Electronics Inside Everything

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Welcome!
You are entering
Electronics or better MICROELECTRONICS wonderland
Semiconductor industry is ...
--- an industry built in sand

Sand ....  << $1/Kg.
Polysilicon ..... $50/Kg.
200mm Prime Wafer ..... $1,400/Kg.
200mm Processed Wafer .... $25000/Kg. >10^6 !!
Packaged Integrated Circuit .... $500,000/Kg.
with a Street Value of more than $1,000,000/Kg.
The beginning of an adventure!

Face challenges with courage

And pursue the victory

Manage complexity
You certainly know what electronics is
You certainly know what electronics is
But, ... Do you know what is inside?

No? ... Well, don’t be afraid!
Let’s go inside …
From simple to complex
All this was made possible by…

A fast evolution
Archeology of Microelectronics

A BIT OF HISTORY

Electronics is a young discipline. It was initiated in 1904 when, after some related inventions, J. A. Fleming conceived the first electronic device: the vacuum tube diode.

Two years later L. Deforest added a third terminal, the grid, and invented the vacuum tube triode.
Archeology of Microelectronics

Focus of electronic designers was on being able to connect few active devices (the vacuum tubes) with a large number of passive components (resistors, capacitors and inductors) to build up a circuit, a situation almost unchanged even when Shockley, Bardeen and Brattain invented the transistor in 1947.
In 1958 Jack Kilby, newly employed, had been set to work on a project to build smaller electrical circuits. Because he was newly employed, that summer Kilby had no vacation like the rest of the staff. Working alone in the lab, he saw an opportunity to find a solution of his own to the miniaturization problem: the integrated circuit.
In January of 1959, Robert Noyce, at the small Fairchild Semiconductor startup company, also realized a whole circuit could be made on a single chip. Noyce thought of the best way to connect the parts.
Evolution of Microelectronics

Nowadays many integrated circuits are made only of transistors with total count that approximately doubled every two years. Some digital circuits contain billions of elementary components, each of them extremely small.
The grow trend followed the so called Moore Law, which predicts an almost exponential increase in time of the capabilities of many digital electronic devices: processing speed, memory capacity, sensors and even the number and size of pixels in digital cameras.

**Moore's Law**

"The number of transistors on a piece of silicon would double every couple of years"
Array of Microprocessors, 2010
1.4 billion of transistors

Test Chip 22 nm
2.9 billion of transistors
Now, More Moore and More than Moore
Microelectronics is responsible of big changes:

- New social paradigm
- New labor paradigm
- New education paradigm
- New research paradigm
Labor Paradigm
What can happen …

Microelectronics era
Unemployment

Temporary or structural?
How to generate new jobs?

With resources generated by technology
Educational Paradigm
What is changing?

Technology impatience

The video-game generation wants to see immediate results

BUILD KNOWLEDGE WITH SOLID BASIS, BUT...
A new approach is necessary.
In short, it is necessary to favor

**Using the brain**

and not hands!
Build the knowledge

... beginning from the roof
Albert Einstein noted perceptively,

It is in fact nothing short of a miracle that modern methods of instruction have not yet strangled the holy curiosity of inquiry. It is a very grave mistake to think that enjoyment of seeing and searching can be promoted by means of coercion and a sense of duty.
Summing up

- This is the beginning of a process or, better, an adventure that will enable you to learn about electronics. After a preparation phase, you to meet electronic systems, and down until examining blocks made by transistors and interconnections.

- Electronic systems are *user friendly* but the design and deep understanding of modern electronic systems is **very difficult**.

- Everybody assumes that using electronics is not difficult: electronic devices are (and must be) user friendly. Moreover, many presume useless knowing what is inside the device, ...  

- The difficult task we are facing is transforming a user of friendly electronics or microelectronics into an expert of microelectronics.

- It is essential to be aware that fundamentals are important (or, better, vital). It is well known that a solid foundation is better than sand: a castle built on sand, without foundation, will certainly collapse.
The Learning Process

There are five different features:

- **Learning** as memorizing, storing simple information that can be reproduced without significant changes.

- **Learning** as a quantitative increase in knowledge, just collecting information. In this case the information is stored as rough notions.

- **Learning** as acquiring skills and methods that can be retained as background knowledge and used when necessary.

- **Learning** as making sense or abstracting meaning. Learning involves relating parts of the subject matter to each other and to the real world.

- **Learning** as interpreting and understanding facts in a different way, which involves comprehending the world by reinterpreting knowledge.
Why Examples and Computer simulations are Important?

The expected benefits are:

- **Beat incredulity**: very often the results of a theoretical description made with doubtful approximated assumptions are unconvincing. The outcome seems too simple, not general enough or maybe simply unbelievable.

- **Understand limits of approximation**: the simple models used for hand calculations are often too approximate and can generate misleading results. Nevertheless, simple equations and simplified rules are keys for directing the designer's activity.

- **Reinforce knowledge**: this is a general beneficial effect of using examples and computer simulations. For electronics, since often knowledge is not codified by reliable equations or reasonable rules, using examples and computer verifications is particularly helpful.

- **Learn rules of thumb**: the use of rules of thumb is very common in expert designers' activity; with examples and simulations it is possible to accumulate knowledge that is codified in a set of rules of thumb.