,988

*\*Career Development Center Data  
As of July, 2005*

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# National Averages for Starting Salaries

- BSEE \$53.6k (\$56k at top schools)
- MSEE \$66.5k (\$70k at top schools)
- PhDEE \$69.1k (\$80k at top schools)

Note that an MS degree is worth from \$13-14k per year, on the average and takes 1-2 years to complete (usually about 1.5 years & less than one year with significant advanced placement or summer school). Thus, the MS degree produces the greatest improvement in salary per dollar invested.

# Job Info from NACE Link

<http://www.jobweb.com/joboutlook/2006/default.htm>

- 2005 Top Demand: BS
  - Accounting
  - Electrical engineering
  - Mechanical engineering
  - Business administration/management
  - Economics/finance
  - Computer science
  - ~~Computer engineering~~
  - Marketing/marketing management
  - Chemical engineering
  - Information sciences and systems
- 2006 Top Demand: BS
  - Mechanical engineering
  - Electrical engineering
  - Accounting
  - Business administration/management
  - Economics/finance
  - Computer science
  - Information sciences and systems
  - Marketing/marketing management
  - Computer engineering
  - Chemical engineering

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# Masters Degree Demand 2006

- M.B.A.
- Electrical Engineering
- Mechanical Engineering
- Accounting
- Computer Engineering

# Top 5 Undergrad Majors Targeted by Region

- Northeast

- Electrical Engineering
- Mechanical Engineering
- Accounting
- Information Sciences Systems
- Chemical Engineering

- West

- Electrical Engineering
- Computer Science
- Mechanical Engineering
- Computer Engineering
- Accounting

# Top 5 Undergrad Majors Targeted by Region

- Midwest
  - Accounting
  - Mechanical Engineering
  - Electrical Engineering
  - Economics/Finance (incl. banking)
  - Marketing/Marketing Management
- South
  - Business Administration/Management
  - Accounting
  - Mechanical Engineering
  - Electrical Engineering
  - Economics/Finance (incl. banking)

# US IT Jobs 1999/2003 (BLS)

Programmers *****	529	403
SE applications	289	410
SE systems	209	293
Computer support	463	481
Computer systems analysts	428	486
Database administrators *****	101	97
Network and systems admin	205	245
Network & data communications analysts	98	156
Computer systems managers *****	281	257
Hardware engineers	60	70
Total	2688	2922



# Additional Information on History, the Profession, Etc.



- <http://ieee-virtual-museum.org/> The IEEE Virtual Museum
- <http://www.eweek.org/> National Engineers Week

# Career Information



- IEEE  
[http://www.ieee.org/organizations/eab/studentcareers\\_text.htm](http://www.ieee.org/organizations/eab/studentcareers_text.htm)
- ESCAPE (Purdue)  
<http://FrE.www.ecn.purdue.edu/FrE/ESCAPE/>
- About Electrical and Computer Engineering (Discover Engineering Online)  
[http://www.discoverengineering.org/Engineers/electrical\\_engineering.asp](http://www.discoverengineering.org/Engineers/electrical_engineering.asp)
- GradNet <http://gradnet.iec.org/index.asp>
- [IEEE Spectrum Careers](#)

# More Career Information

- National Society of Professional Engineers  
<http://www.nspe.org/students/>
- National Action Council for Minorities in Engineering  
<http://guidemenacme.org/>
- Society of Women Engineers  
<http://www.swe.org/>
- National Society of Black Engineers  
<http://www.nsbe.org>
- Society of Hispanic Professional Engineers  
<http://www.shpe.org/>

# Job Descriptions from Company Websites



- Intel  
[http://www.intel.com/jobs/index.htm?iid=Homepage+IntelLinks\\_jobs&](http://www.intel.com/jobs/index.htm?iid=Homepage+IntelLinks_jobs&)
- Texas Instruments  
<http://www.ti.com/recruit/index.htm>
- Motorola  
<http://motorolacareers.com/index2.cfm?srcCode=10838943>
- Maxim <http://www.maxim-ic.com/AboutMaxim/Jobs/StartPage.htm>

# Additional Information



How Stuff Works – Started by ECSE grad

Marshall Brain <http://www.howstuffworks.com/>

How Things Work from the University of Virginia

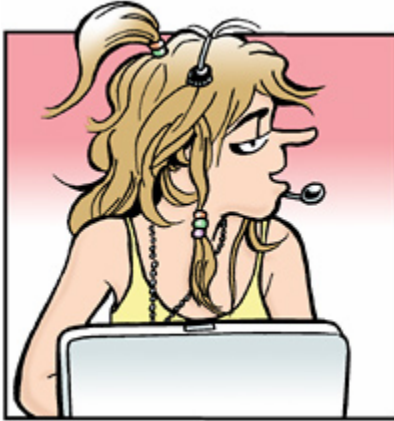
<http://howthingswork.virginia.edu/>

The Straight Dope <http://www.straightdope.com>

# Questions?



K. A. Connor



# Contact Information

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- <http://www.rpi.edu/~connor>

All of the link information is also available on my webpage.