

Challenges and Opportunities for Technion and the Israeli Chip Industry

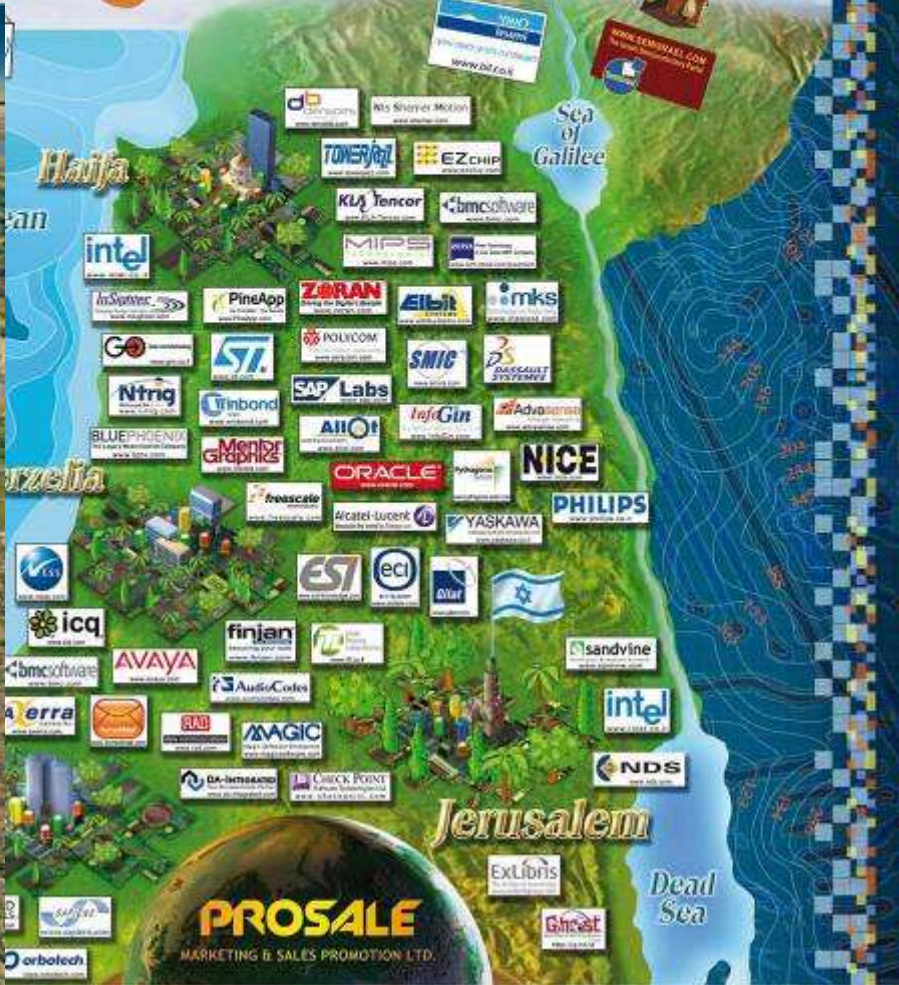
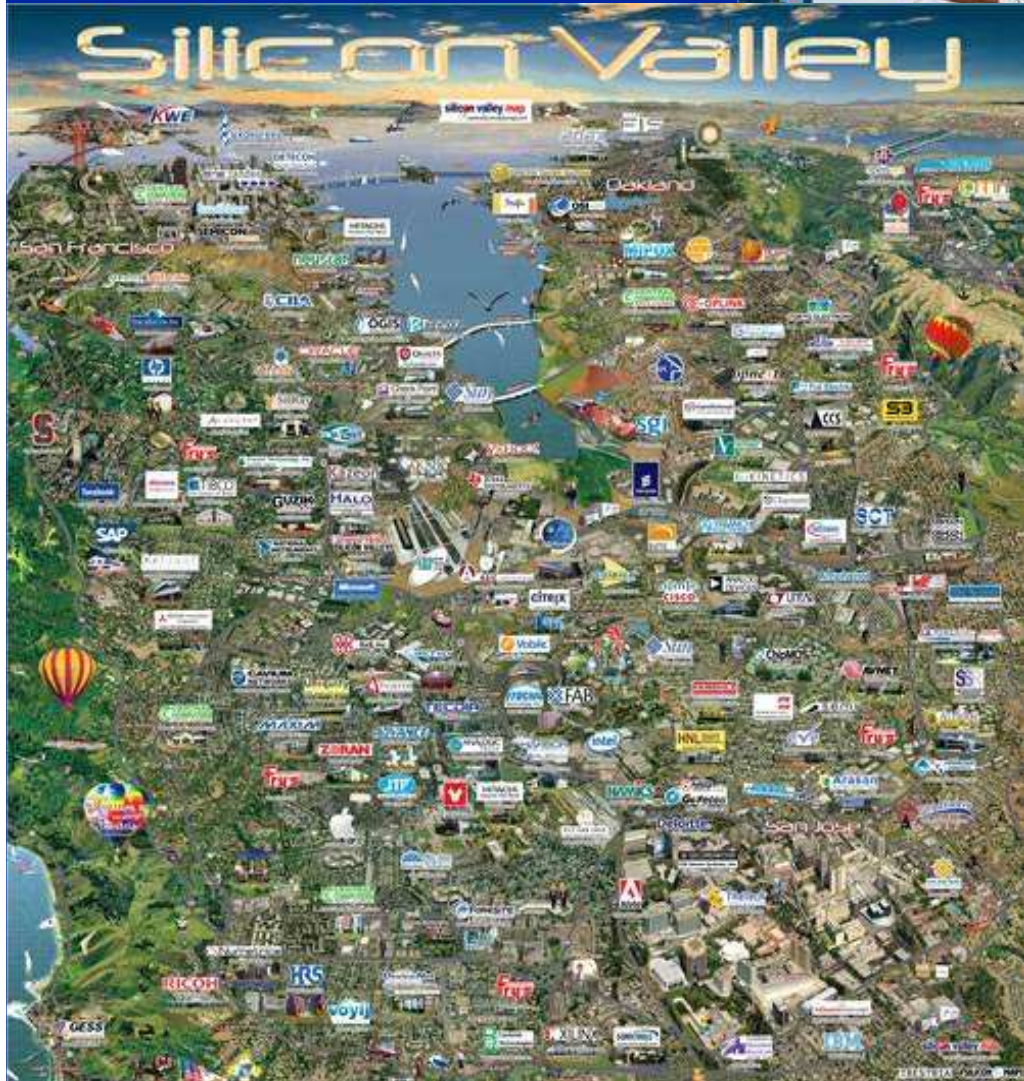
Avinoam Kolodny

EE Department
Technion – Israel Institute of Technology

July 2010



ISRAEL SILICON VALLEY 2010





Evolution of an industry - Personal Viewpoint

- **Between Technion and Intel**

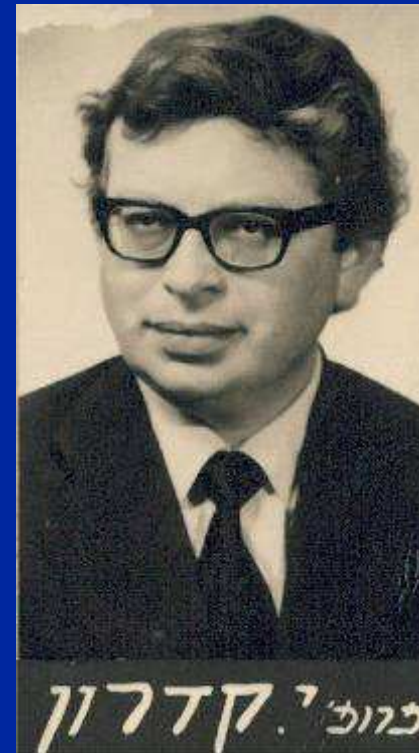


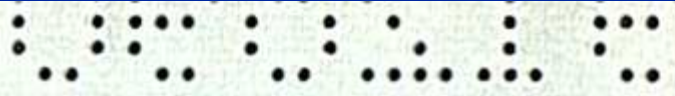
1975: Graduated with EE



First trip to Intel Santa Clara

- Intel Israel acquired a minicomputer
- Needed a software person
- I was still a Technion graduate student...
- ... I asked my advisor...





Visas אשרות

No 040463



THE UNITED STATES
OF AMERICA
VISA
ISSUED AT

TEL AVIV

B-1

24 MAY 1976

CLASSIFICATION

DATE

VALID UNTIL

24 Aug 1976

FOR

THREE

APPLICATIONS FOR

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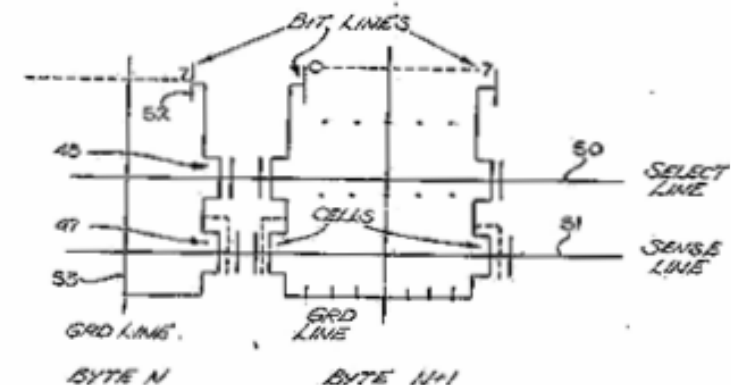
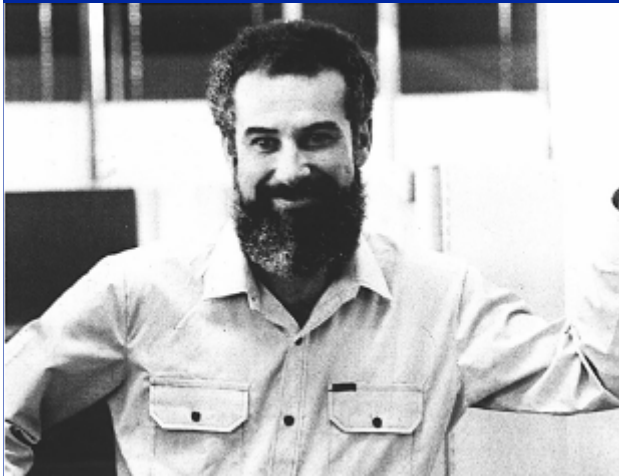
Avivaan KOLODNY

John M. Peters

CONSULAR OFFICER



Post Doc at Intel's Non-Volatile Memory Group



HYBRID E² CELL AND RELATED ARRAY

Inventors: Boaz Eitan, Sunnyvale; Avi Kolodny, Cupertino; Daniel Amrany, Sunnyvale; James McCreary, Los Gatos, all of Calif.

Assignee: Intel Corporation, Santa Clara, Calif.



- 1980's: Intel moved from memories to processors

Design Automation for Processors

TABLE 1. INTEL PROCESSORS, 1971-1993.

PROCESSOR	INTRO DATE	PROCESS	TRANSISTORS	FREQUENCY
4004	1971	10 μm	2,300	108 KHz
8080	1974	6 μm	6,000	2 MHz
8086	1978	3 μm	29,000	10 MHz
80286	1982	1.5 μm	134,000	12 MHz
80386	1985	1 μm	275,000	16 MHz
Intel 486 DX	1989	1 μm	1.2 M	33 MHz
Pentium	1993	0.8 μm	3.1 M	60 MHz

RTL modeling
Timing Analysis
Cell libraries
Logic Synthesis

Coping with the complexity



Intel's CAD History

SUMMER 2010

IEEE SOLID-STATE CIRCUITS MAGAZINE



*Patrick Gelsinger, Desmond Kirkpatrick,
Avinoam Kolodny, and Gadi Singer*

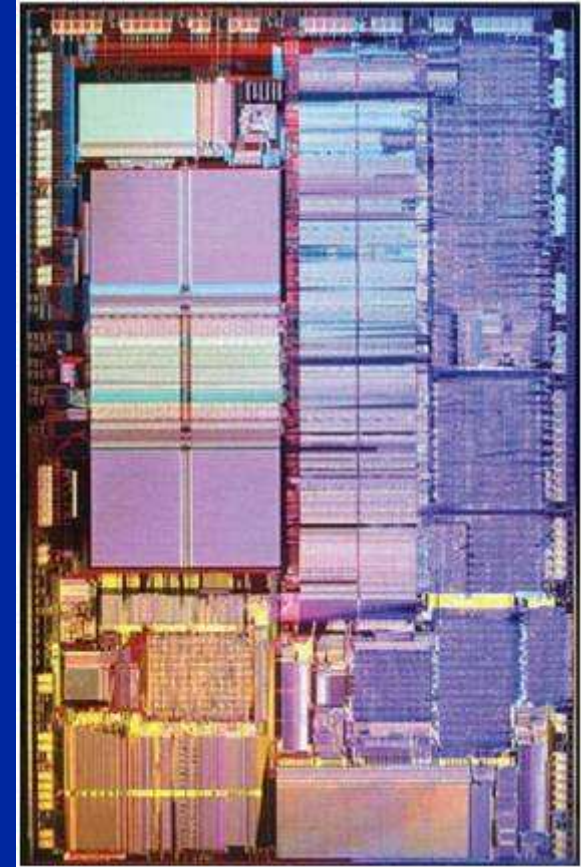
Such a CAD!

*Coping with the complexity of
microprocessor design at intel.*



Synthesis-Based Chip Design

- Logic designers became programmers
- Israel became “Land of chips and software”



The 486 Processor

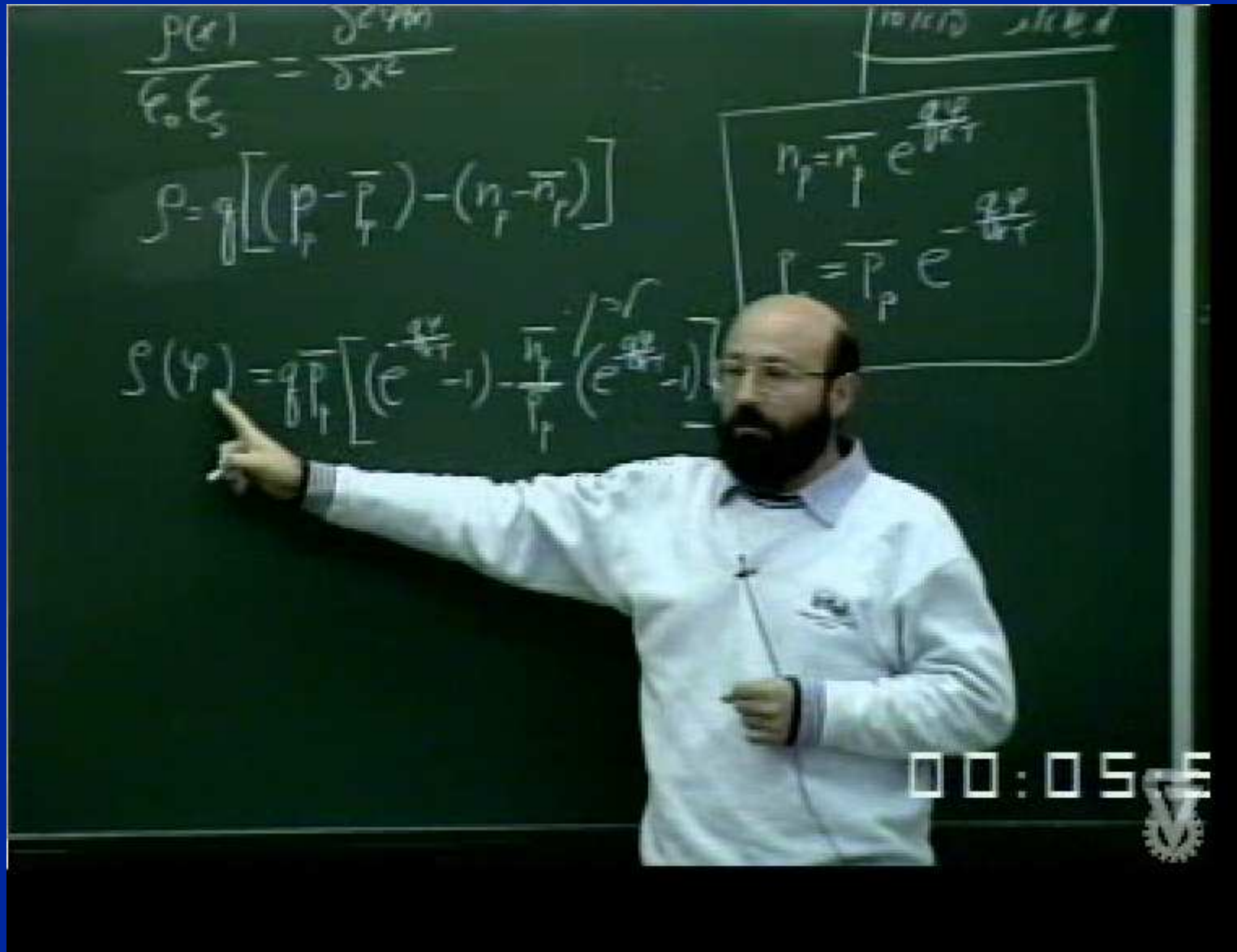


It was all implied by Moore's Law:

- From memories to processors to systems
- Digital revolution: changed the world



Contribution to Education



A lecturer with a beard and glasses, wearing a white jacket, is pointing at a chalkboard. The chalkboard contains several mathematical equations related to the photoelectric effect. The equations are:

$$\frac{p(x)}{E_0 E_s} = \frac{\delta \psi(x)}{\delta x^2}$$
$$J = q \left[(p - \bar{p}) - (n - \bar{n}) \right]$$
$$J(\psi) = q \bar{p} \left[\left(e^{-\frac{q\psi}{kT}} - 1 \right) - \frac{\bar{n}}{\bar{p}} \left(e^{\frac{q\psi}{kT}} - 1 \right) \right]$$

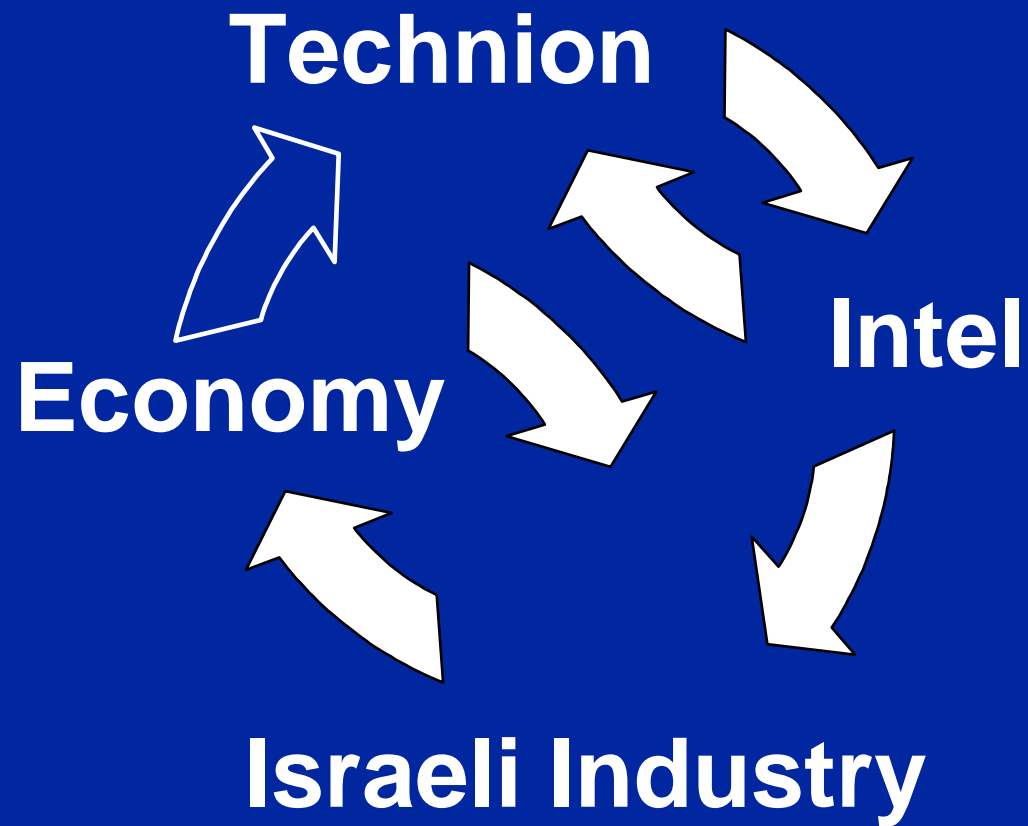
Inside a box on the right side of the board, the following equations are written:

$$n = \bar{n} e^{\frac{q\psi}{kT}}$$
$$p = \bar{p} e^{-\frac{q\psi}{kT}}$$

A digital timer in the bottom right corner of the video frame shows 00:05.5. A small logo is visible in the bottom right corner of the video frame.



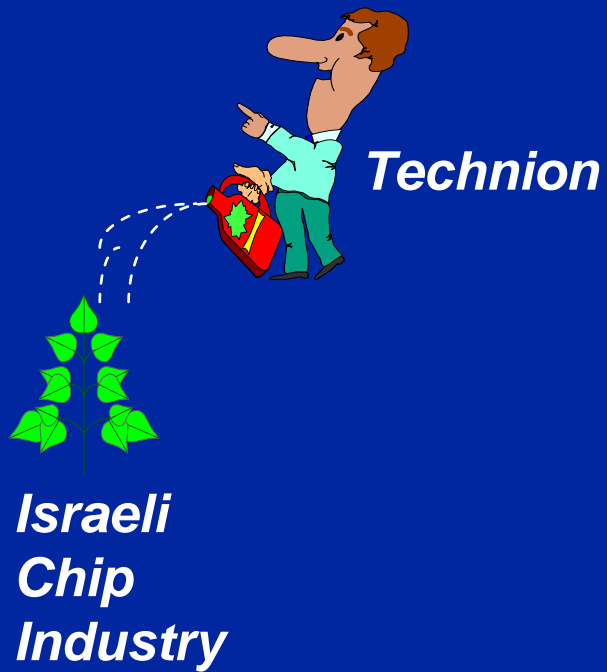
The Positive Spiral



Technion and the Israeli Chip Industry

Past

Present





Back to Technion

Avinoam Kolodny's Home Page



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BSc 1975; MSc 1977, DSc 1980, Technion

Research

Electronic Design Automation; Device, circuit and system modeling; Circuit design techniques; Engineering methodologies; Algorithms and software for analysis and synthesis of VLSI systems; VLSI architecture; VLSI interconnect; Networks on Chip.

[Network-on-Chip](#)

[IEEE International NoC Symposium](#)

[MATRICS: Multiple AsymmeTRic Interconnected Core Systems](#)

Courses

- [044127 Basics of Semiconductor Devices](#)

יסודות התקני מוליכים למחצה - מל"מ



Current Research Challenges

- Interconnect
- Energy efficiency
- Programming of 'many-core' systems

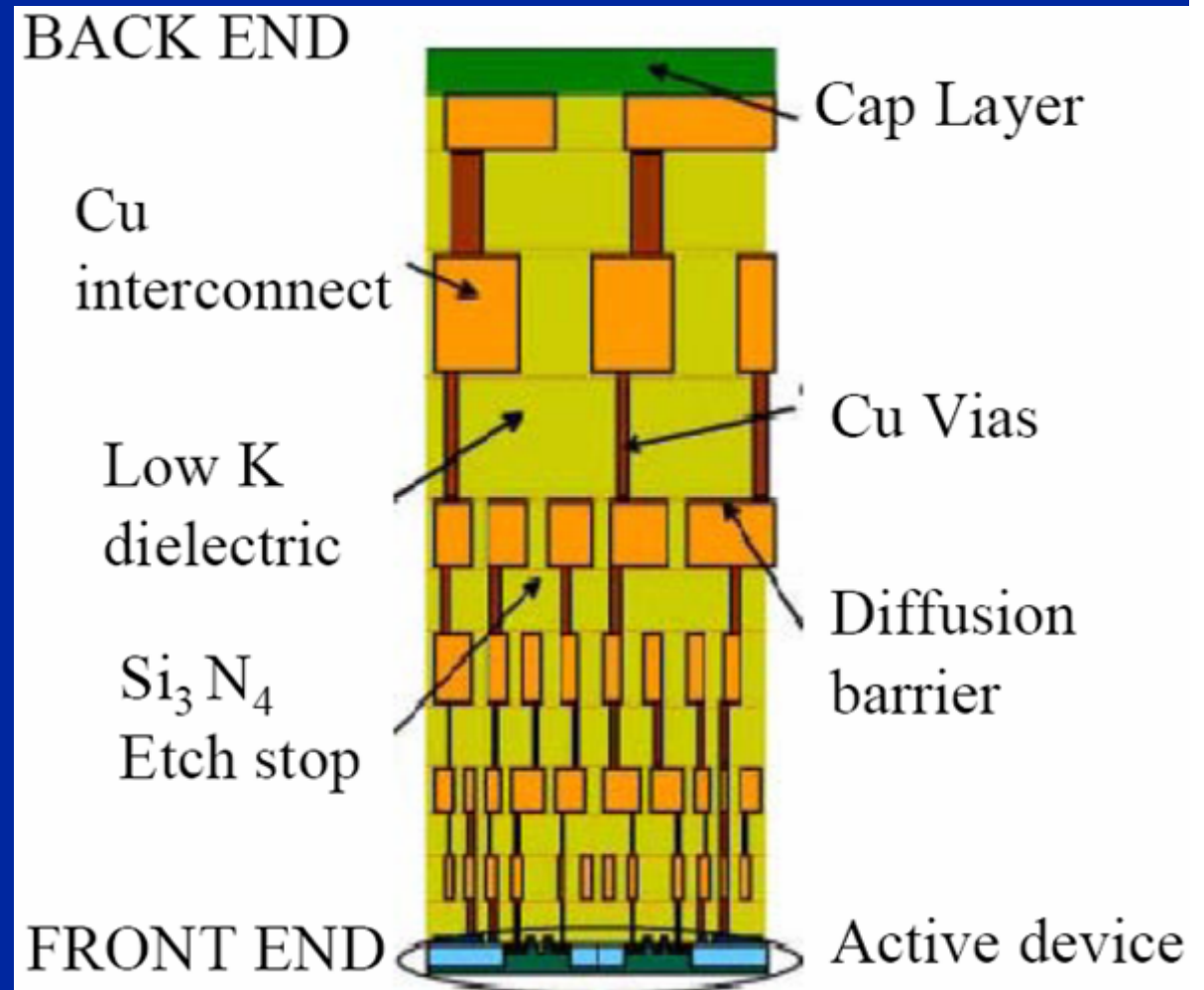
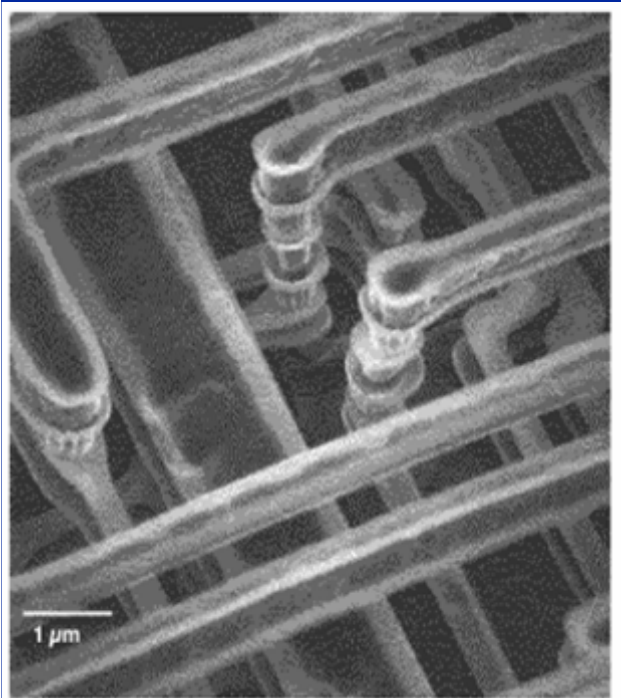


Interconnect and Complexity



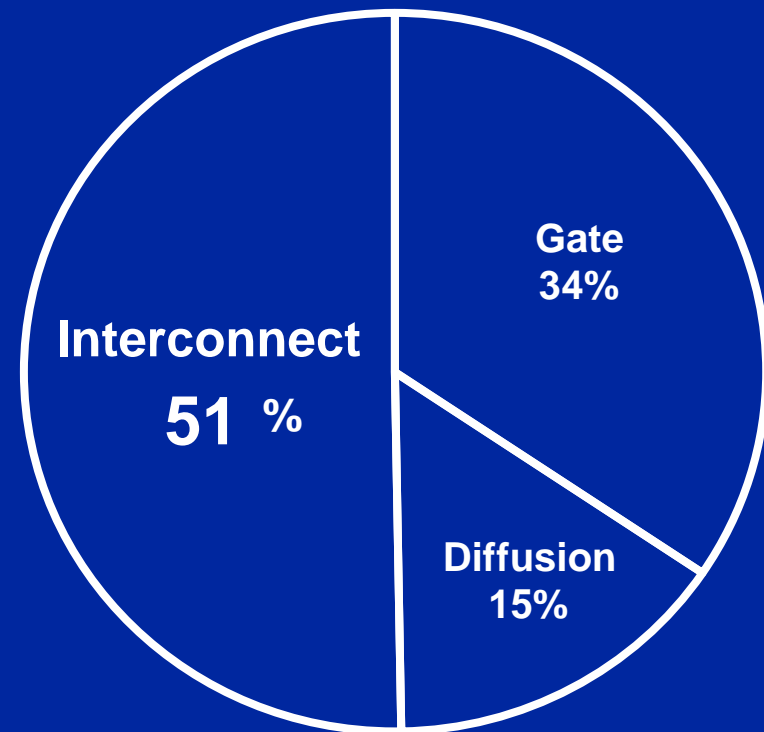
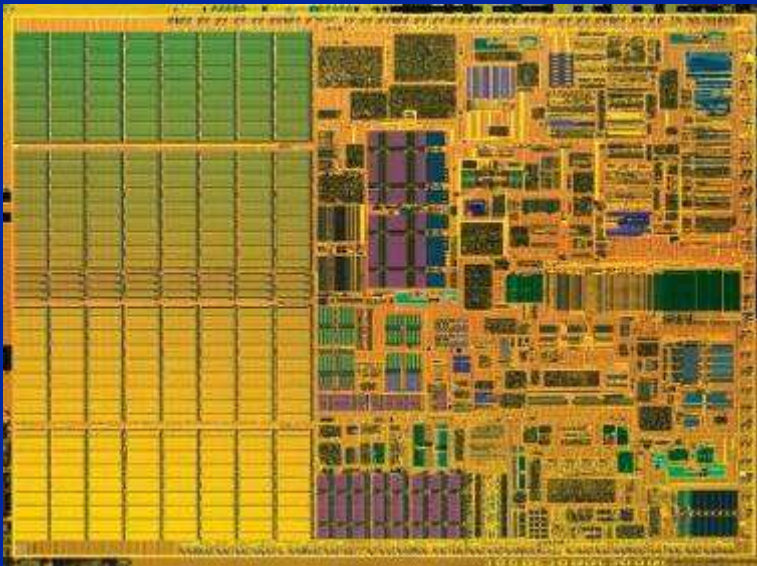
Adding metal Layers in Chips

- Wires dominate:
 - Speed
 - Power
 - Noise
 - Reliability
 - Cost



Interconnect Power: 2004 case study

- Intel's Pentium-M (designed in Haifa)
- Energy Consumption:
 - **Bit-Transportation > computation !**



* N. Magen, A. Kolodny, U. Weiser and N. Shamir, "Interconnect-Related Energy dissipation in a Low-Power Microprocessor", Proc. SLIP, 2004.



Bits as Cars on the Information highway



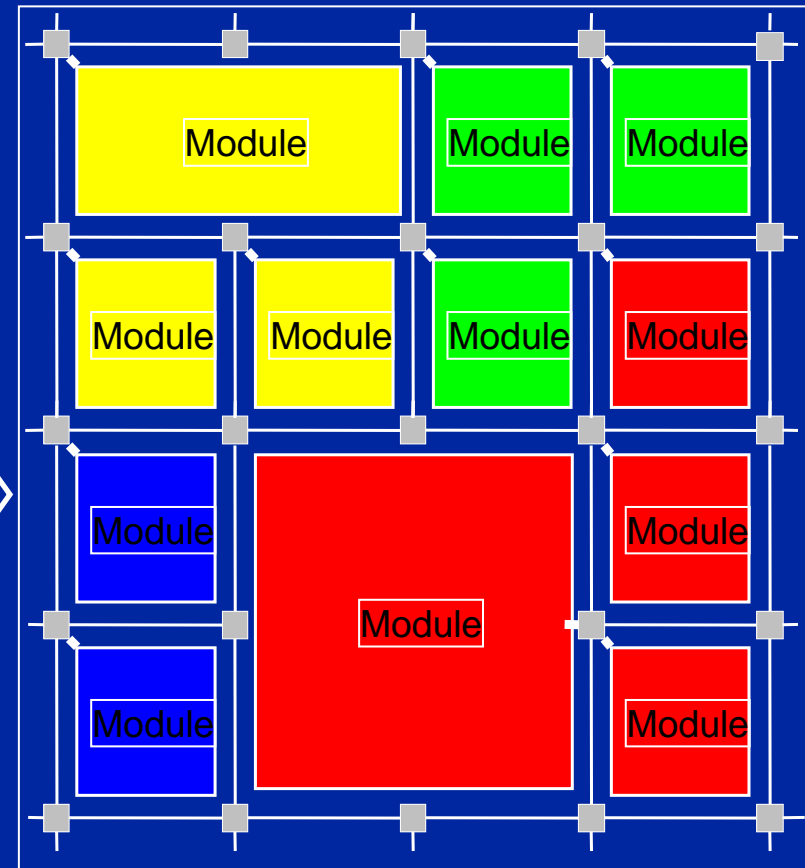
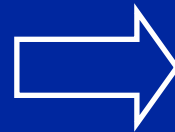
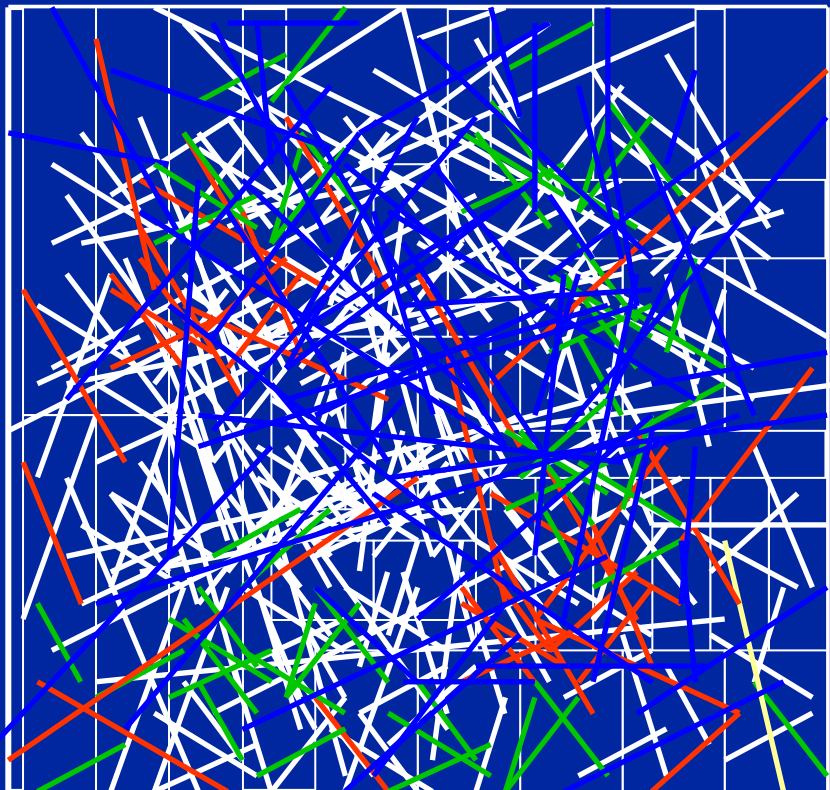
- Energy efficiency in chip design



paradigm shift in VLSI: Network on Chip (NoC)

From: **Dedicated signal wires**

to: **Shared network**



* E. Bolotin, I. Cidon, R. Ginosar and A. Kolodny., "QNoC: QoS architecture and design process for Network on Chip", *JSA special issue on NoC*, 2004.

 **Computing Resource**

 **Network switch**

 **Network link**

Advanced Circuit Research Center



Mellanox TI Marvell
Zoran Intel

ACRC opening ceremony, 2008



- A Technion/Industry joint effort

Beyond 10 Years Ahead: Future Challenges and Opportunities

- **MOS Device Scaling will slow down**
 - **New ways for system integration**
 - **Back to basic sciences**
 - **Interdisciplinary solutions**
 - **New architectures**



Long Term Issues for the Industry

- Flat world
 - Competition with Asia
- Imperatives for Technion and the industry
 - Israel can win by innovation
 - Education: more Ph.D.'s
 - Need stronger research collaboration



Mythical Academia-Industry Mismatch

- **Industry**

- Working results
- Secret IP
- Tight schedule
- Low Risk
- Control
- Money

- **Academia**

- Paper results
- Publish
- Slow
- High risk
- Freedom
- Fame



The Innovation Paradox - Applied Creativity in Organizations



- **Avi Kolodny**
(Technion)



- **Dadi Perlmutter**
(Intel)



- **Shlomo Mital**
(TIM)

* F. Chu, A. Kolodny, S. Mital and D. Perlmutter,

“The innovation paradox: Reconciling creativity & discipline – How winning organizations combine inspiration with perspiration,” *Proceedings of IEEE International Engineering Management Conference*, October 2004.



“Head in the Clouds, Feet on the Ground”

- **Let’s apply this for academia-industry joint research!**



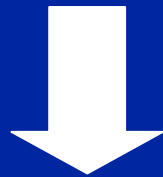
Technion and the Industry –

Summary of Opportunities



1) Research Partnership

Technion enabled Israeli hi-tech
Mostly as an engineering school



Industry will need research to innovate

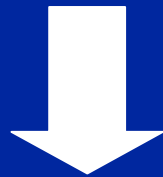
- More Ph.D.'s
- Collaboration in research



2) Industry Funded Research

Technology driven by defense

Government funded research



Economic developments lead

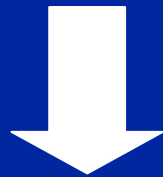
Industry must fund academic research



3) Culture Transformation

Technion: theory and individual research

Industry: practical short term results



Joint research in computer engineering

- Long and short terms
- Teamwork



A Specific Plan: Computer Engineering Research Center





High Performance Computing



Create a focal point

**The center as a focal point for collaboration
Research in Israel, centered at the Technion, including
Academia, R&D from Hi-Tech industry, as well as
R&D from leading international companies
(Microsoft, Intel, Google, etc.)**

- **The Technion gave invaluable leverage to**
 - Israel
 - Israeli hi-tech industry
 - Individual Alumni
- **Let's work together for future success!**

