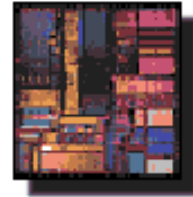# Digital Systems Design Automation

Unit 1: Course Introduction and Overview
Lecture 1.2: Design Complexity and Need for EDA

Anand Raghunathan
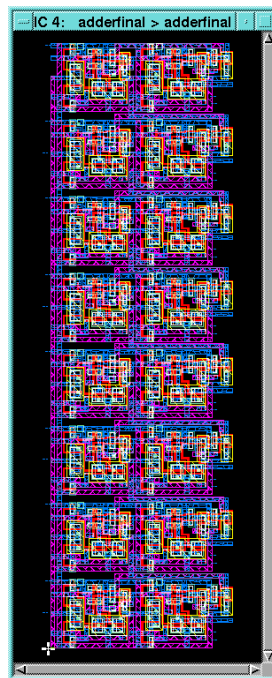
raghunathan@purdue.edu

Outline

1.1 Moore's Law

1.2 Design Complexity and need for EDA

1.3 Course Overview

1.4 Taxonomy of integrated circuits

1.5 Levels of abstraction in IC design

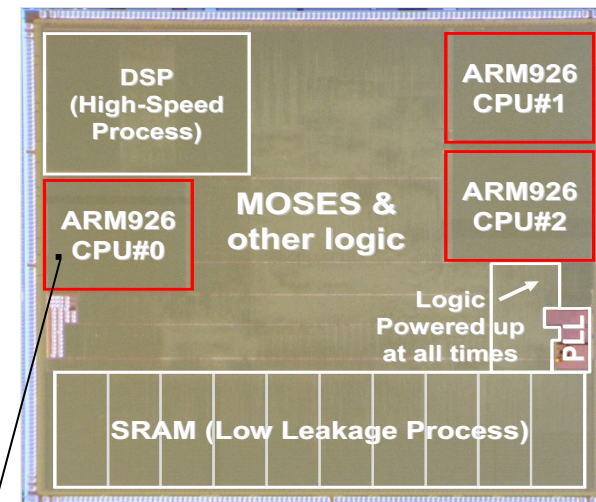1.6 A quick tour of logic level design automation

The Tyranny of Scale

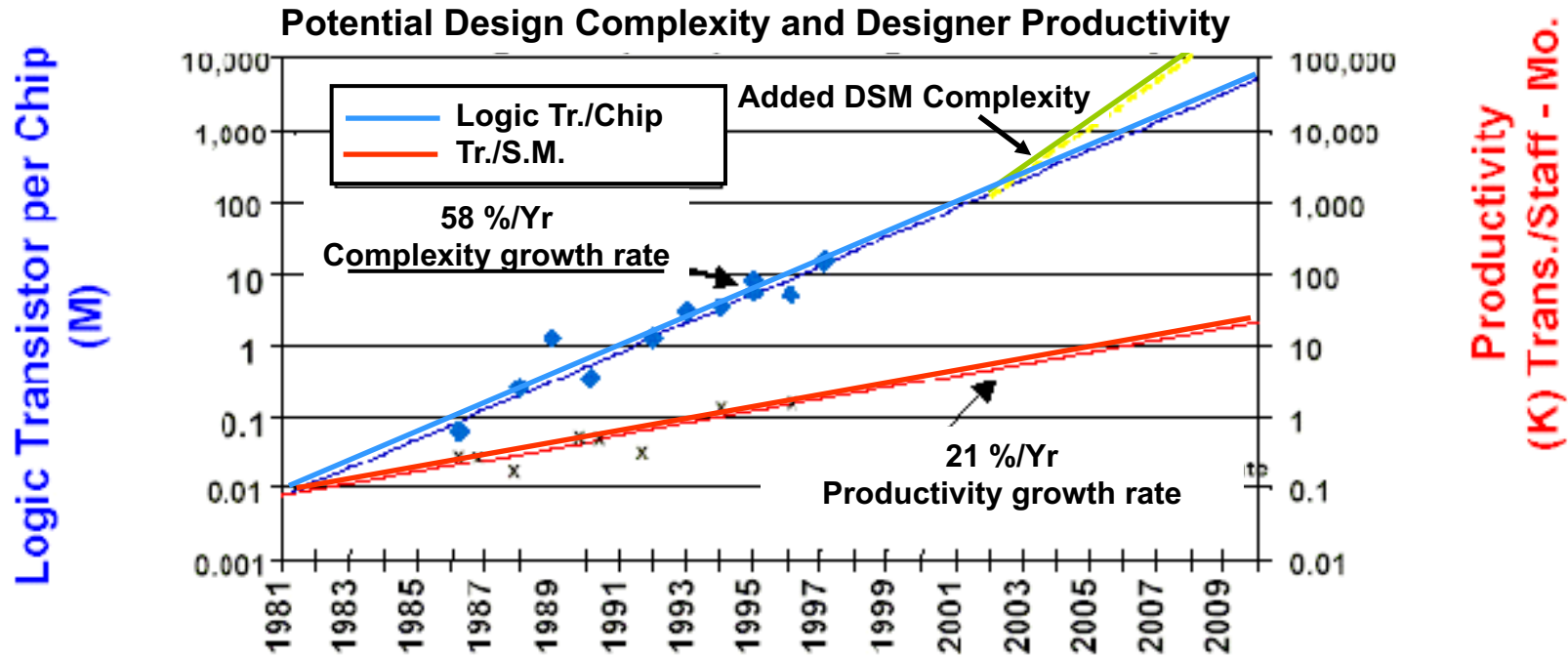- Manual design is not feasible for all but the simplest of ICs!

16-bit ALU (VLSI Design Class Project)

NEC's MP211 processor for mobile phones
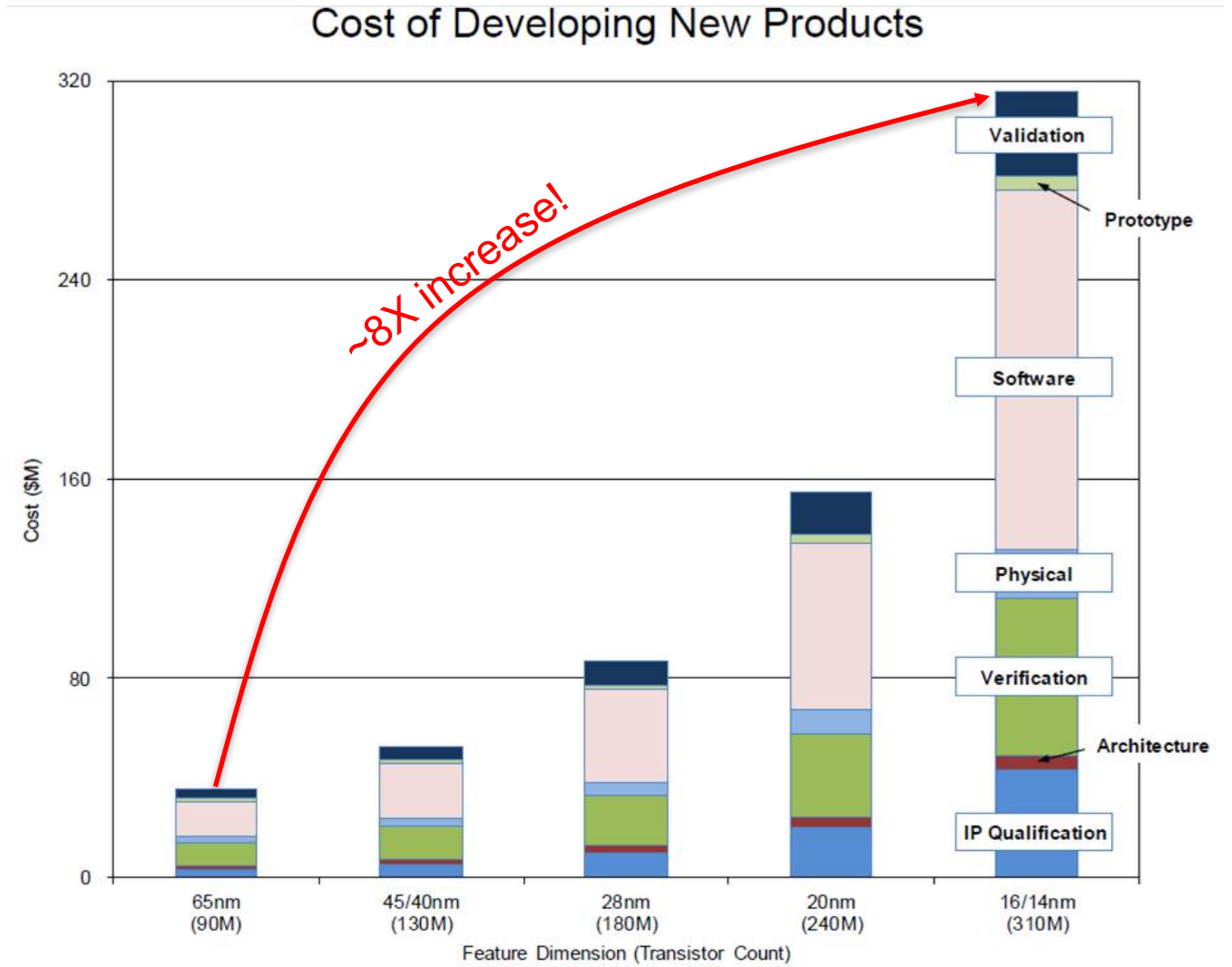

32-bit ALU

Design Productivity Gap

Potential Design Complexity and Designer Productivity

Year	Technology	Chip Complexity	Frequency	3 Yr. Design cycle Staff	Staff Cost*
1997	250 nm	13 M Tr.	400 MHz	210	90 M
1998	250 nm	20 M Tr.	500	270	120 M
1999	180 nm	32 M Tr.	600	360	160 M
2002	130 nm	130 M Tr.	800	800	360 M

*** @ $ 150 k / Staff Yr. (In 1997 Dollars)**

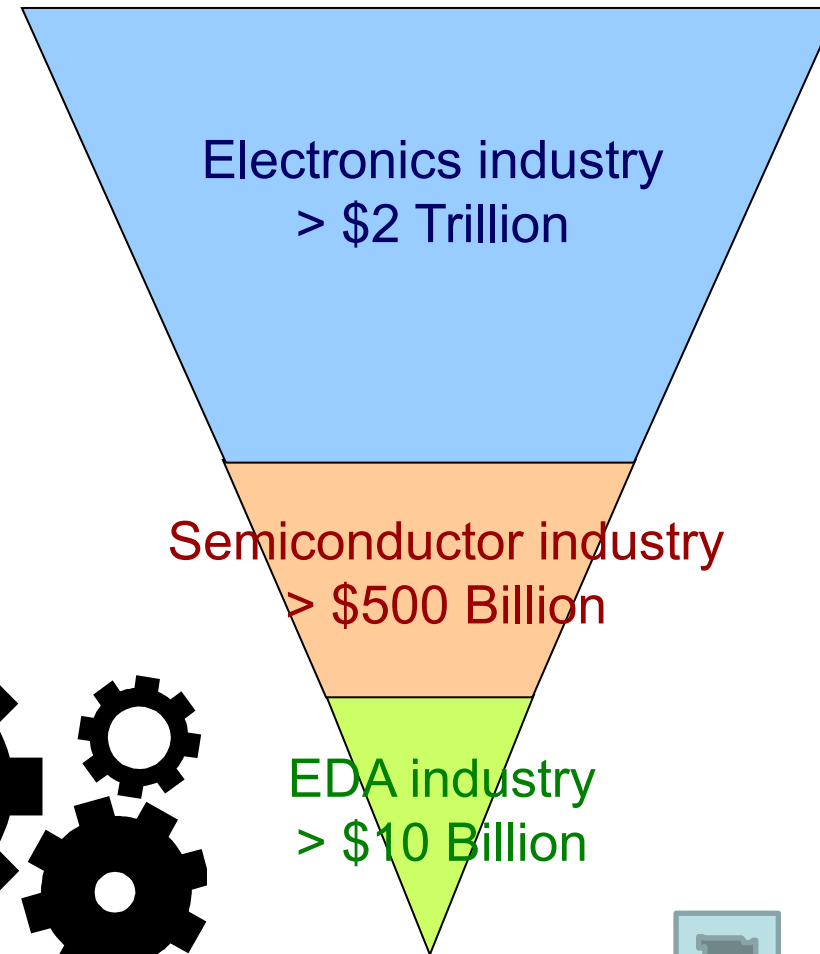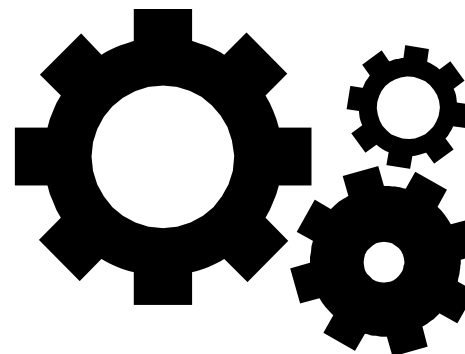**Source: SEMATECH**

IC Design Cost

Electronic Design Automation (EDA)

- Automation (software tools) used to design Integrated Circuits (ICs)
- Today, virtually all ICs are designed using design automation tools
  - Microprocessors, graphics processors, networking processors, smartphone application processors and modems, automotive electronics, …

IC Design
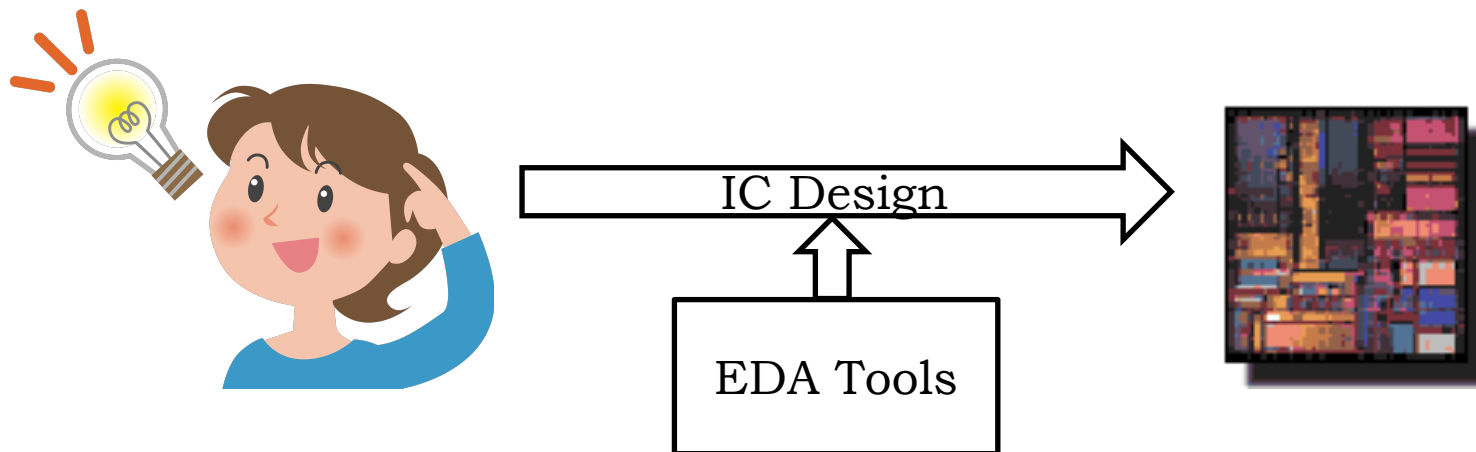
EDA Tools

EDA: Where Electronics Begins

- Why is it important?
  - Enabler to the semiconductor and electronics industries
- Why is it interesting?
  - Full of challenging computational problems

Electronics industry
> $2 Trillion

Semiconductor industry
> $500 Billion

EDA industry
> $10 Billion

Sources: EDA Consortium, Gartner, JEITA Worldwide Electronics and IT Trends Report

EDA as a driver of computing

- Input sizes to EDA tools grow with chip complexity
- EDA is often a driver of algorithmic advances that are used in other application domains
  - Satisfiability solvers, Symbolic model checkers, Graph partitioning, etc.

```
loop{
    design_next_gen_ICs(using_today's_computers);
} forever;
```

Recurring Themes in EDA

- **Dealing with increasing circuit complexity**
  - Many problems in EDA are NP-Hard
  - Even efficient heuristics are $O(N^2)$ or $O(N * \log N)$
  - Effective speed of computers is increasing much slower than $O(N)$
- **Improving quality of implementation**
  - Correctness, performance, power consumption, area, reliability, …
- **New challenges introduced by manufacturing process or market trends**
  - Nanoscale effects, decreasing market cycles

More scalable algorithms ← → Better quality of implementation

New challenges
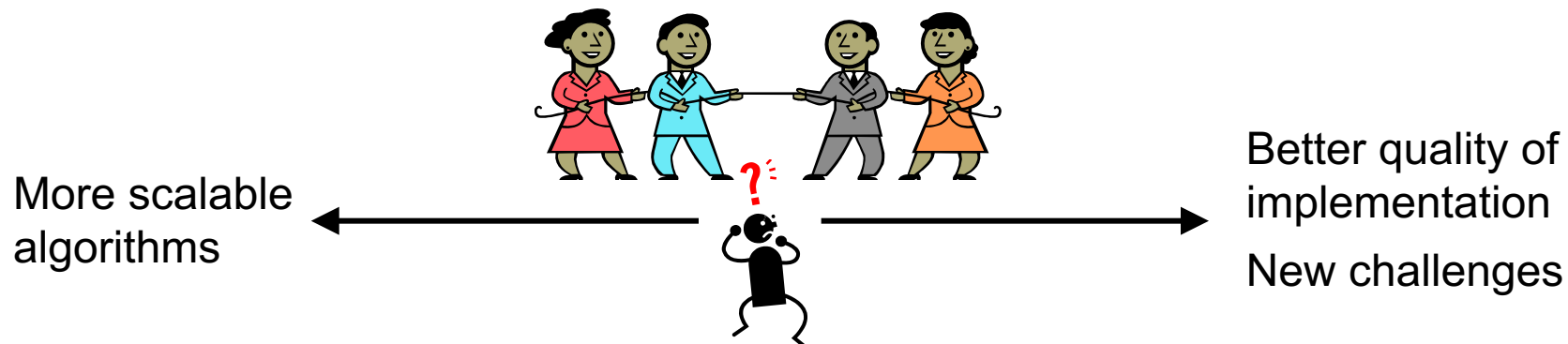
EDA and You

- If you plan to be an IC designer
  - You <u>will</u> use EDA tools
  - EDA tools will profoundly impact the nature of your job

or

or

  - Better understanding of how tools work
    - Designers need this to become "power users"
    - Necessary background for research / work in EDA
- Others
  - EDA can teach us how to deal with computationally challenging problems