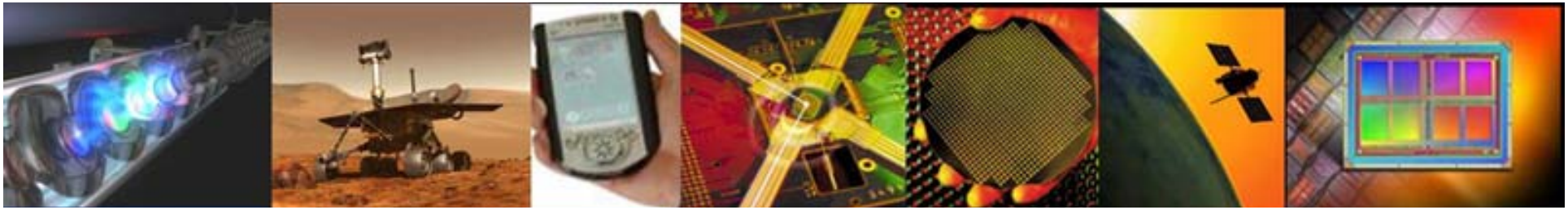


18-200 Fall 2005

The Emerging Trends in Electrical and Computer Engineering

Hosting instructor: Prof. Jimmy Zhu; Time: Thursdays 3:30-4:20pm; Location: DH 2210

	Date	Lecturer	Lecture Contents
L01	09/01	Prof. T.E. Schlesinger	The forefront of new paradigms in technology
L02	09/08	Prof. Bruce Krogh	ECE undergraduate curriculum
L03	09/15	Prof. James Bain	Student advising
L04	09/22	Prof. Diana Marculescu	Ambient intelligent systems
L05	09/29	Prof. Ken Gabriel	Akustica
L06	10/06	Dr. Marios Savvides	Biometrics
L07	10/13	Prof. Dan Stancil	Wireless communication
L08	10/20	Prof. David Lambeth	Advanced sensor systems
L09	10/27	Prof. Jim Hoburg	Magnetic levitation
L10	11/03	Prof. Phil Koopman	Embedded systems
L11	11/10	Prof. Yi Luo	Nanotechnology and nano-electronics
L12	11/17	Prof. Illa Nourbakhsh	Robotics
L13	12/01	Prof. Shawn Blanton	Testing of Integrated Circuit
L14	12/08	Prof. Mike Reiter	Cyber Security

Electrical and Computer Engineering The Forefront of New Paradigms in Technology

Ed Schlesinger

Professor and Head, Electrical & Computer Engineering

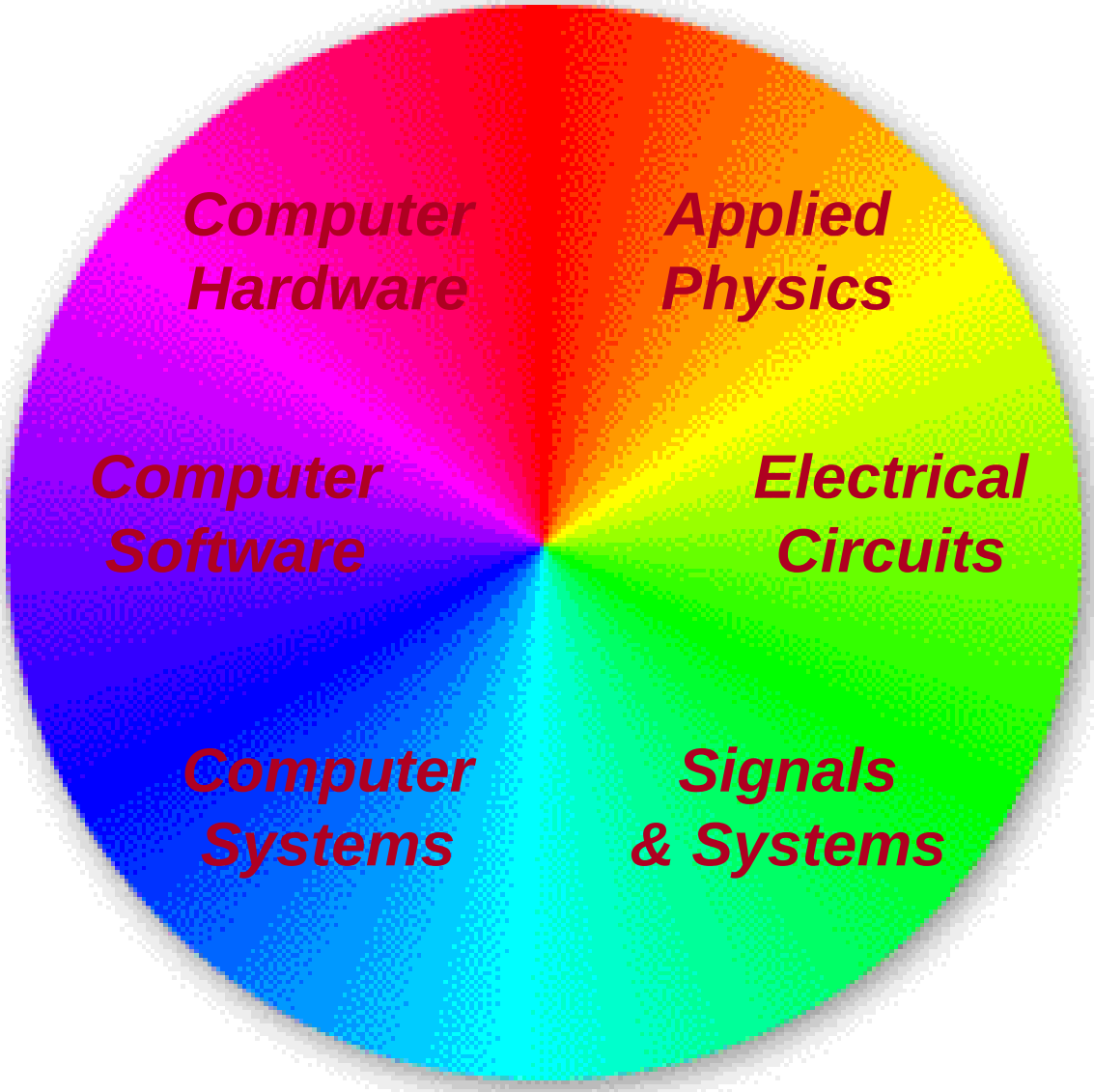
ed@ece.cmu.edu

Carnegie Mellon

Overview

- *ECE Technical Spectrum*
- *Some Example Work in ECE*
- *Some "trends"*
- *ECE Curriculum*
- *ECE Faculty*
- *ECE Students*

The ECE Technical Spectrum



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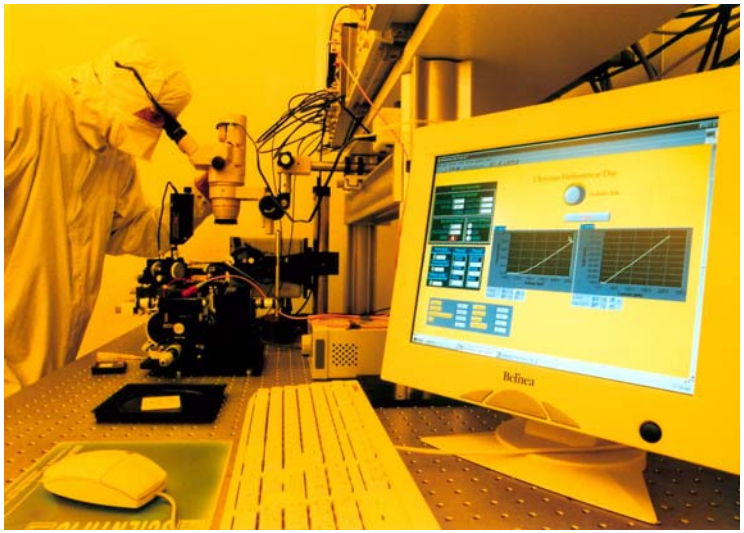
Applied Physics

Semiconductor Devices

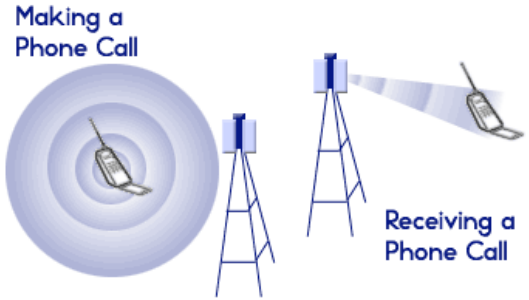
MEMS

Integrated Circuit (IC) Manufacturing



Sensors

Wireless transmission



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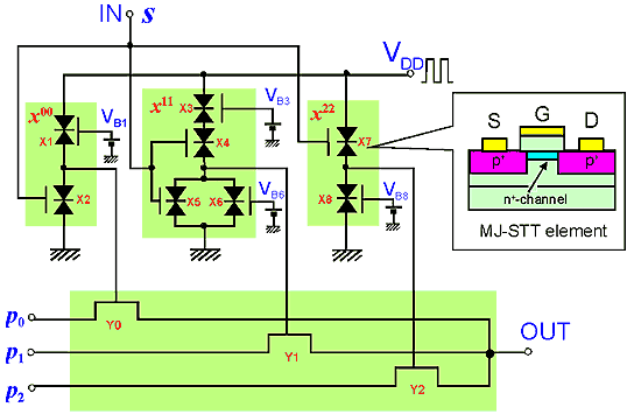
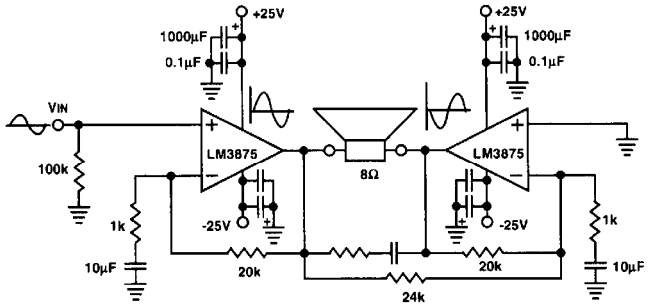
Electrical Circuits

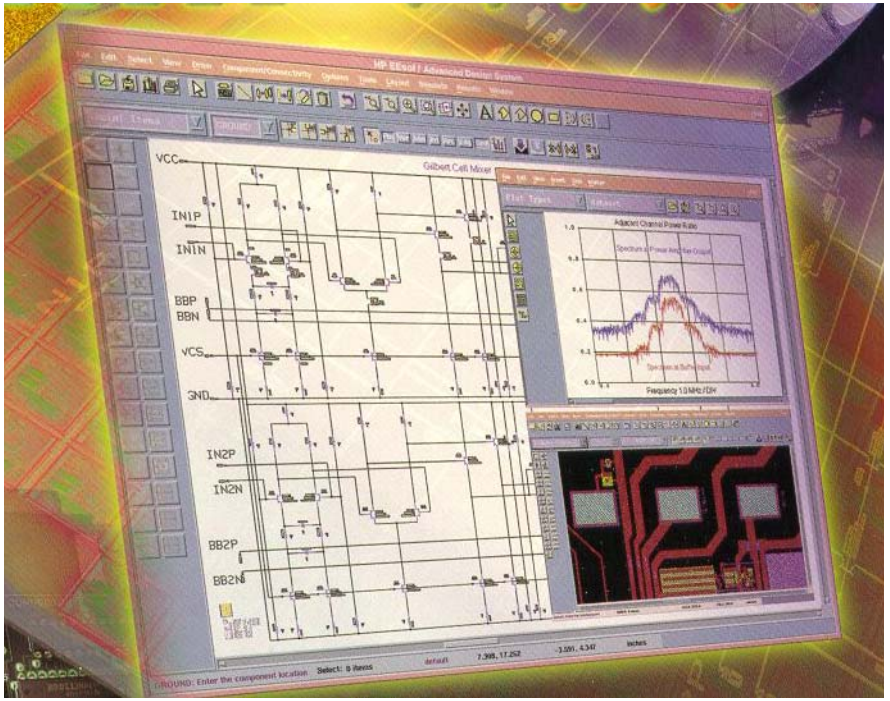
Digital Circuits



Analog Circuits



Electronic Design Automation



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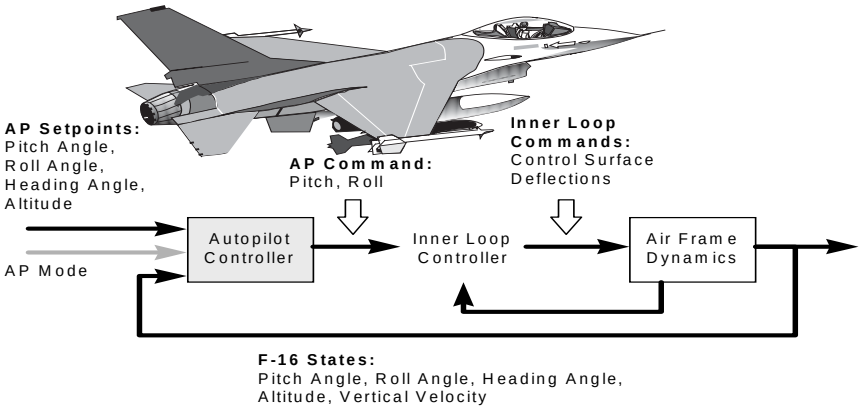
Signals & Systems

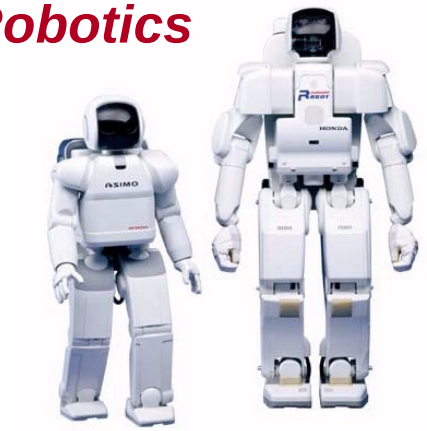
Digital Communication

Image Processing

Control Systems



Robotics



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Computer Systems

Computer Networks

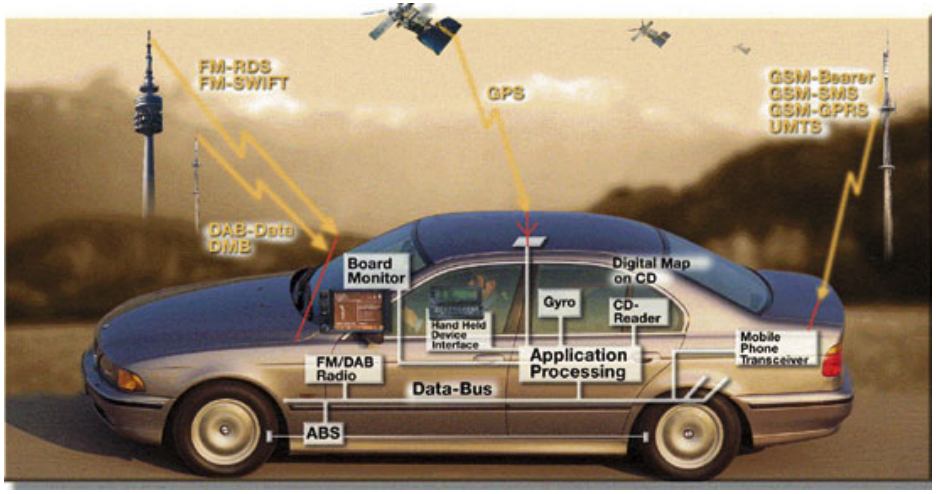
Data Storage Systems

Computer Security

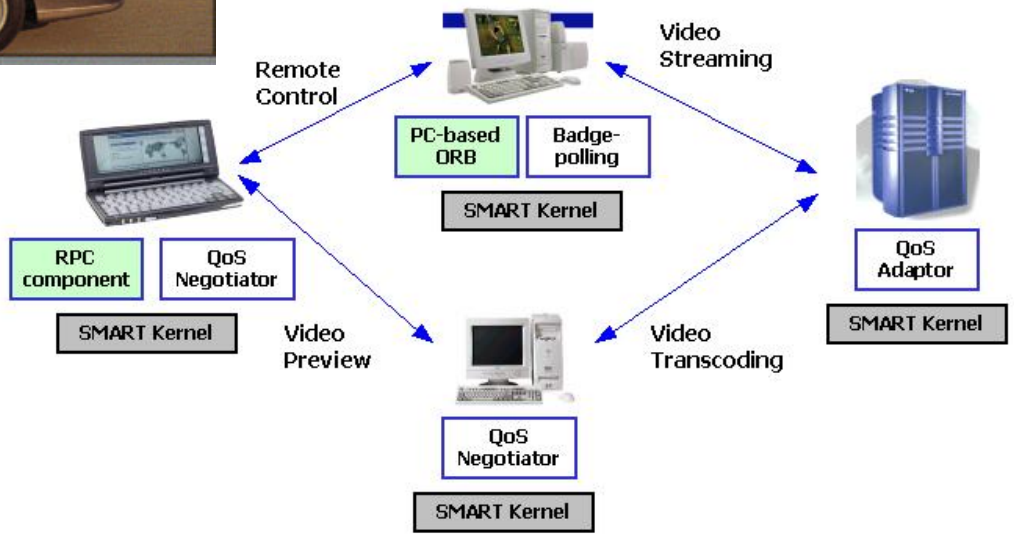
Electrical & Computer ENGINEERING

Computer Software

Embedded Systems

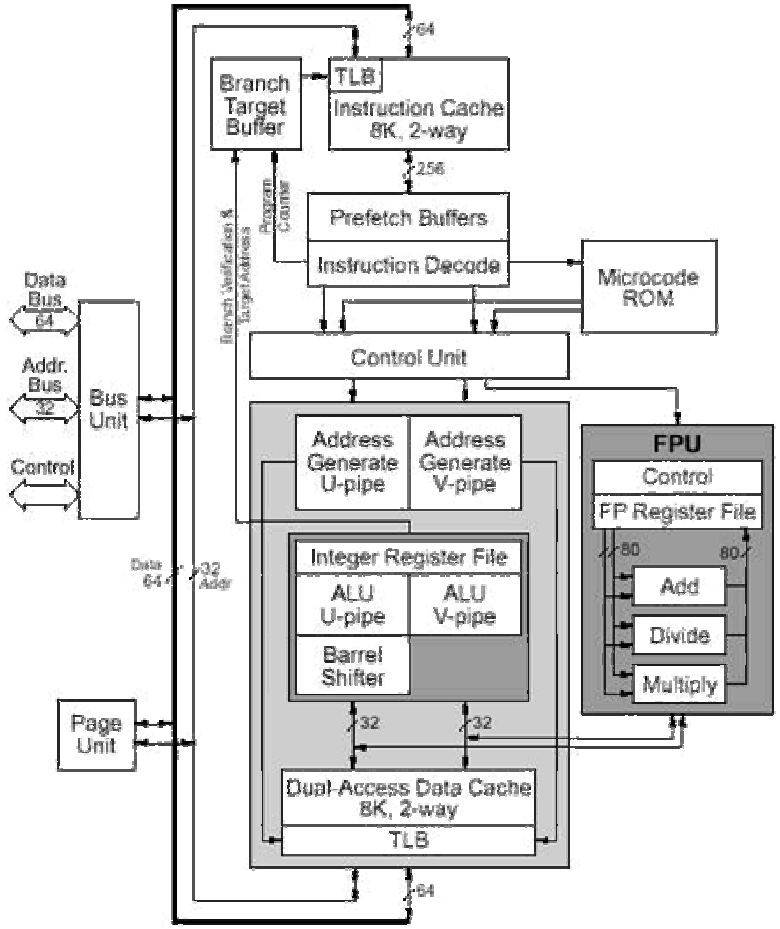


Middleware



Computer Hardware

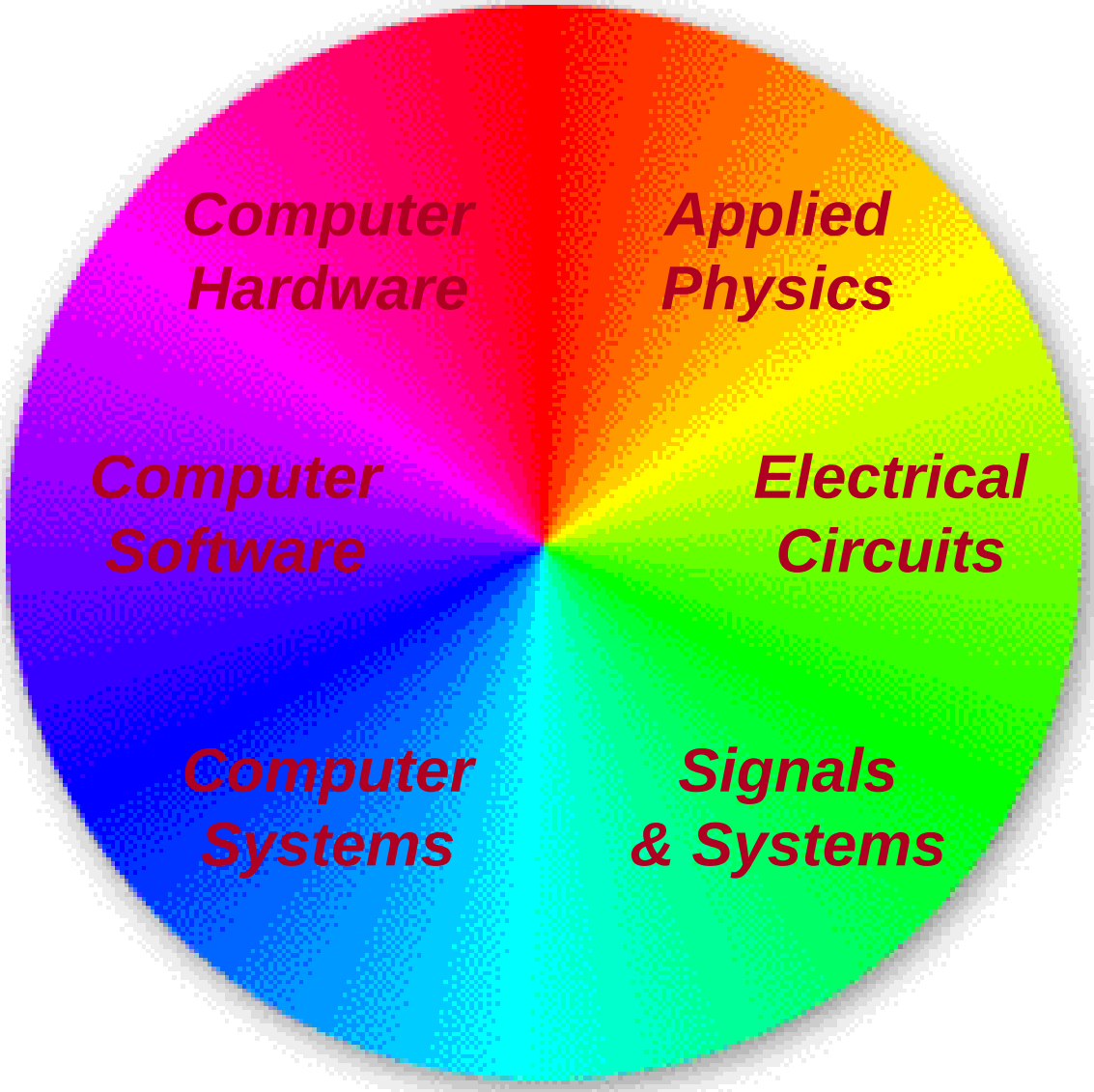
Processor Architectures



Pentium block diagram.

Embedded Systems

The ECE Technical Spectrum



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Embedded Systems: Computers Inside a Product

How many computers are in a car seat?

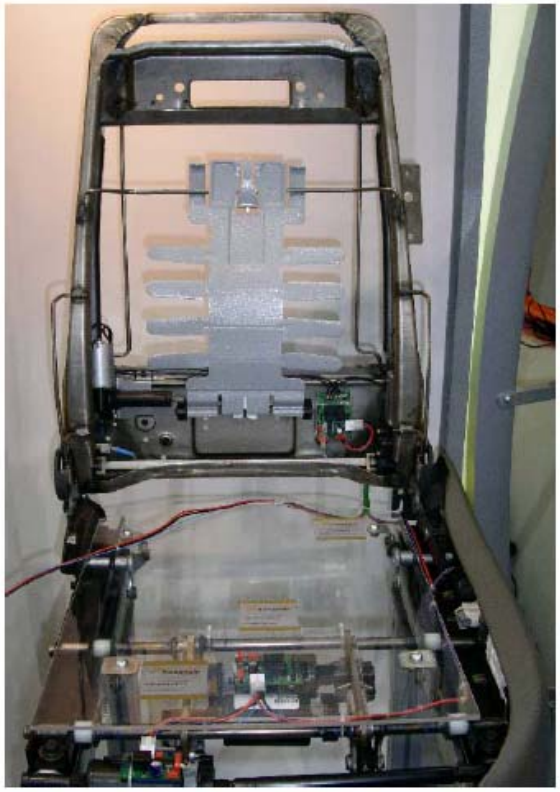

Photo: Convergence 2004, Automotive Electronics Show

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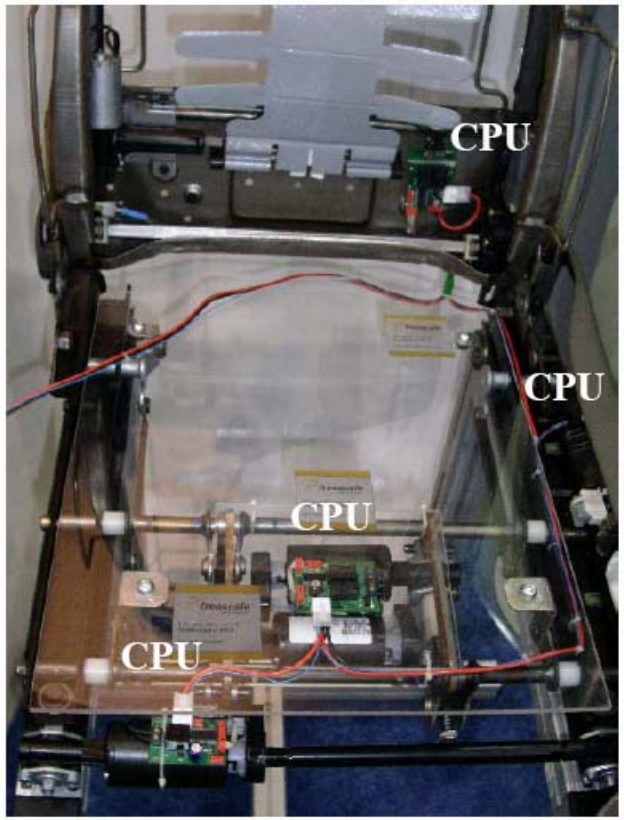
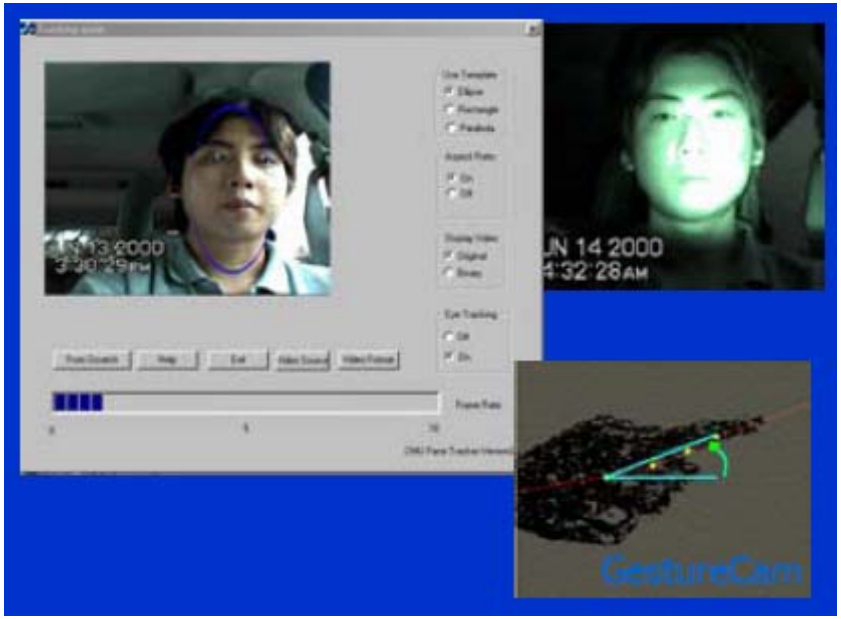
Car Seat as Computer and Communications Network

- *Low speed network to connect seat motion control nodes*
- *This is a distributed embedded system*
  - *Front-back motion*
  - *Seat tilt motion*
  - *Lumbar support*
  - *Control button interface*



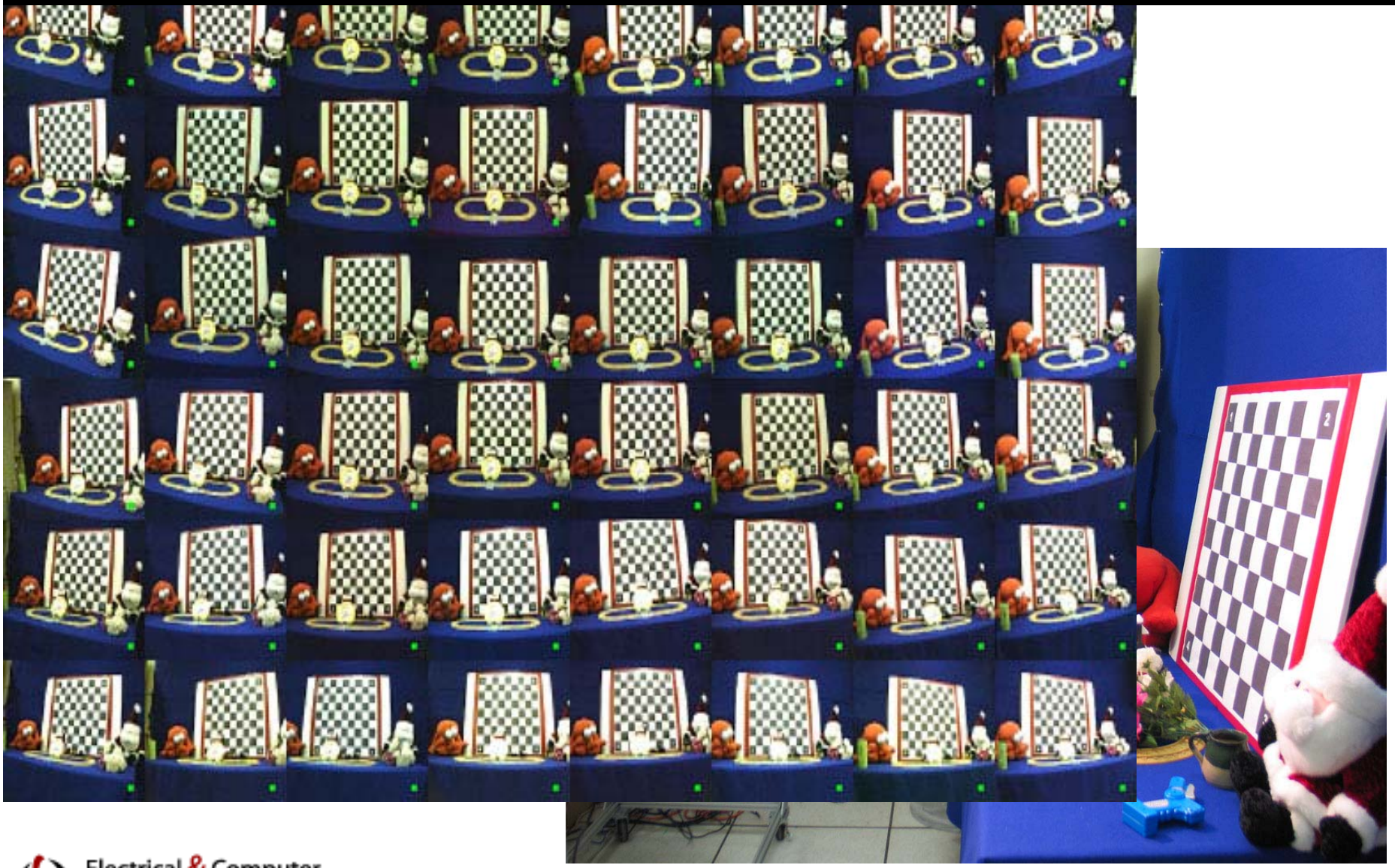
CMU – GM Collaborative Research Lab

- *Face/Eye/Hand Tracking*
  - *Driver-vehicle interfaces*
  - *Cognitive overflow study*
- *Driver ID and Encryption*
  - *Security*
  - *Safety*
  - *User Preference*
- *Airbag Deployment Control*
  - *Mirror, wheel, panel, seat*



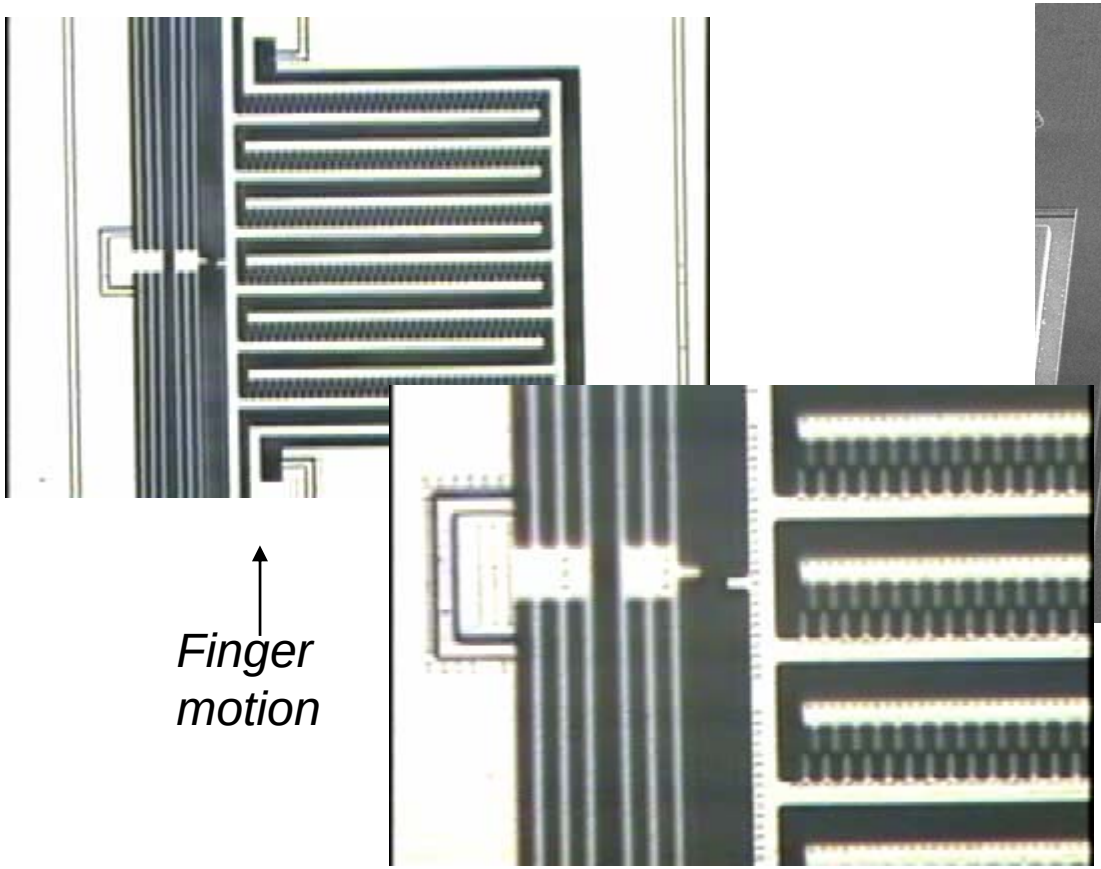
Electrical & Computer ENGINEERING

Imaging Arrays

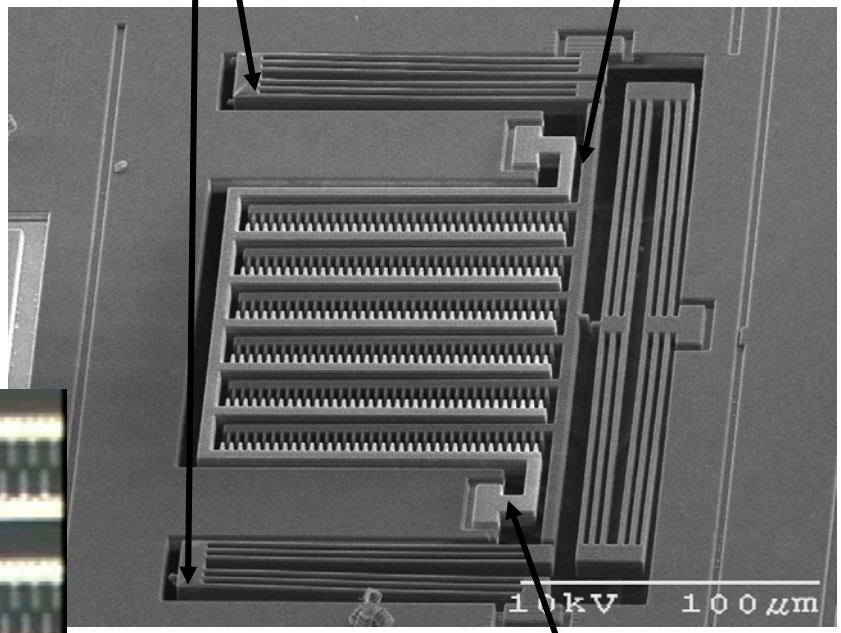


CMOS MEMS at CMU

- *Moving capacitor in 0.35 µm CMOS*
- *Dense comb array provides variable capacitance*



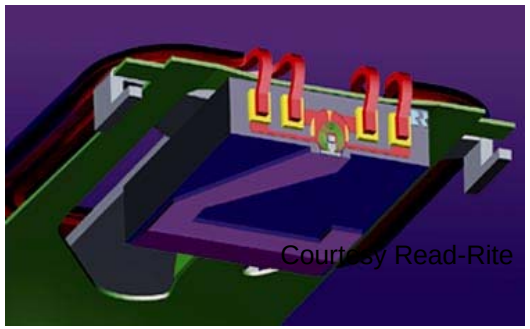
Finger motion



A. Oz, G. K. Fedder, IEEE Transducers 2003 & MTT-S RFIC 2003, June 2003

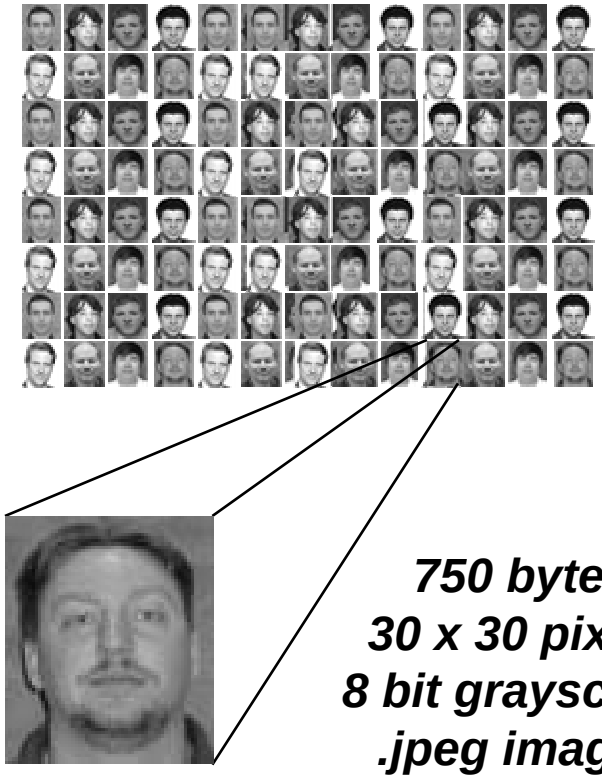
Information Storage Technology

Seagate Barracuda ATA II



Head

What is 1 Tbit/in^2?



750 byte
30 x 30 pixel
8 bit grayscale
.jpeg image

Technology goal today 1 Tbit/in^2

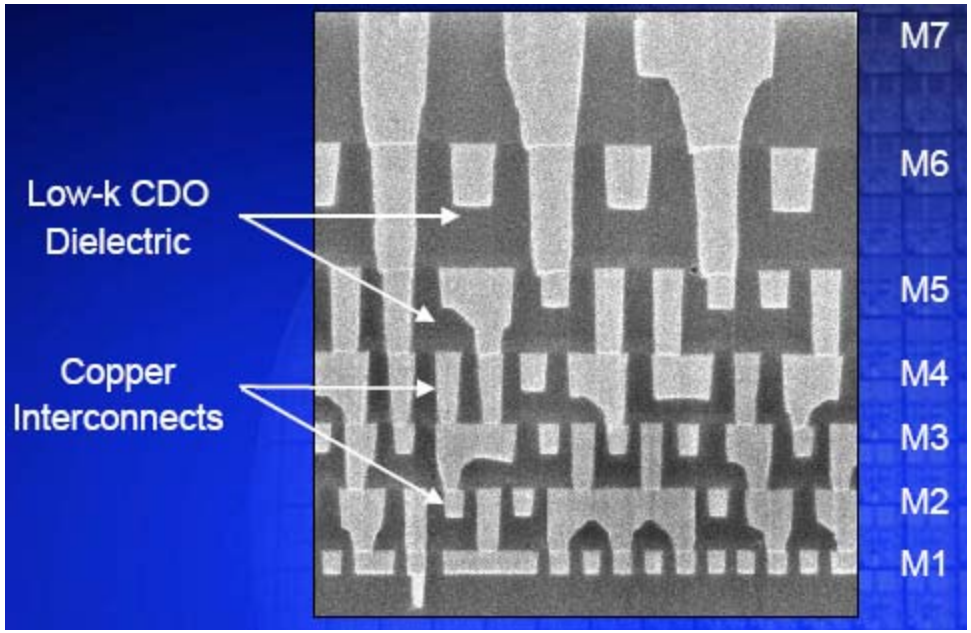
At 1 Tbit/in^2 you can save a picture of every man, women and child on earth on a disk the size of a Compact Disk

Courtesy: T. Rausch

Individuals will own libraries of information

Electrical & Computer ENGINEERING

Today's State of the Art in CMOS

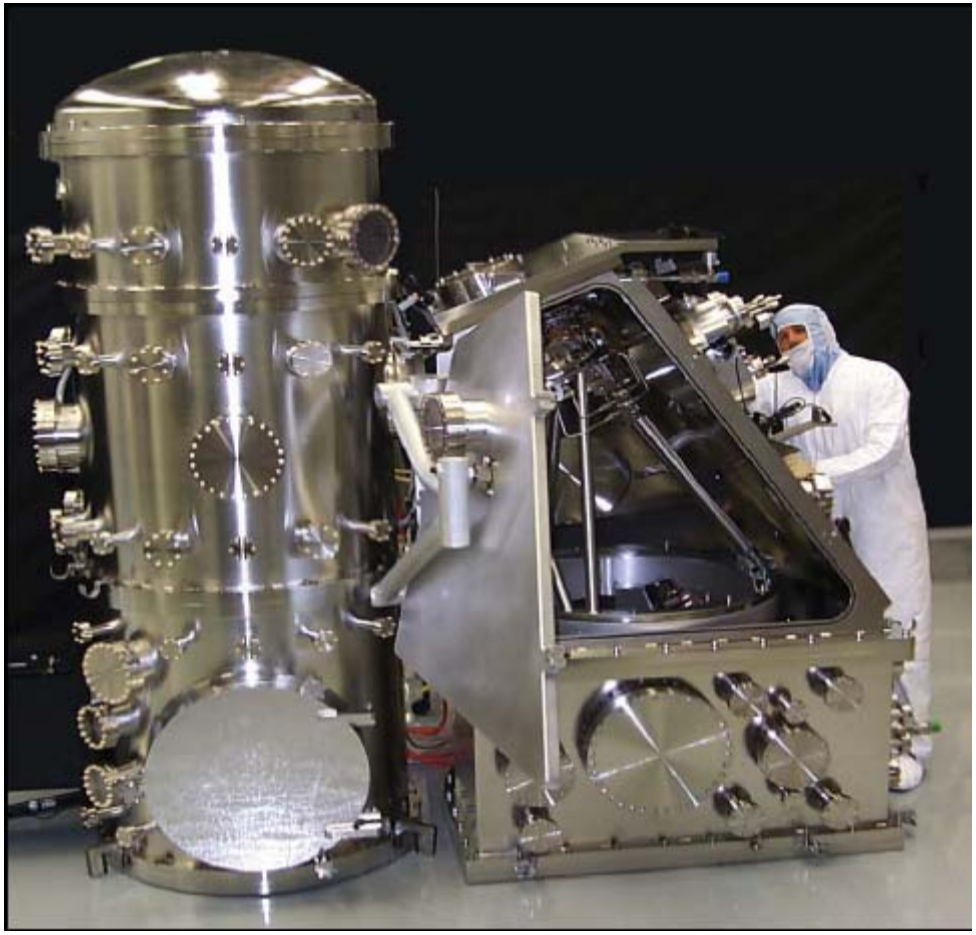


90 nm lithography

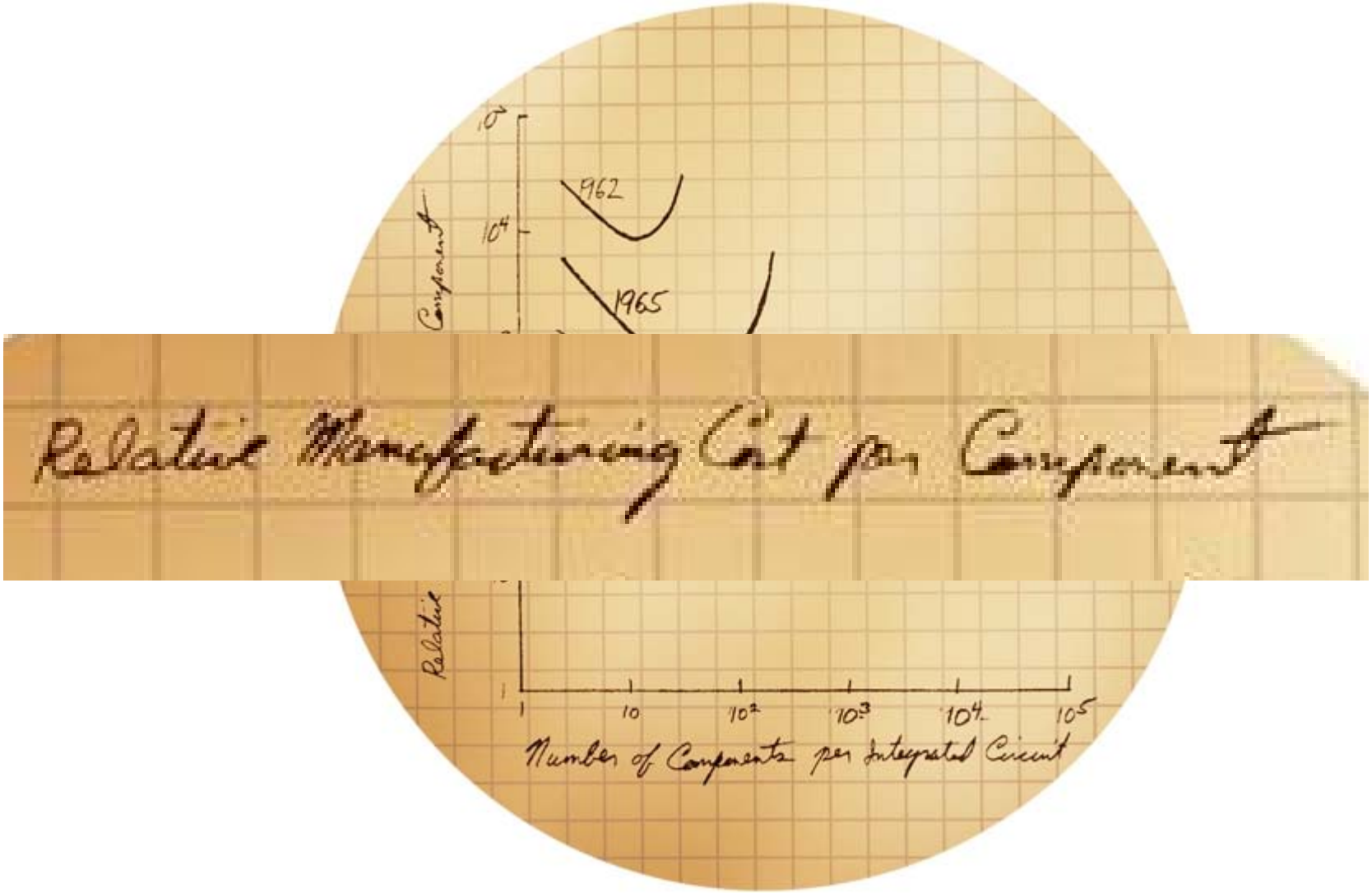
How long can physical limits on scaling be avoided?

Gordon Moore ISSCC 2003

Extreme Ultraviolet Lithography



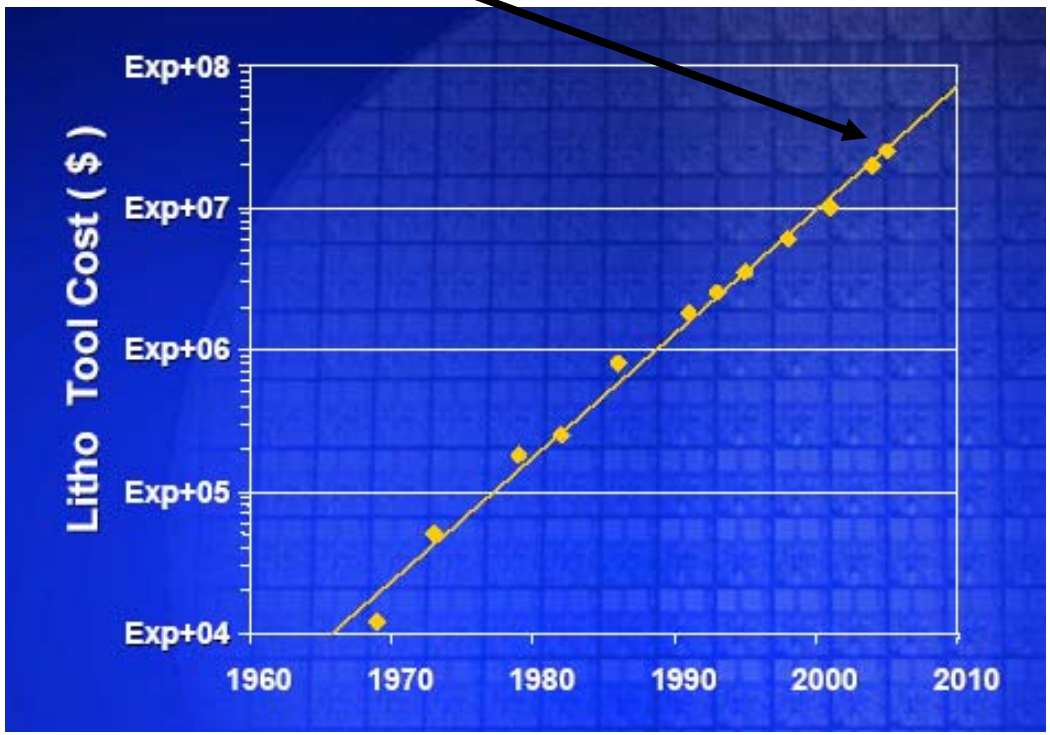
Moore's Law (Original)



Problems in the IC Industry

- *$30 M/tool today*
- *$250 M/tool in ten years*
- *$1 B/tool in twenty years!*

Moore's "Law" is all about cost <u>reduction</u> not density



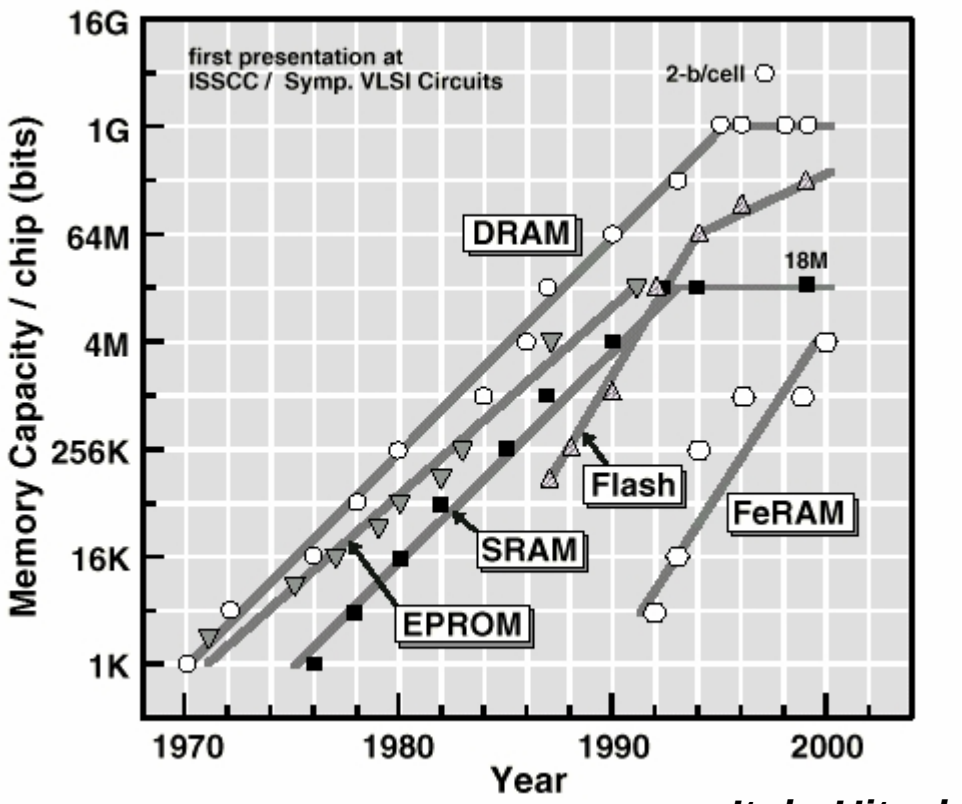
**Fabs cost 100x the tool cost*

Gordon Moore ISSCC 2003

The late economist Herb Stein said "anything that can't go on forever, won't."

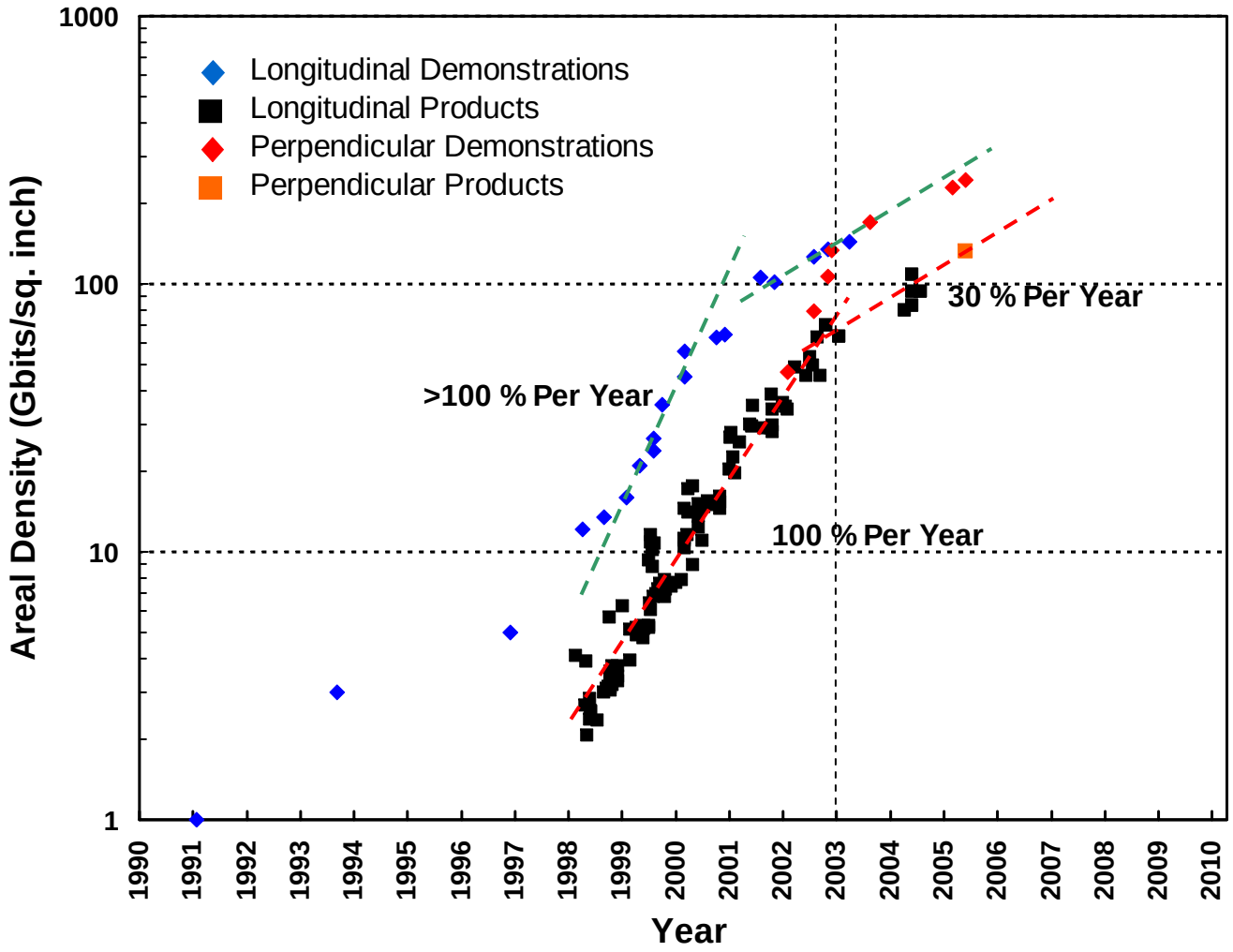
Electrical & Computer ENGINEERING

Memory Trends

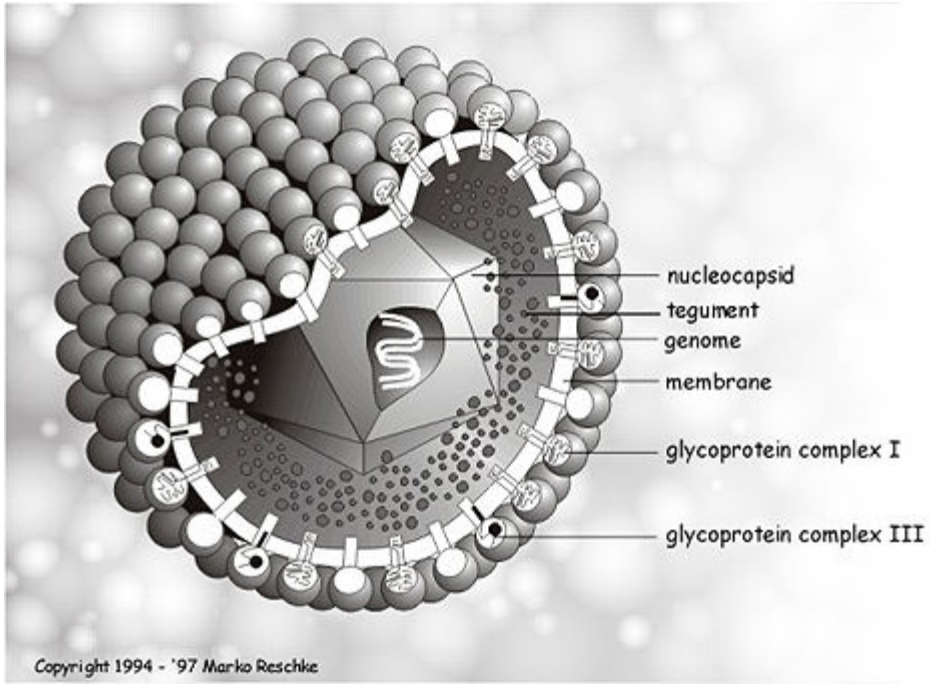


Itoh, Hitachi

HDD Density Trends



Human Cytomegalovirus (CMV)



200,000 base pairs
Nucleocapsid ~ 100 nm diameter

Information storage density $4x10^5$ bits per $\pi(50x10^{-9})^2$ m^{-2}

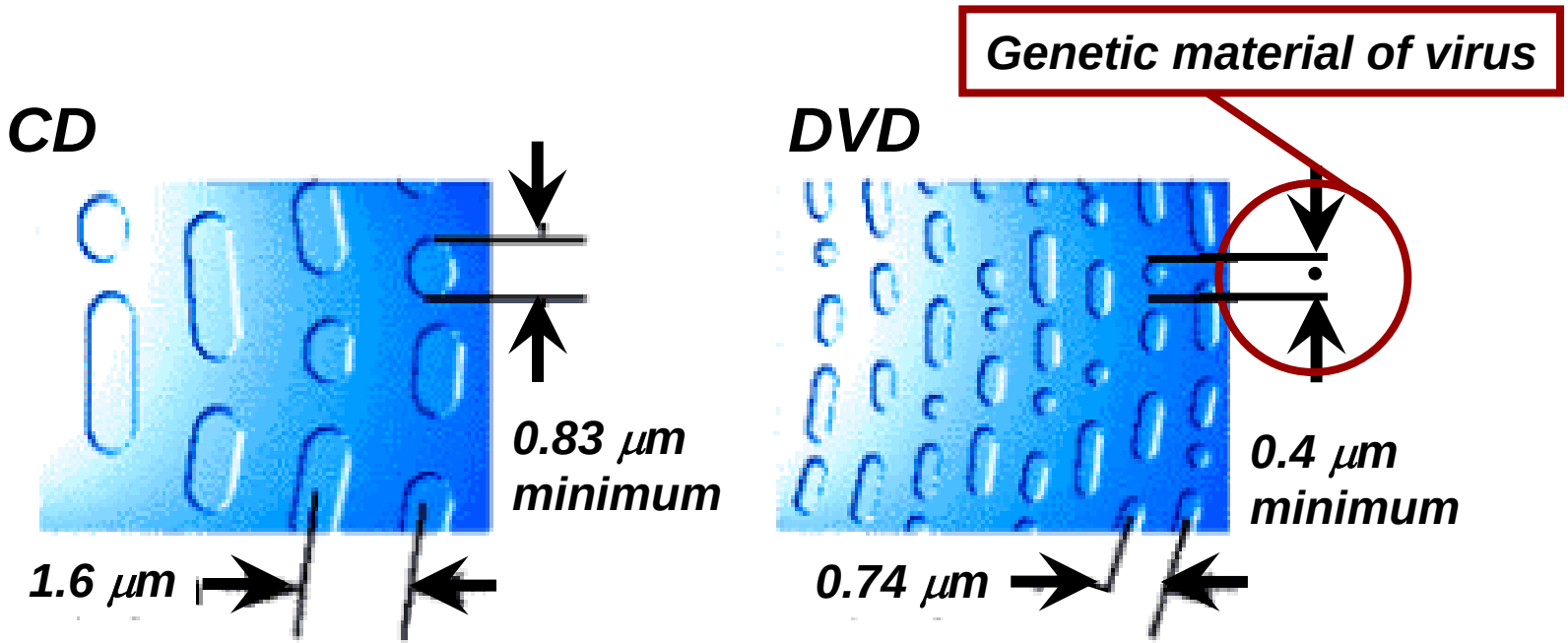
or about $3x10^{16}$ bits/inch^2

A factor of 10^5 times today's state-of-the-art

or equivalent to > 30 years of development

Electrical & Computer ENGINEERING

Relative Sizes

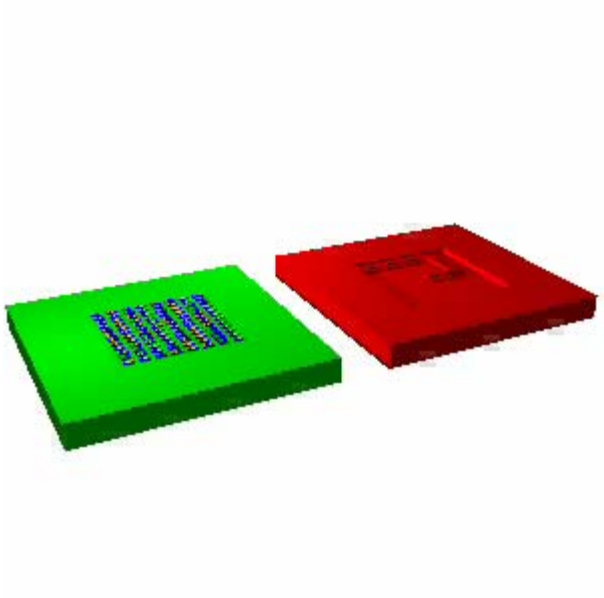


Heavier than air flight is possible…..

Bald Eagle in flight

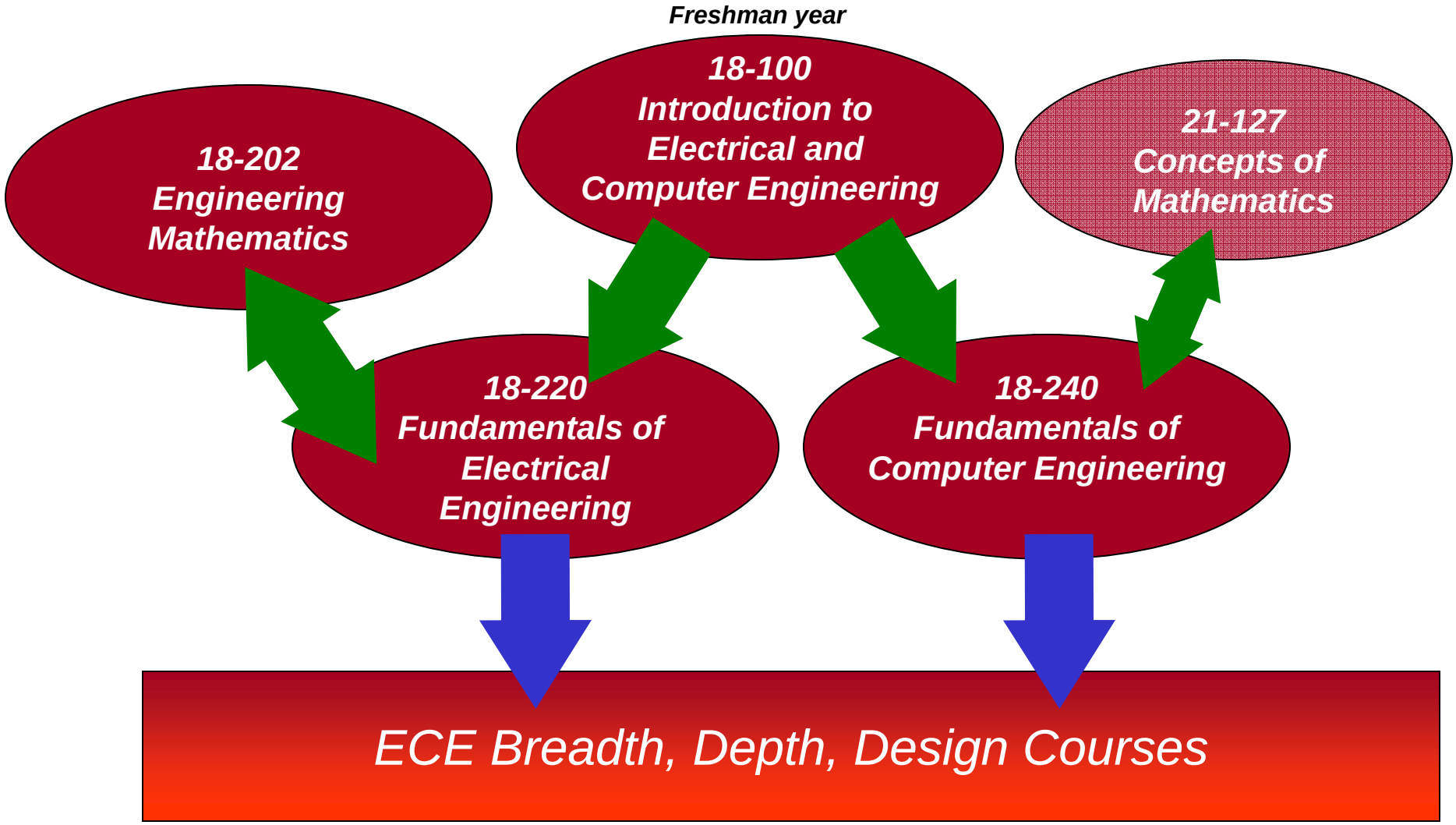
F-15 Eagle in flight

Memory Intensive Self-Configuring ICs (MISC IC)



This technology integrates memory and processing technology, is able to tolerate defects and irregularities, and is reconfigurable in the field and most importantly allows IC systems to move beyond CMOS and its scaling paradigm.

The ECE Curriculum: Core Courses



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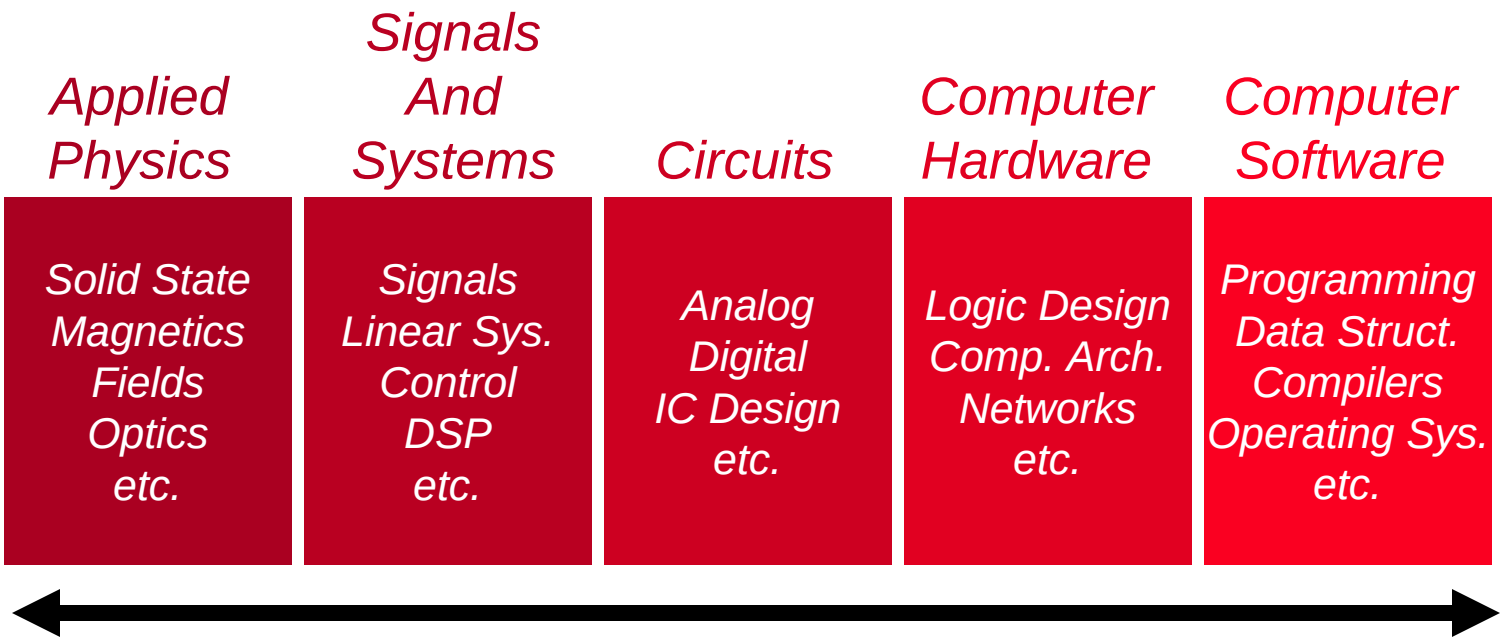
ECE Breadth Areas



Electrical and Computer Engineering

Requirements

breadth: one course from three different areas
depth: a two-course sequence in one area
coverage: two additional ECE courses

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Capstone Design Courses

18-517	Data Storage Systems Design
18-523	Analog Integrated Circuit Design
18-525	Integrated Circuit Design Project
18-544	Network Design and Evaluation
18-545	Advanced Digital Design Project
18-549	Distributed Embedded Systems
18-551	Digital Communications and Signal Processing Systems
18-575	Control System Design
18-578	Mechatronic Design

Courses and Course Trees

http://www.ece.cmu.edu/users/shared/primer/appendix/currlist.php

ECE Faculty

- *Cover the complete ECE technical spectrum*
- *~90 faculty members - including research, adjunct, and courtesy faculty*
- *Over 20 IEEE Fellows*
  *(The Institution of Electrical and Electronics Engineers is the world's largest professional society)**
- *6 Members of the National Academy of Engineering*

* *All ECE sophomores receive a free IEEE membership!*

Electrical & Computer ENGINEERING

ECE Students

- *140-160 per class (soph-senior)*
- *Many continue for an MS through our IMB program*
  IMB = Integrated Masters Bachelors
- *Many double majors (CS, Engineering & Public Policy, Biomedical Engineering, Economics, etc.)*
- *Some employers of 2005 graduates*
  - *Semiconductor companies*
  - *Consulting companies*
  - *Software developers*
  - *Aerospace companies*
  - *Investment/finance industry*
  - *Government agencies*

More Information:
http://www.ece.cmu.edu/

ECE Sophomore Welcome Reception

Thursday, September 1
4:30 to 6:30 p.m.

Singleton Room,
Roberts Engineering Hall

Network with Peers

Meet Your ECE Advisor

Enjoy Plenty of Great Food