EE-224: Digital Logic Design

Course Introduction

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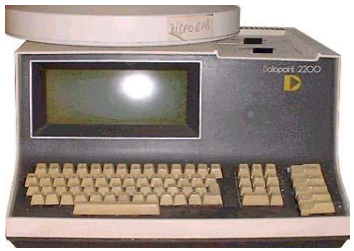
Lecture 0 (01 August 2023)

CADSL

WHAT IS THE DIFFERENCE BETWEEN THE COMPUTING INDUSTRY AND THE PAPER TOWEL INDUSTRY?

Industry of Replacement

1971 2023





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Industry of new possibilities

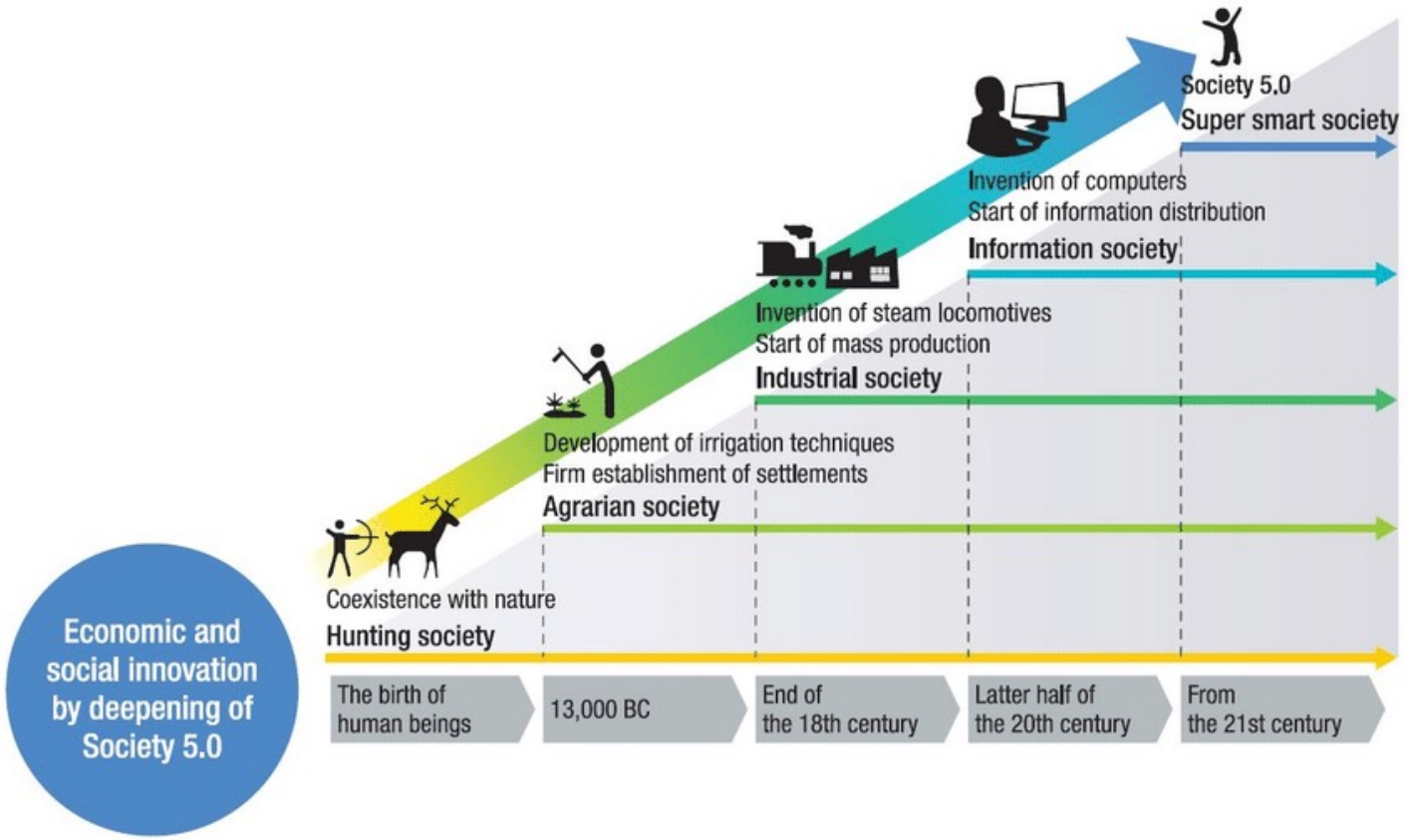
CAN WE CONTINUE BEING AN INDUSTRY OF NEW POSSIBILITIES ???

Personalized healthcare

Virtual reality

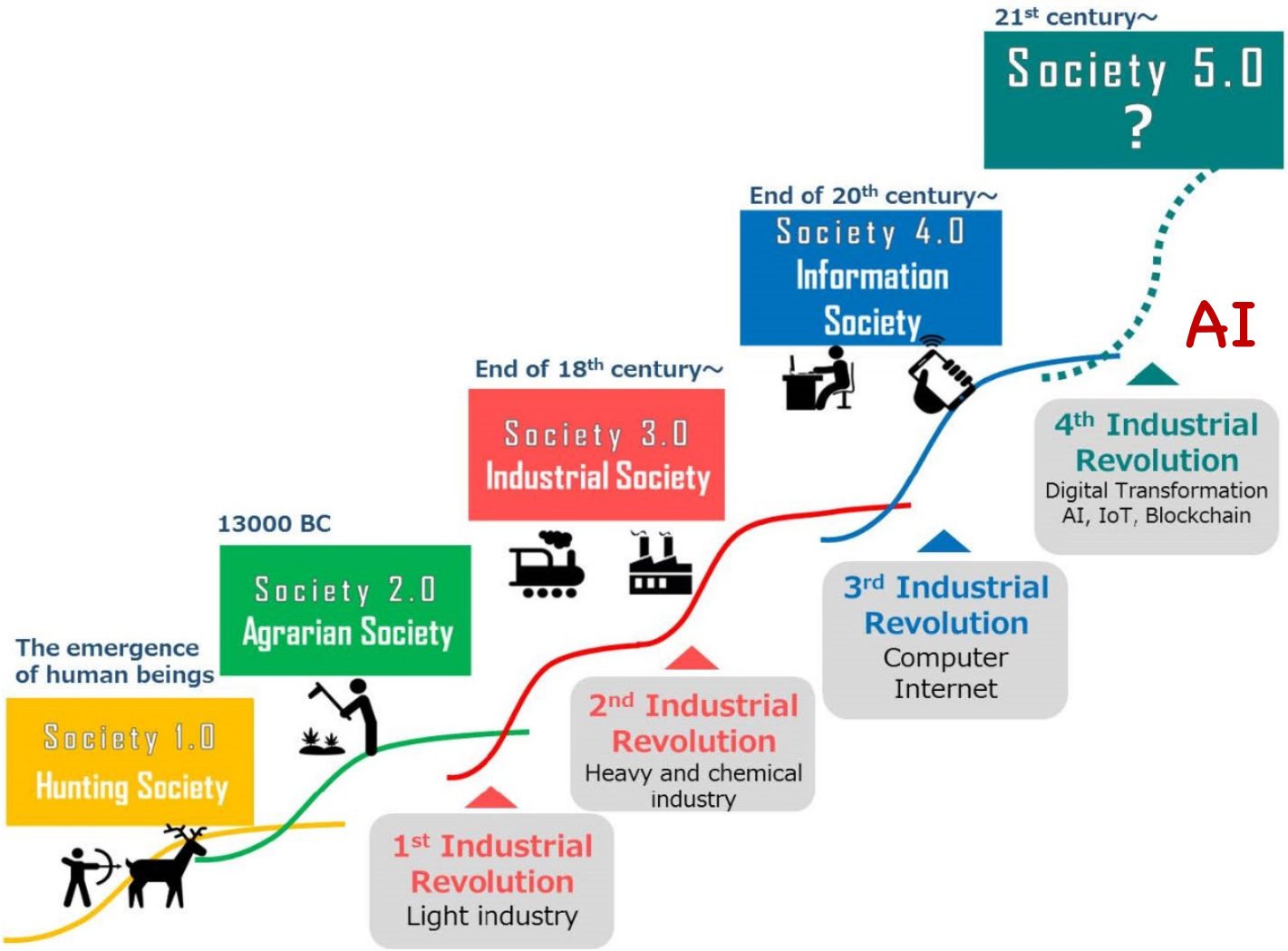
Real-time translators

Evolution of Society



Source: Prepared by the author based on material from the Japan Business Federation (Keidanren) "Japan's initiatives — Society 5.0"; Y. Harayama, "Society 5.0: Aiming for a New Human-centered Society", Hitachi Review, vol. 66, no. 6, 2017, pp. 556–557

Evolution of Society



History of Electronics

- There were many inventions in the 20th century:

  Airplane, Nuclear power generation, Computer,

  Space aircraft, etc.

- However, everything has to be controlled by electronics

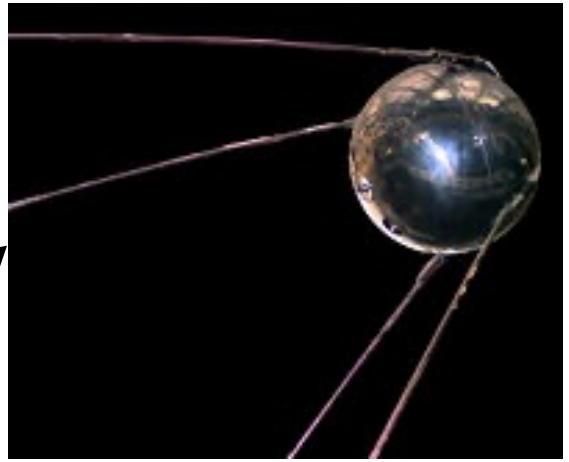
- Electronics

  Most important invention in the 20th century

World of 1958:

65 Years is a long time!

Artificial Satellite
Sputnik, Oct.4, 1957



Radio → TV (made of Vacuum Tube)

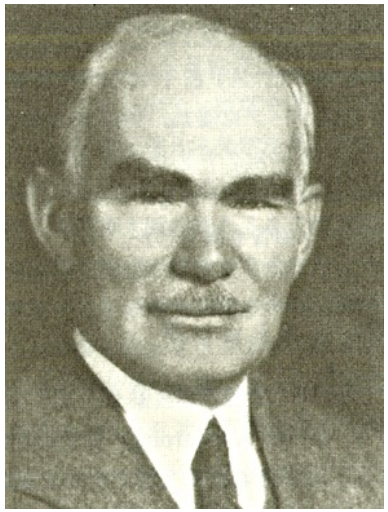
Sony Transistor
Radio Started 1955

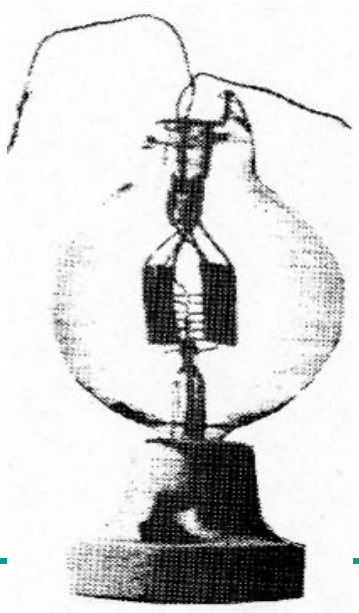
History of Electronics

- Electronics is the most important invention of the 20th century
- Electronic Circuits in 100 years

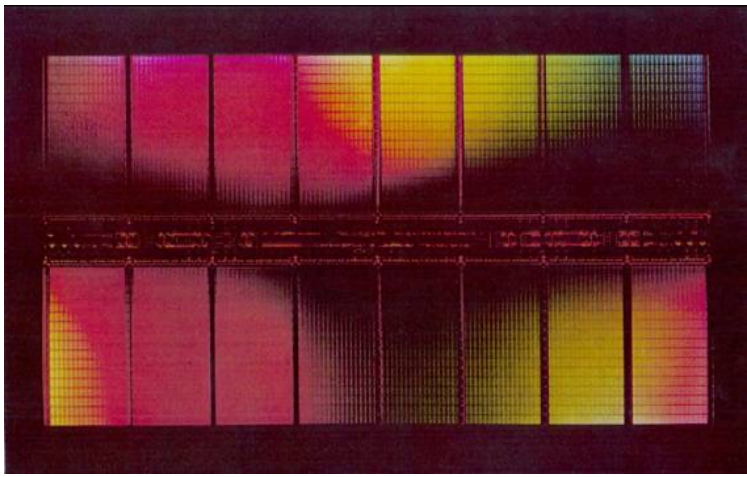
Vacuum tube → VLSI (Very Large Scale Integrated circuits)

17 yeas ago, it was the 100 year anniversary



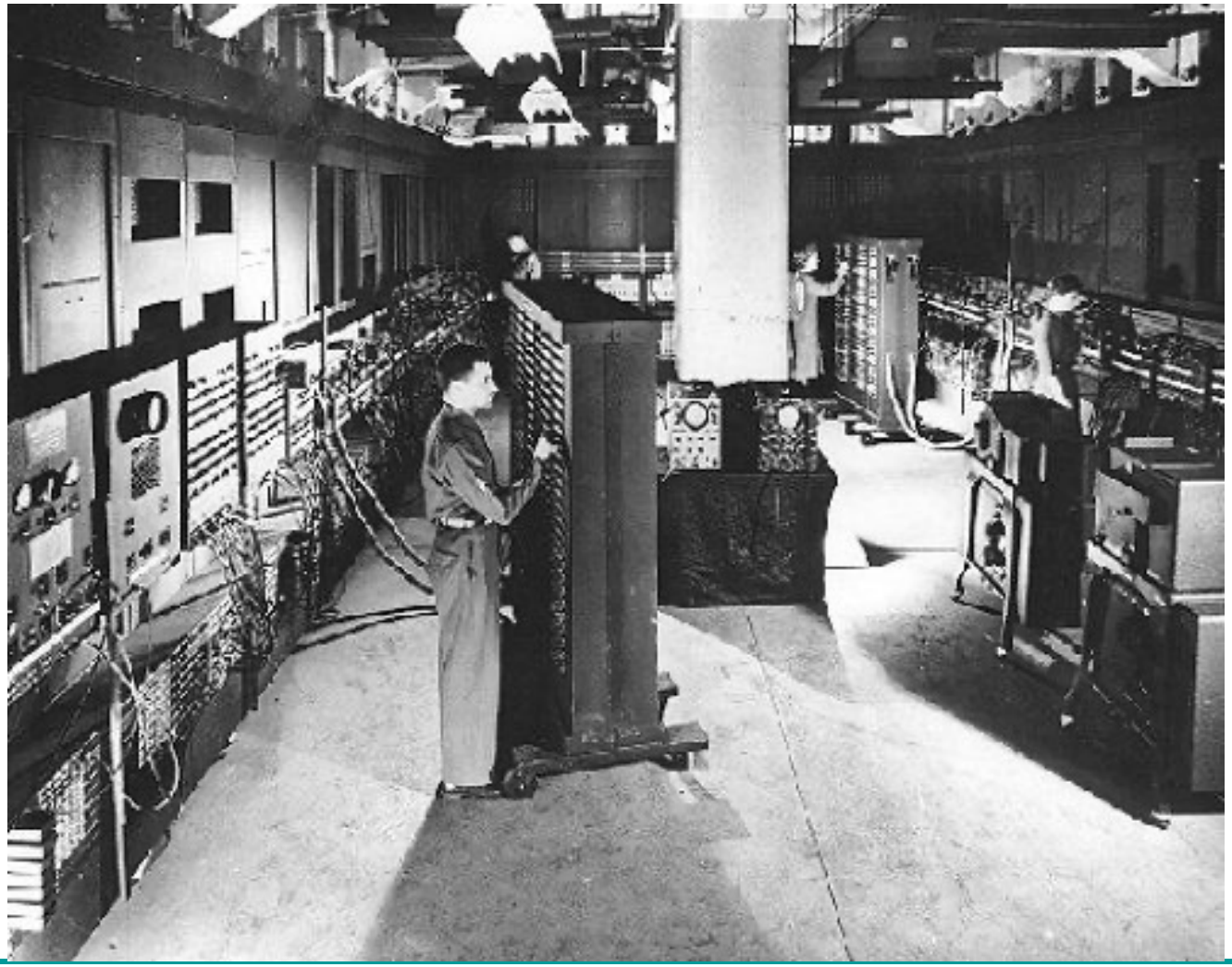


1906

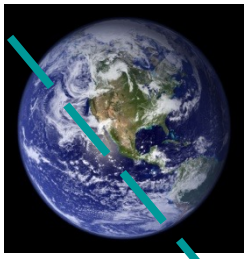


Electronic Computer

First Computer ENIAC: made of huge number of vacuum tubes, Big size, huge power, short life time filament



Wanted: **CUSTOMERS**, who breathe, eat, and live in…..

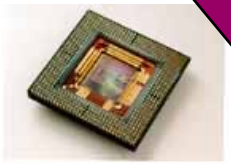


Global & Regional Political & Macro-Economic Environments

Customer Demand

Electronic End Equipment — ~$ 1050B

Semiconductors — ~$ 400B



Semiconductor Equipment & Materials — ~$ 100B

~$ 50,000B

Sources: NASA Gov.'; SEMI

Interesting Applications

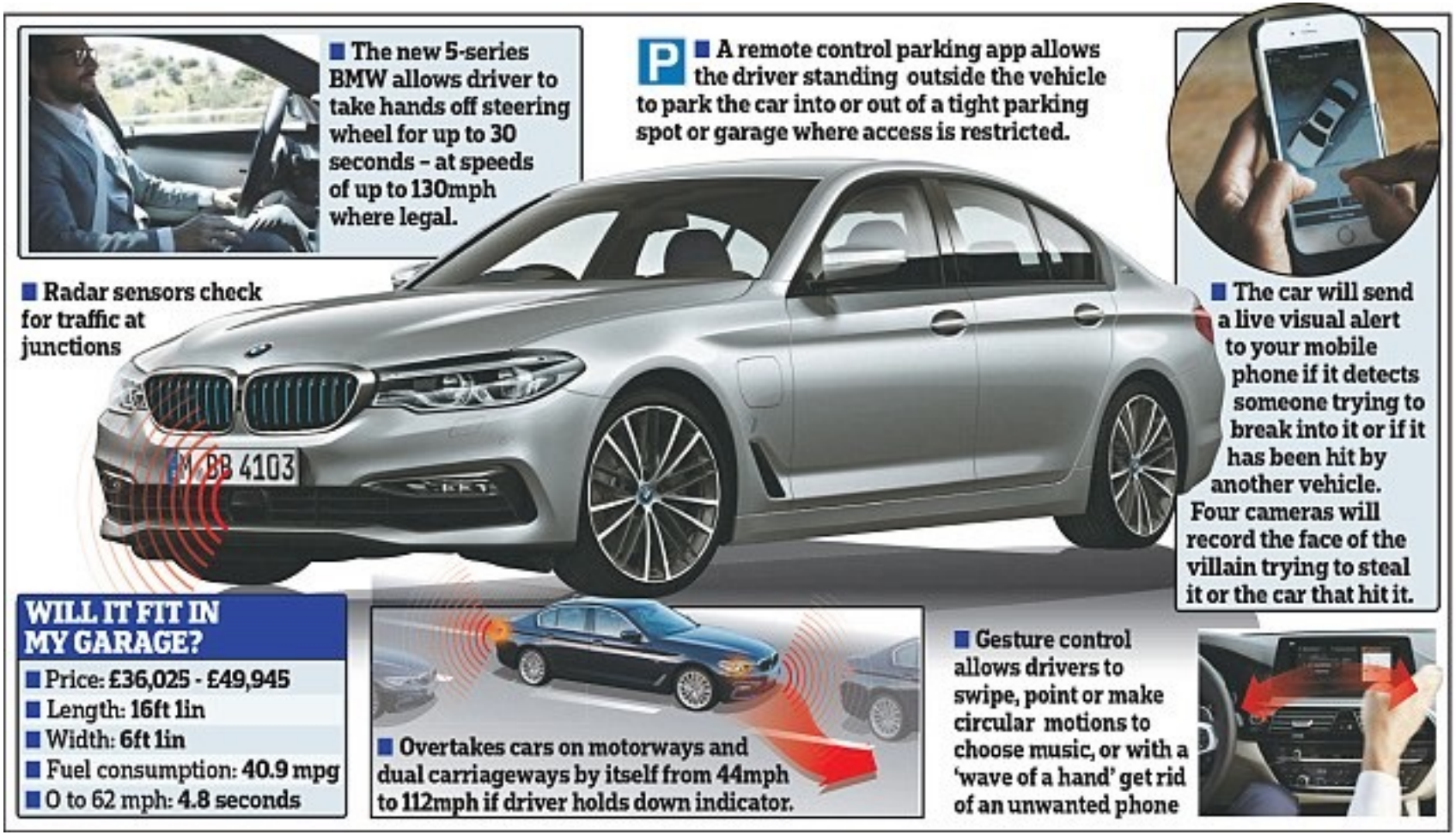
Why Study Digital Design?

- It's exciting!; It has never been more exciting!
- It impacts every other aspect of electrical engineering and computer science

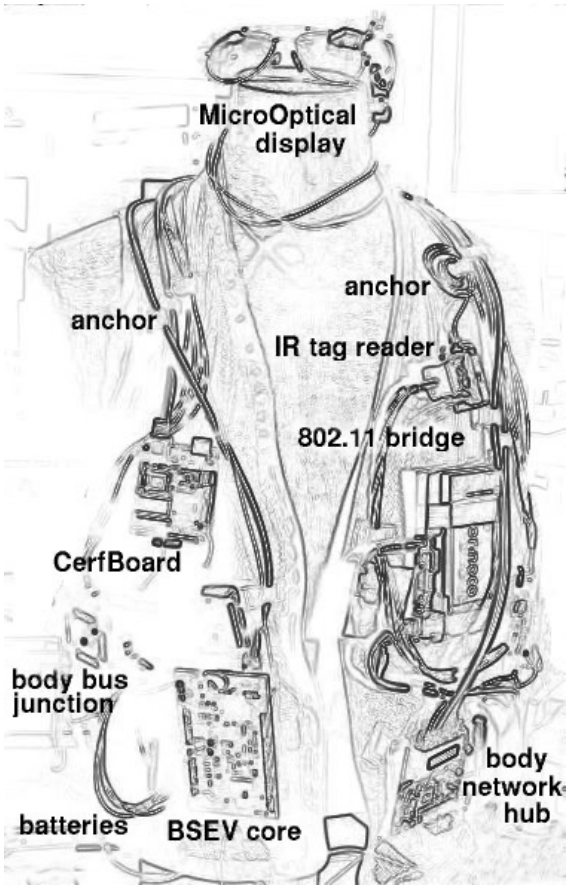
Bionics:
Sensors in latex fingers instantly register hot and cold, and an electronic interface in his artificial limb stimulates the nerve endings in his upper arm, which then pass the information to his brain. The $3,000 system allows his hand to feel pressure and weight, so for the first time since losing his arms in a 1986 accident, he can pick up a can of soda without crushing it or having it slip through his fingers. *One Digital Day*

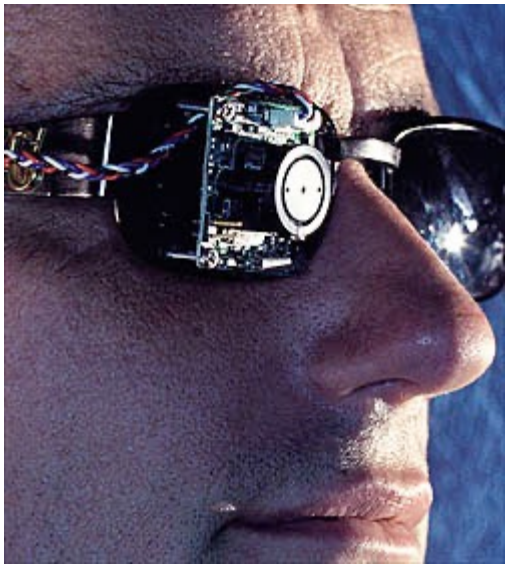
Next Generation Vehicles

Next Generation Vehicles

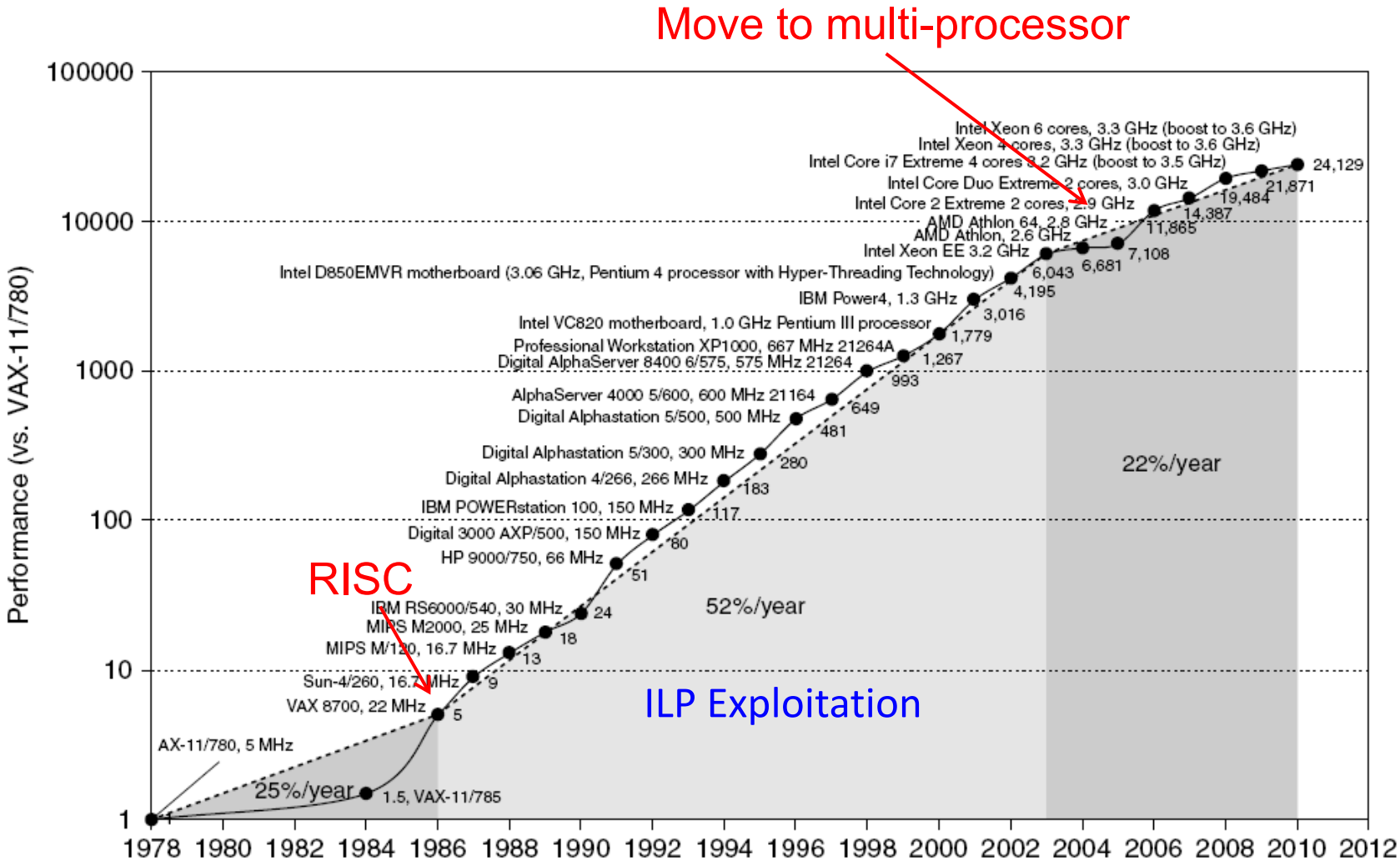


Why to Study Digital Design?





Single Processor Performance



Putting it all in Perspective…

"If the automobile had followed the same development cycle as the computer, a Rolls-Royce would today cost $100, get a million miles per gallon, and explode once a year, killing everyone inside."

– *Robert X. Cringely*

Technical Writer, Broadcaster

http://www.pbs.org/cringely/about/

Triumph of the Nerds

A history of the PC industry,

An ABC program a few years ago

LOGIC

What is logic?

- Logic is the study of valid reasoning.
- That is, logic tries to establish criteria to decide whether some piece of reasoning is valid or invalid.

Valid Reasoning

- While in every piece of reasoning certain statements are *claimed to* follow from others, this may in fact not be the case.
- Example: "If I win the lottery, then I'm happy. However, I did not win the lottery. Therefore, I am not happy."
- A piece of reasoning is *valid* if the statements that are claimed to follow from previous ones do *indeed* follow from those. Otherwise, the reasoning is said to be *invalid*.

Logic

- Crucial for mathematical reasoning
- Used for designing electronic circuitry

- Logic is a system based on propositions.
- A proposition is a statement that is either true or false (not both).
- We say that the truth value of a proposition is either true (T) or false (F).

- Corresponds to 1 and 0 in digital circuits

The Statement/Proposition Game

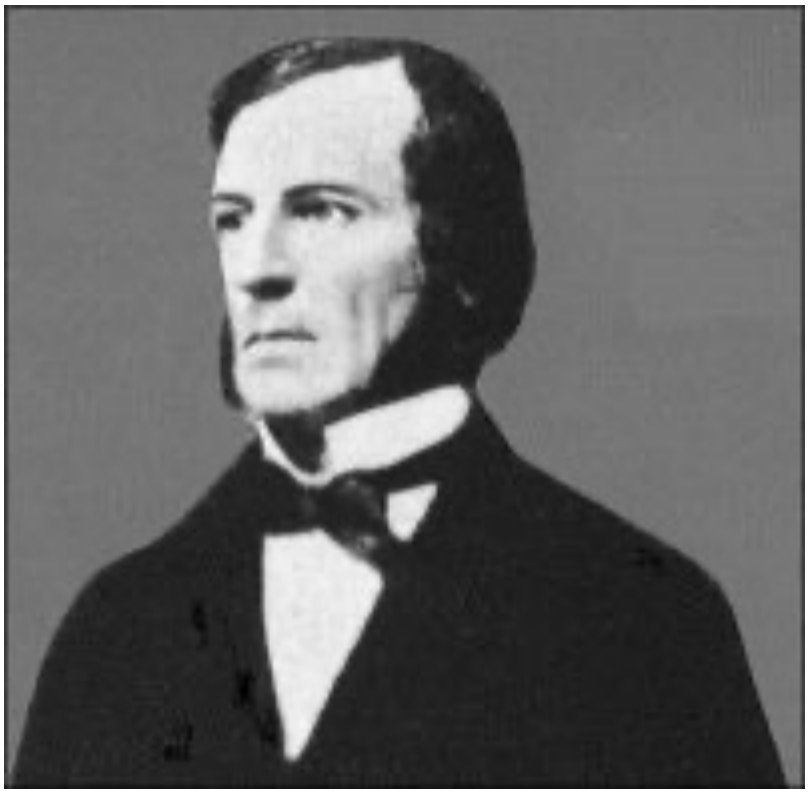
- "Elephants are bigger than mice."

Is this a statement? yes

Is this a proposition? yes

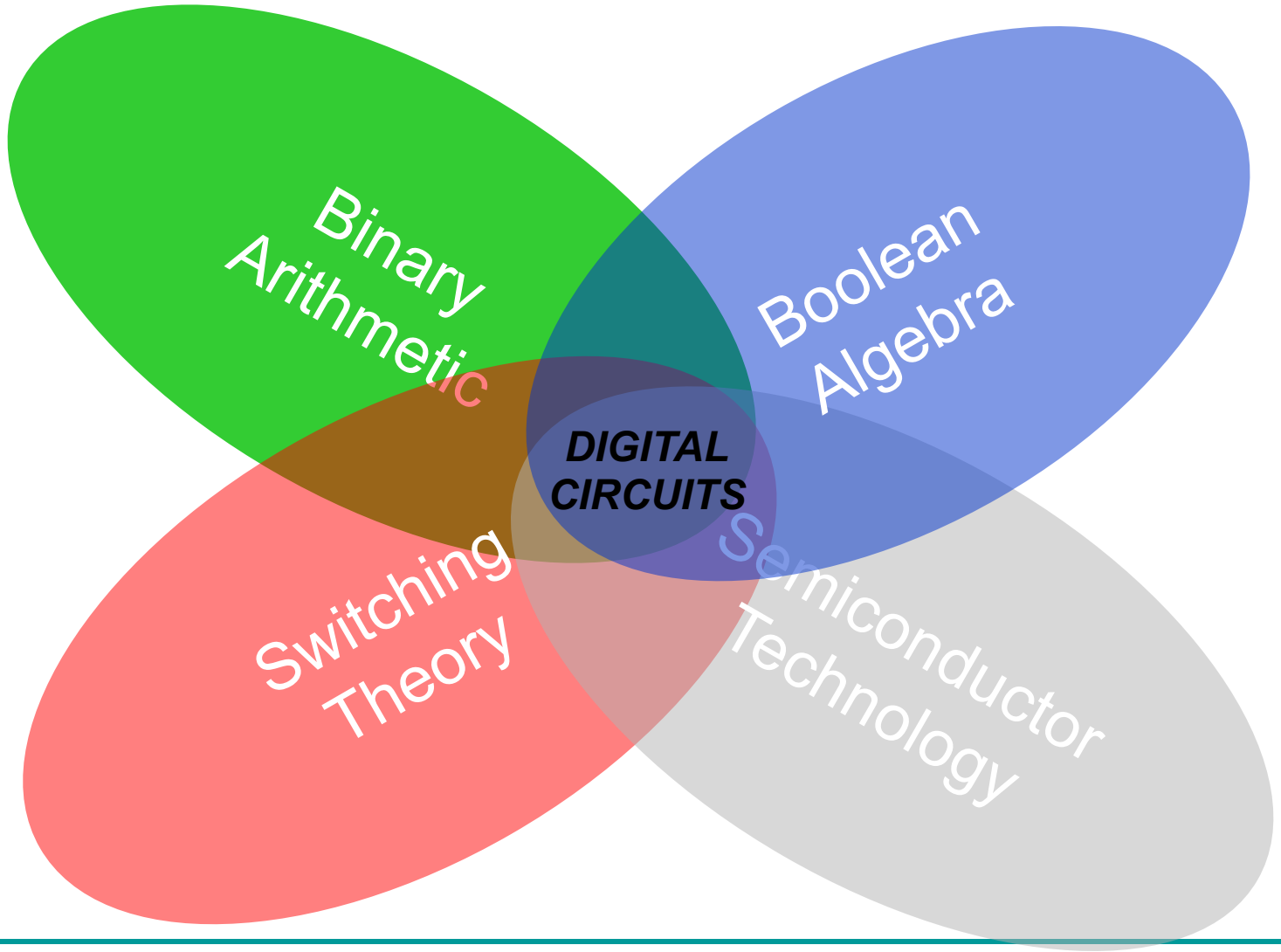
What is the truth value of the proposition? true

George Boole, 1815-1864



- Born, Lincoln, England
- Professor of Math., Queen's College, Cork, Ireland
- Book, *The Laws of Thought*, 1853

Digital Systems



Course Contents

- Logic design process
- Boolean Algebra
- Logic representation
- Combinational circuits
- Circuit optimization
- Arithmetic circuits
- Verification and testing
- Sequential synchronous circuits
- Finite state machine optimization and verification
- Computing system design
- Asynchronous circuits [if time permits]

Course Schedule

Class Hours: Slot 3

- Monday: 10:35 am to 11:30 am
- Tuesday: 11:35 am to 12:30 pm
- Thursday: 8:30 am to 9:30 am

Office Hours: TBD

Course Evaluation

- Mid Term Exam (15%)
  - Open Book/Notes Exam
- Final Exam (35%) – may be broken in two parts
  - Open Book/Notes Exam
- Assignments (10%)
  - Set of assignments will be given periodically
- Continuous Evaluations (25%) – weekly quiz (on Tuesday)
  - Weekly Quiz – Open Book
- Project (15%) – Group of 4

- [Bonus] Surprise Quizzes (5%)
- [Bonus] Class Notes (5%)
- [Bonus] Project (10%)

Grades

Absolute Grade

- > 90: AA
- 81 – 90: AB
- 71 – 80: BB
- 61 – 70: BC
- 51 – 60: CC
- 45 – 50: CD
- 40 – 44: DD
- < 40 : FR

Books

- Switching and Finite Automata Theory
  - Kohavi and Jha
- Digital Design
  - John F Wakerley
- Digital Design
  - Moris Mano

Thank You