3.155J/6.152J Lecture 1: Introduction

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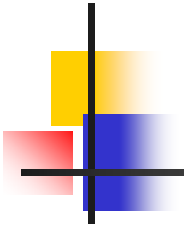
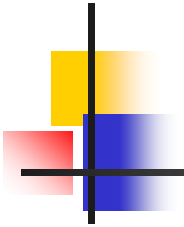
Massachusetts Institute of Technology

9/7/2005



Outline

- Introductions
  - Staff
  - You
- Motivation
- Course Organization
  - Handout
- Lab Assignments
- Safety



Tiny Technologies

- A definition which captures two extremes:
  - Miniaturization
    - Making things smaller, often using Integrated Circuit process technologies
  - Atom-level Manipulation/Assembly/Growth
    - Often to achieve a unique material property
      - e.g. Carbon Nanotubes
  - We will focus on the former

The Driver: Microelectronics

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www.ibm.com

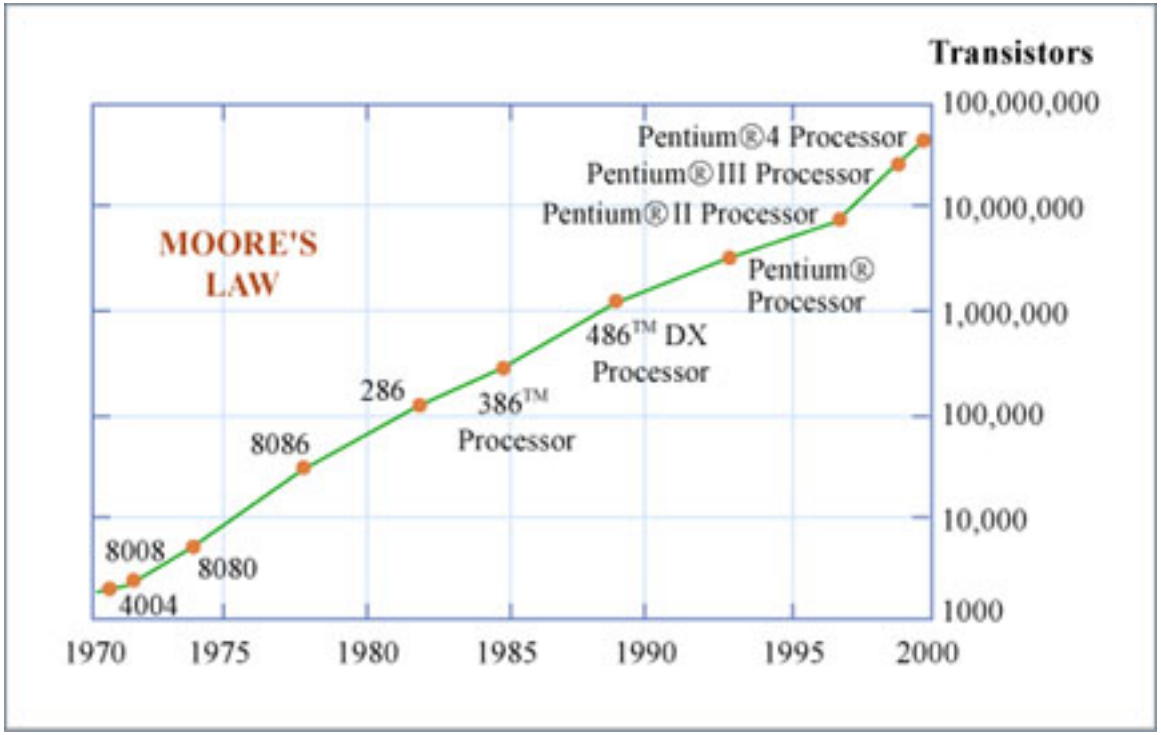

Figure by MIT OCW.

www.intel.com

Transistors the size of DNA

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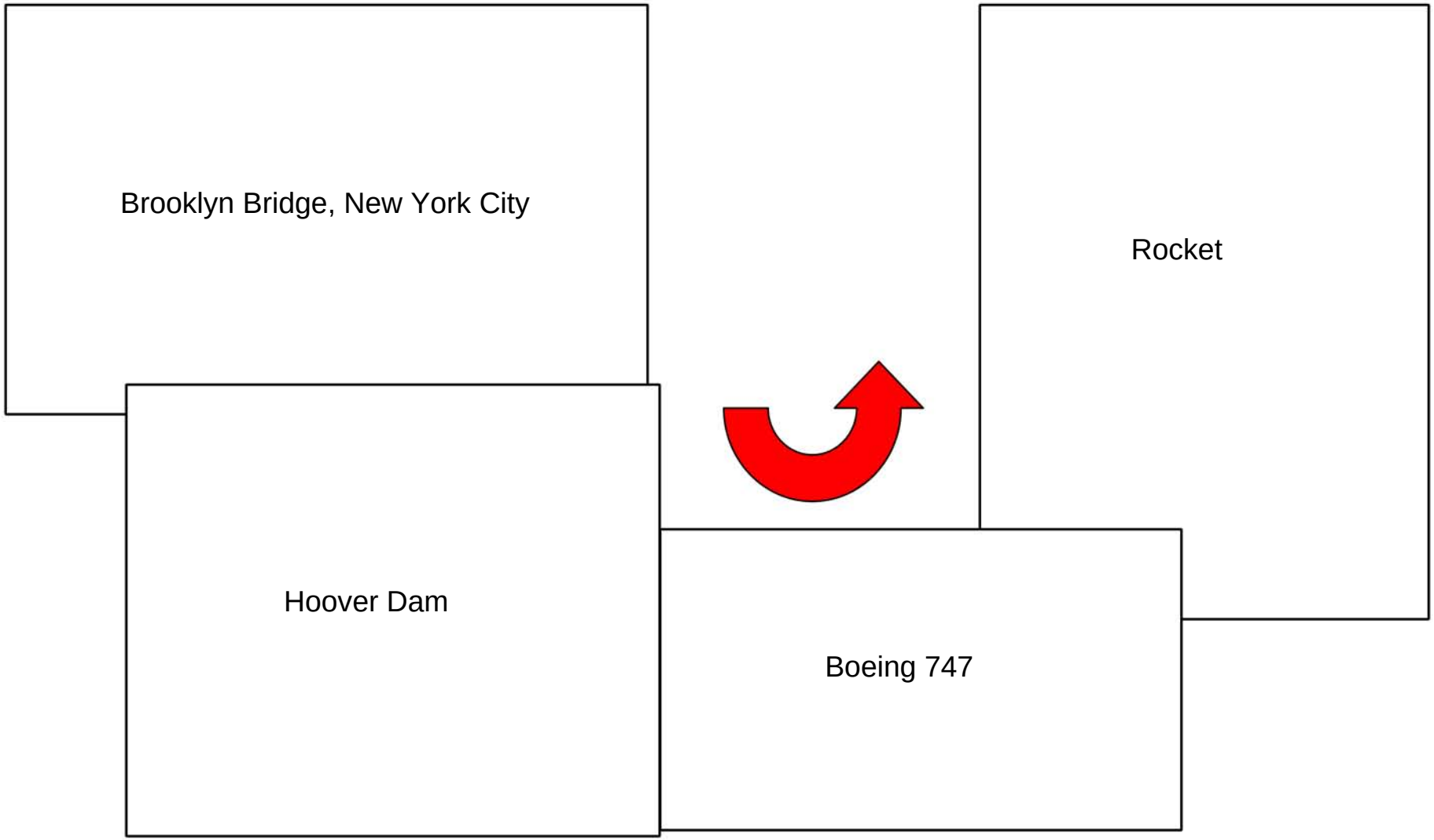
Engineering Challenges of the 20th Century: INCREASING SCALE

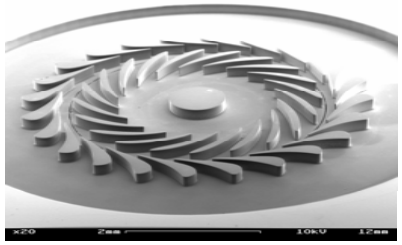


Engineering Challenges of the 21st Century: DECREASING SCALE

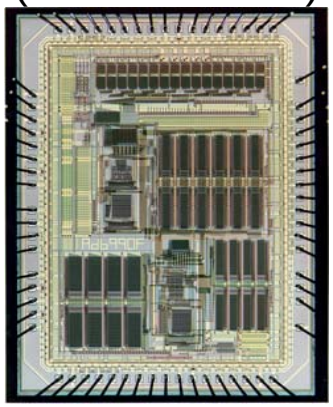
- Portable, Distributed Systems
- Manipulation of Small Things
  - Drugs
  - Biological Cells
  - Biological Matter
    - DNA
    - Proteins
  - Atoms

MIT Tiny Technologies

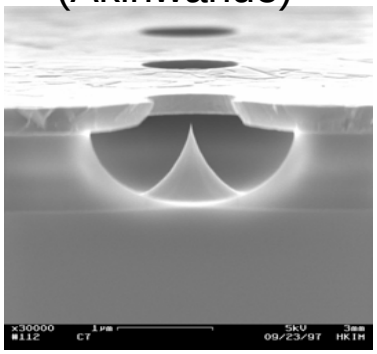
Microengines



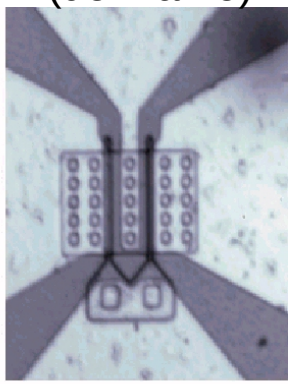
Low Power DSP
(Chandrakasan)



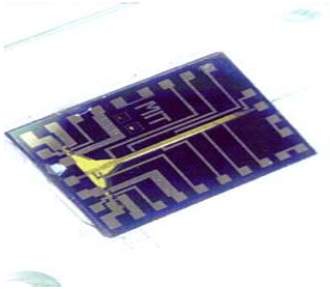
Displays
(Akinwande)



Transistors
(delAlamo)

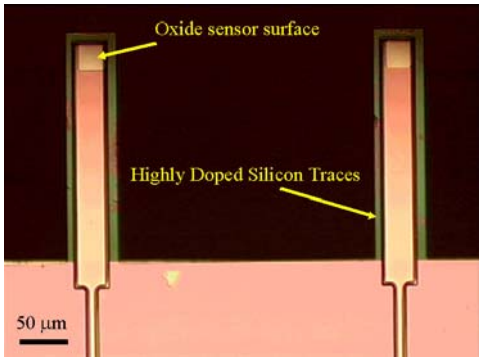


mm μm nm

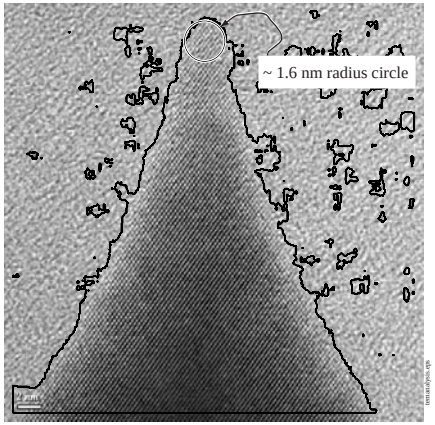


Microchemical
Plants
(Jensen)

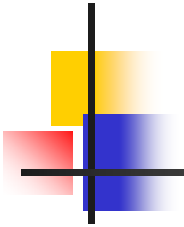
Connectors
(Slocum)



Biosensors
(Manalis)



Nanotips
(Akinwande)



Organization

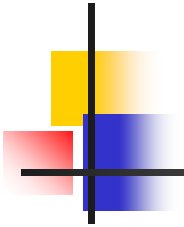
- Pre-Req
- Total overhaul two years ago
  - Spring ’03 was trial run
- Three lab modules
  - IC
  - MEMS
  - Microfluidics
- Lecture alignment with labs

Laboratory

- Each *session* is 4 hours (9-1 or 1-5)
  - Tuesday, Thursday, Friday
  - Groups A,B,C,D,E,F
- Each *lab* is 3 sessions
  - 2 for processing, 1 for testing
- Three labs
  - IC : MOS Capacitor
  - MEMS : Silicon Nitride Nanocantilever
  - Fluids : Micromixer
- Lab report for each lab

Lecture Schedule

- 13 Topical Lectures
  - Oxidation, Diffusion/Implantation, Vacuum Systems, CVD, Sputtering, Evaporation, Lithography, Etching, CMOS, and Advanced Silicon Devices
- 3 Lab Overview Lectures
  - Given in first week of lab
- 3 Lab Report Lectures
  - Given in last week of lab
- Two In-Class Quizzes
- Two Take-Home Quiz / Patents Lectures
- Two Advanced Topic Lectures (Guests)
- Writing Lectures (embedded in other lectures)
- Analog Devices MEMS Fab Tour

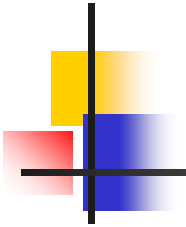


Grading

- Quizzes (15% each)
  - Covers 13 Topical Lectures
- Take Home (15%)
  - An Integrated Design Problem
- Lab Reports
  - IC Lab – (15% technical, 5% writing)
    - Satisfies CIM
  - MEMS Lab – (15%)
  - Fluids Lab – (5%) Simplified report
- Homework (10%)
  - Eight written assignments
  - Advanced topic lecture participation counts as 2 homeworks
- Lab Participation (5%)
  - Lab instructor evaluations

Policy for Academic Conduct

- Homework
  - Collaboration OK, everyone must contribute
  - Contributors must be identified
- Take-Home and Quizzes
  - No collaboration
- Lab Reports
  - Each group shares the same data, but...
  - Data reduction, analysis, discussion MUST be done individually
    - Use of old lab reports not permitted



Books, References

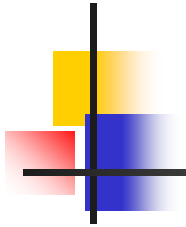
- Lecturer will handout notes
- Copies of chapters when appropriate
- Recommended book:
  - Plummer
- Other references

Schedule – 1st Half

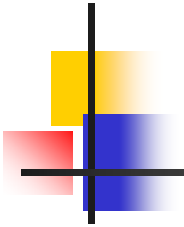
Day	Date	Lecturer	Topic	Lab	Assignments Out	Assignments Due
W	9/7	MAS	Overview/Safety/Lab assignment*		HW1 (IC Process) - MAS	
M	9/12	MAS	IC Lab - Overview	IC-1: Gate oxide/poly		
W	9/14	MAS	Oxidation		HW2 (Oxidation) - MAS	HW1 (IC Process)
M	9/19	☺	Holiday	IC-2: Backside Etch		
W	9/21	RCOH	Diffusion		HW3 (Diffusion) - RCOH	HW2 (Oxidation)
M	9/26	MAS	IC Lab: Testing*	IC-3: Test	IC Lab Report	
W	9/28	RCOH	Diffusion/Implantation			
M	10/3	MAS	MEMS Lab: Overview	MEMS-1: Photolith		HW3 (Diffusion)
W	10/5	RCOH	Vacuum System		HW4 (Vac/CVD) - RCOH	IC Lab Report (in lab)
M	10/10	☺	Columbus Day-Holiday	MEMS-2: KOH etch		
W	10/12	RCOH	CVD			
M	10/17	MAS	MEMS Lab: Testing*	MEMS-3: Test	MEMS Lab Report	HW4 (Vac/CVD)
W	10/19	Staff	Quiz 1: Through CVD			
M	10/24	MAS	Fluids Lab: Overview	Fluids-1: Photolith		
W	10/26	RCOH	Sputtering		HW5 (Sput/Evap) - RCOH	IC Lab Report-Resubmit
M	10/31	RCOH	Evaporation	Fluids-2: Molding		

Schedule – 2nd Half

M	10/24	MAS	Fluids Lab: Overview	Fluids-1: Photolith		
W	10/26	RCOH	Sputtering		HW5 (Sput/Evap) - RCOH	IC Lab Report-Resubmit
M	10/31	RCOH	Evaporation	Fluids-2: Molding		
W	11/2	MAS	Lithography*		HW6 (Litho) - MAS	HW5 (Sput/Evap)
M	11/7	MAS	Lithography, Soft Lithography	No Lab (Veterans Day)		
W	11/9	RCOH	Etching (wet)		HW7 (Etching) - RCOH	MEMS Lab Report
M	11/14	MAS	Fluids Lab: Testing	Fluids-3: Test	Fluids Lab Report	HW6 (Litho)
W	11/16	RCOH	Etching (dry)			
M	11/21	MAS	CMOS	No Lab	HW8 (CMOS) - MAS	HW7 (Etching)
W	11/23	MAS	Advanced Silicon Devices			
M	11/28	MAS	Take Home Introduction / Patents	No Lab	Take Home Exam	HW8 (CMOS)
W	11/30	Staff	Quiz 2: Through Adv.Si.Dev.			
M	12/5	Guest	Take Home Discussion	No Lab		
W	12/7	Guest	Advanced Topics			Fluids Lab Report
M	12/12	Guest	Advanced Topics	No Lab		
W	12/14		Analog Devices Fab Tour			Take Home Quiz



Lab Assignments



Safety

- Sleep
  - Better safe than sorry
- Be responsible
- Ask questions
- Respect but don’t fear
  - No injuries in the history of the class