DIGITAL DESIGN IN CONTEMPORARY COMPUTER ENGINEERING CURRICULUM

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OUTLINE

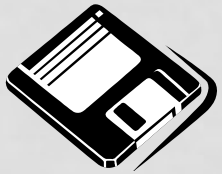
- Introduction. Computer Engineering
- Dilemmas in Digital Design course
- Taxonomy of Digital Design
- Cyber-physical systems design
- Conclusions

WHAT COMPUTER ENGINEERS DO?

Apply
computing, mathematics and engineering theories and principles to the
design of
computer hardware, software, networks and computerized equipment
to solve technical problems
in diverse application domains.

COMPUTER ENGINEERING

- **All** about designing and building computers
  - Silicon chip design
  - Combining chips into systems
  - Combining systems into networks
  - Helping systems recover from failure
  - Software design to help computers run faster and more efficiently
  - Design Automation (CAD)



IEEE COMPUTER SOCIETY

IEEE/ACM TRANSACTIONS ON COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

IEEE TRANSACTIONS ON COMPUTERS

IEEE TRANSACTIONS ON DEPENDABLE AND SECURE COMPUTING

IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING

IEEE TRANSACTIONS ON MOBILE COMPUTING

IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS

IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE

IEEE TRANSACTIONS ON SOFTWARE ENGINEERING

IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS

IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS

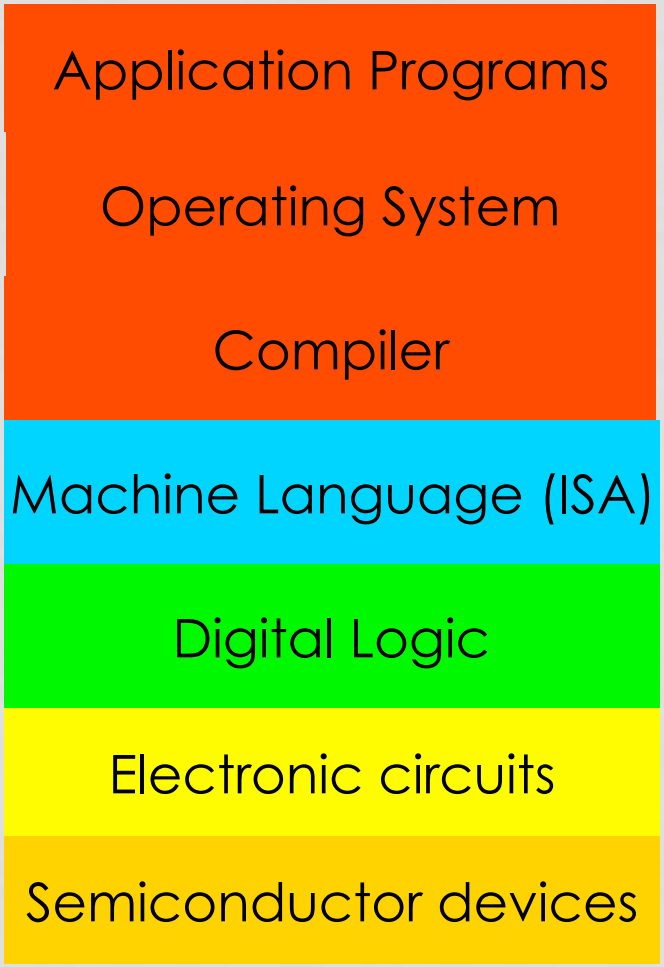
IEEE TRANSACTIONS ON MULTIMEDIA

IEEE/ACM *Transactions on* Networking

WHY IS ABSTRACTION IMPORTANT?

Complex interfaces implemented by layers below

- Abstraction hides detail
- Hundreds of engineers build one product
- Shorter development times
- Complexity unmanageable otherwise



COMPUTER ENGINEERING

- Exercise in engineering tradeoff analysis
  - Find the fastest/cheapest/power-efficient/etc. solution
  - Optimization problem with 1000s of variables
- All the variables are changing continuously
  - At non-uniform rates
  - Only one guarantee: Today's right answer will be wrong tomorrow!

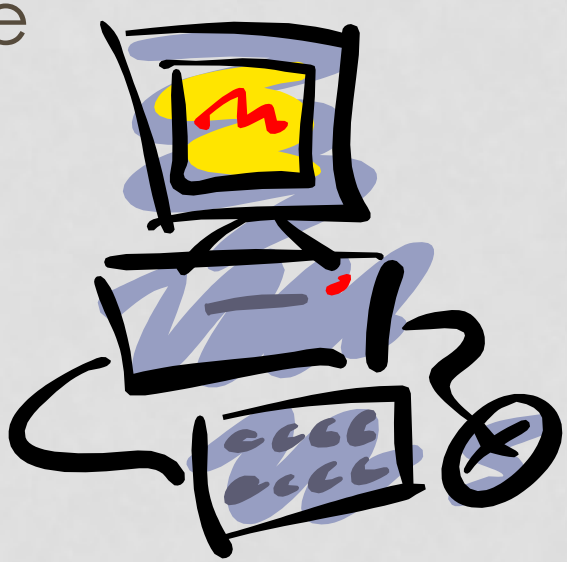
BOTTOM LINE

Designers must know BOTH software and hardware

- Their contribution to the layers of abstraction
- IC costs / performance aspects
- Compilers and Operating Systems
- Design Tools and new Design Methods

RECOMMENDED SKILLS

- Basic understanding of circuits
- Knowledge of how a computer works
- Solid basis in mathematics/algorithms
- Programming knowledge
- Patience/perseverance
- Enthusiasm for the topic



DIGITAL DESIGN IN COMPUTER ENGINEERING CURRICULUM

- Crisis
- Ways of overcoming:
  - Giving up
  - Challenge
  - Patience, believe for the future

CRITICAL DILEMMAS OF THE DIGITAL DESIGN COURSE

- Values vs. Pragmatics
- Science vs. Engineering
- Academy vs. Industry
- Theory vs. Practice
- Digital vs. Analog
- Controller vs. Dataflow

TAXONOMY OF DIGITAL DESIGN

- Root studies
  - Functional classification. Post theorem
  - NPN classification
  - Spectral transform
  - BDD complexity theorem
- Body studies
  - Functional Decomposition
  - Spectral decomposition
  - Threshold logic
- Branch and Leaves
  - FSM decomposition
  - ASM combining
  - Nano PLA

DESIGN OF CYBER-PHYSICAL SYSTEMS AS LEARNING ACTIVITY

- Arduino
- Raspberry Pi
- Intel Galileo

PROPERTIES OF CPD DESIGN AS LEARNING ACTIVITY

- Science-Technology Hybridity
- Analog-Digital Hybridity
- Connectivity
- Context awareness
- Social awareness

CONCLUSIONS

- The Digital Design course is in the prolonged crisis
- Roots of the crisis are multi-dimensional: from social to technological
- The taxonomy of the subject comprising three sources is proposed
- Emergence of cyber-physical systems is a promising phenomenon for the future of Digital Design