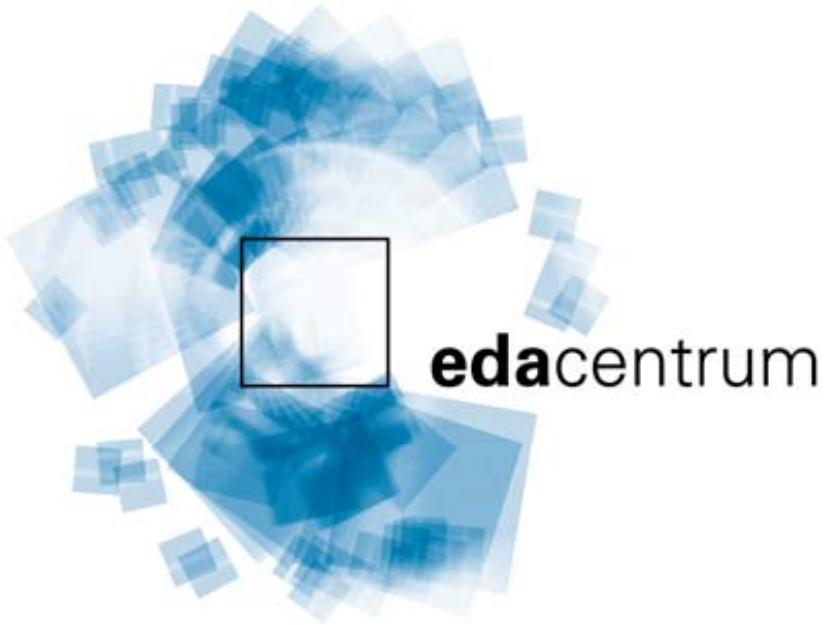


electronic design automation centrum

Design Bridges the Gap between Devices and Applications

Wolfgang Rosenstiel
edacentrum and University of Tübingen

electronic design automation centrum

Design flow today for electronic circuits

› **Every circuit being designed today …**

- … starts with a computational model at a high level of abstraction,
- … then goes through a sequence of synthesis and optimization transformations,
- …followed by rigorous digital simulation and prototyping,
- … as well as formal and semi-formal verification,
- … before it is finally manufactured via advanced lithographical and chemical processes.

Source NSF Workshop 2009

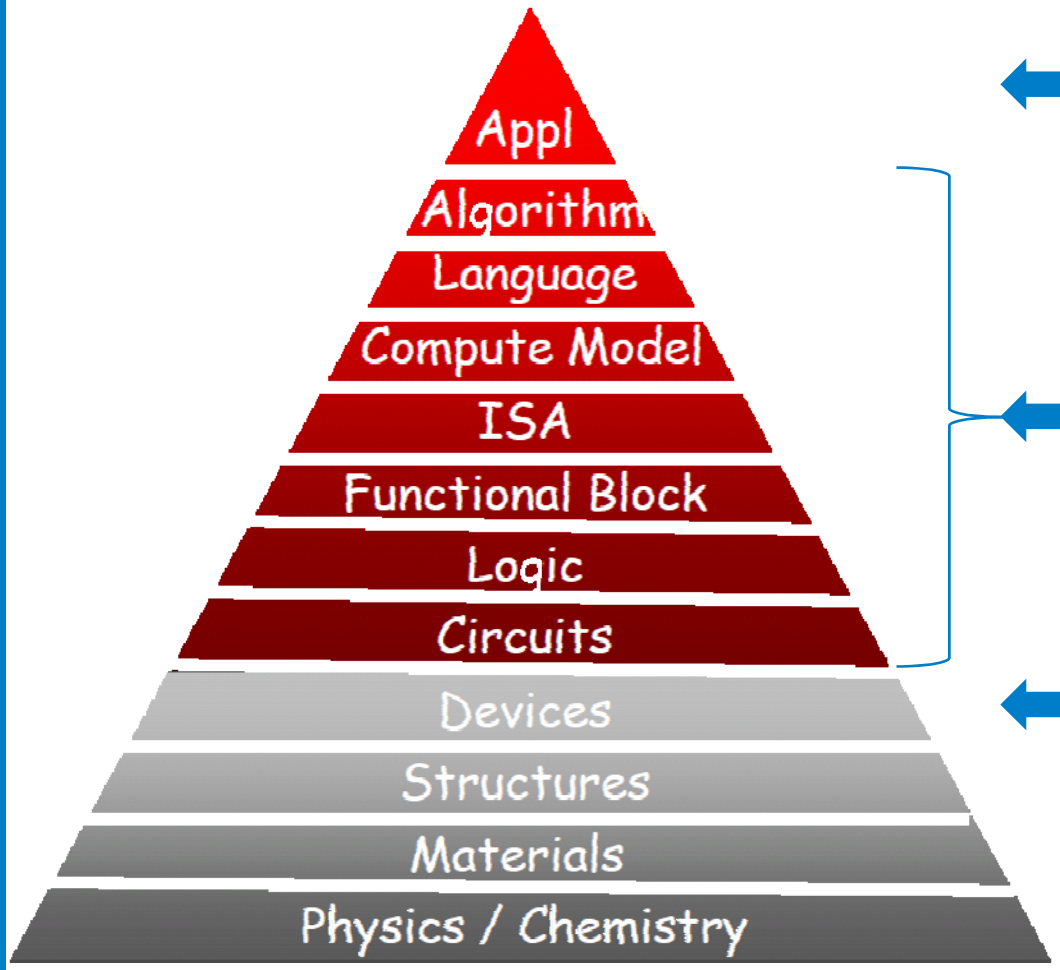
Design drives inter-disciplinary collaboration

› **The EDA field is one of the earliest to engage in inter-disciplinary collaboration between …**

- … computer scientists and engineers in EDA who successfully collaborate with the electrical engineers to derive various levels of circuit models;
- …physicists and chemists to derive manufacturing models;
- … theoretical computer scientists to conduct various kinds of complexity analysis;
- … applied mathematics and optimization experts to improvise highly scalable simulation and synthesis algorithms;
- … with application domain specialists to develop intellectual property (IP) libraries, etc.

Source NSF Workshop 2009

The Food Pyramid

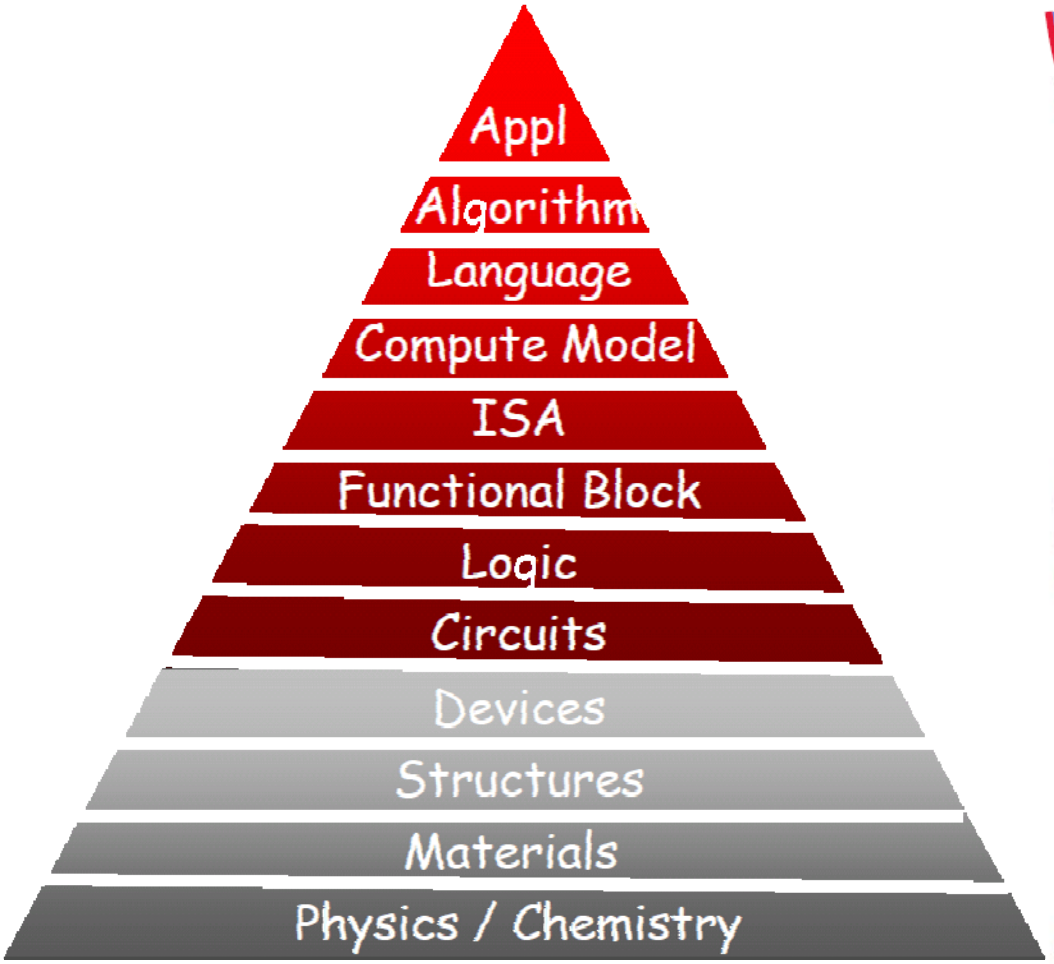


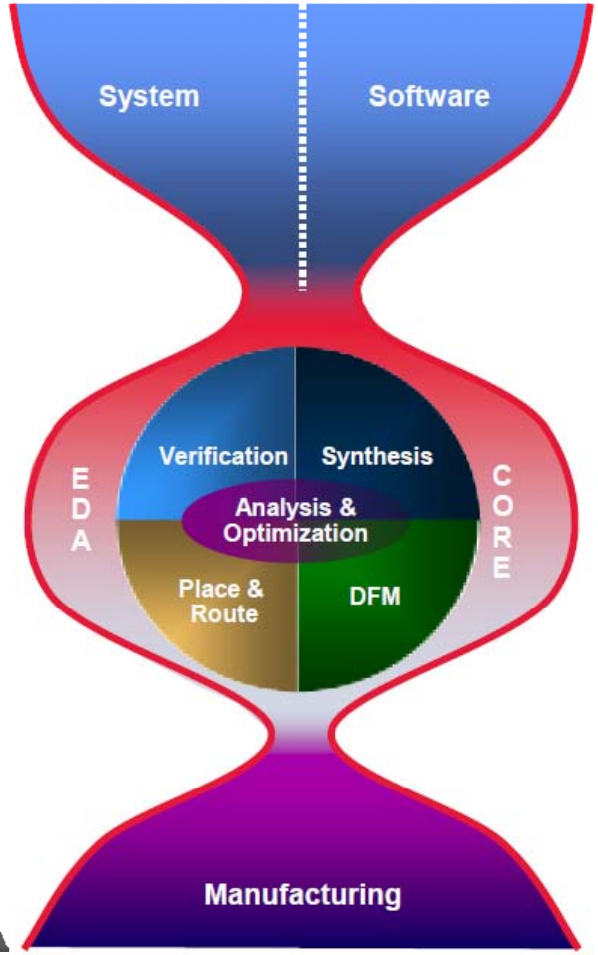
Here needs are born that demand for a solution.

Here Design has to bridge the gap.

Here the Beyond CMOS comes out

A lot of work is done to bridge the gap …



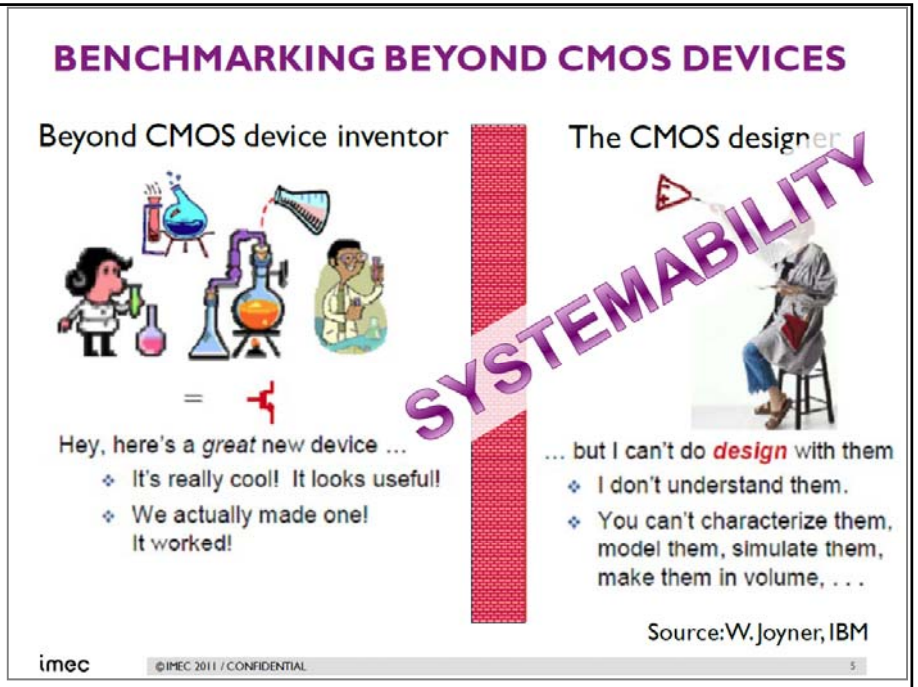


… but most of Design today focuses on the “Middle”

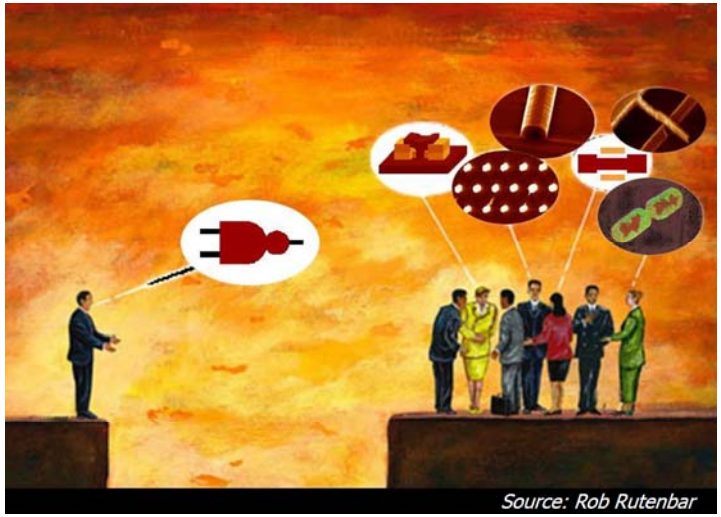
The Gap on the bottom is known!

It is between device and system.

SYSTEMABILITY:
The ability to economically design and manufacture reliable systems from the interaction of devices fabricated in a given technology.



Source : D. Verkest, NANO-TEC-WS2, 2011



A Bridge to the system is needed

SYSTEM = COMPUTATION, STORAGE, INTERCONNECT, I/O, (ANALOG)

Every contender

- Must add value to one or more of the 4 system functions and be compatible with the others
- All-in throughput/Watt and/or transactions/Joule must beat CMOS at time of manufacturing at equivalent or lower cost
- System level manufacturability, reliability, testability must beat ultimate CMOS solutions
- Room temperature operation is mandatory
- Device variability must be mitigated and modeled and cost efficient error resilient design solutions must be available
- Design methods and tools must be in place supporting design from device to system. Design tool development time is 3x technology development time.

Source :
D. Verkest,
NANO-TEC-WS2, 2011

Three Grand Challenges in Design

A powerful new, physically aware, System-level design science and methodologies at the top to increase the productivity of designers, otherwise efficient use cannot be made of advanced devices and materials

Robust optimization methodologies in the middle to provide guaranteed performance of integrated systems composed of devices whose characteristics are highly variable, that operate in several different physical domains, and that have uncertain reliability.

A revamped, systematic, and greatly improved interface to manufacturing (Design for manufacturing) at the back end (and throughout the flow) to support the design of high-yield systems that obtain maximum utilization of a technology and to assure that we can produce products using new technologies.

Models and abstractions are key at all levels of the design process

Source NSF Workshop 2009

To come to the last three “Key Questions”

3.) Will design challenges be different for different applications?

- Definitely YES, for explanation see next slides

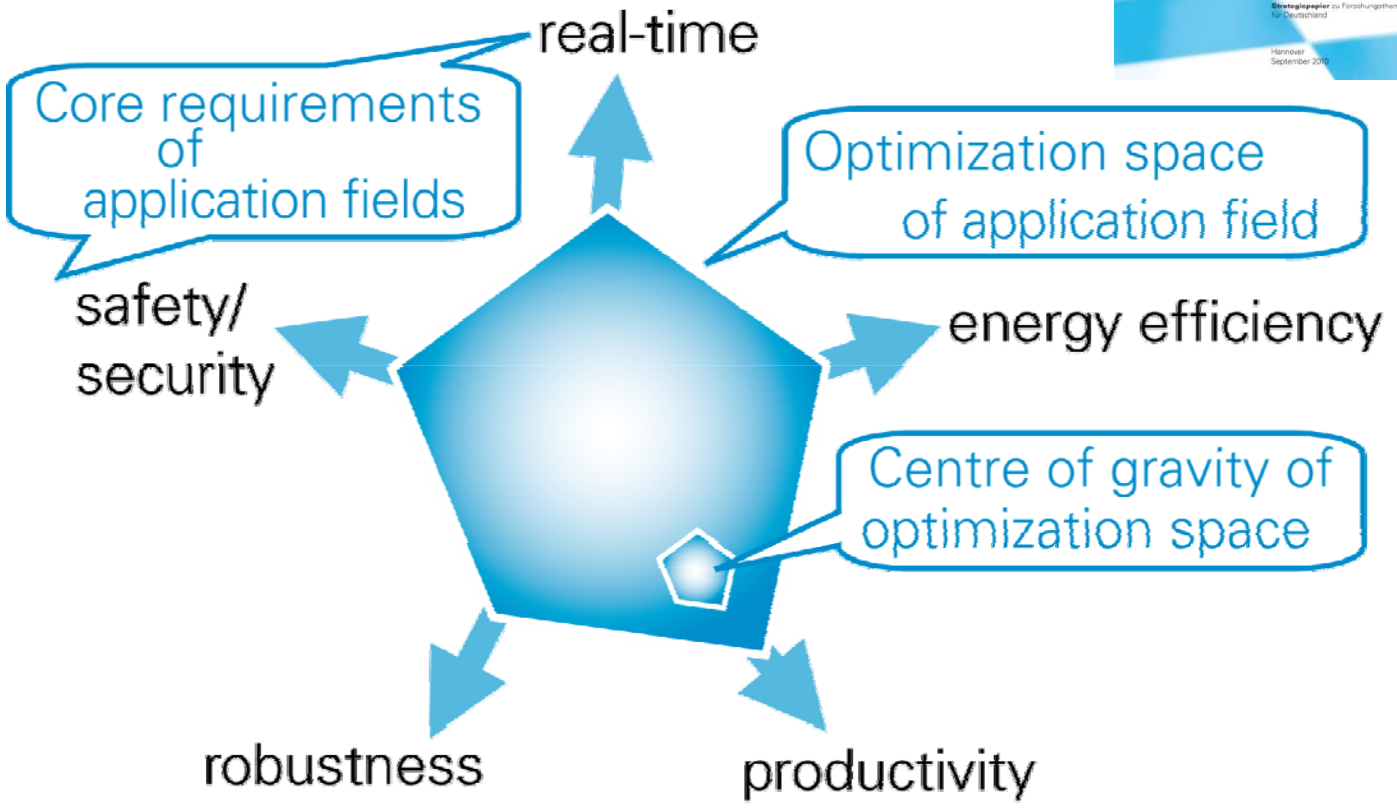
4.) Can design tools be the discriminating factor for the success of one specific technology?

- Definitely YES, no success of any (Beyond CMOS) technology without design tools

5.) Present design tools are a huge legacy: what can trigger the investment needed for new tools?

- The need for a new technology (i.e. when CMOS reaches barriers) will trigger the need for appropriate new tools and methods. Design methodology and tools for a specific Technology will pave its way to success.

Specific Requirements for future Applications



Specific Requirements for future Applications