Crisis-Driven Innovation: An Industry Perspective

Brian L. Halla
Former CEO & Chairman, National Semiconductor
Crisis...

- Of education
- Of talent
- Global
- Innovation
- Of no “Crisis!”
“Good morning. The state of the American education system today is unacceptable. As many as one quarter of American students don’t finish high school.

We've fallen to ninth place in the proportion of young people with college degrees. The quality of our math and science education lags behind many other nations.”

Melody Barnes
Director,
Domestic Policy Council
White House
March 8, 2011
Obama's 2012 budget request breakdown

The White House’s budget request proposes wide-ranging cuts, but still tries to make good on President Barack Obama’s State of the Union promises by asking Congress to maintain federal scientific research funding at or near 2011 levels.

Total 2012 outlays: $3.73 trillion
Science spending represents only a tiny fraction of the total U.S. budget.

<table>
<thead>
<tr>
<th>Science Agencies Combined</th>
<th>2%</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Total Outlays, Major Agencies:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Health and Human Services</td>
<td>$892.81 billion</td>
</tr>
<tr>
<td>Social Security</td>
<td>$817.14 billion</td>
</tr>
<tr>
<td>Defense/Military</td>
<td>$707.47 billion</td>
</tr>
<tr>
<td>Treasury</td>
<td>$129.12 billion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Funding for Science Agencies (total outlays)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>National Institutes of Health</td>
<td>$31.83 billion</td>
</tr>
<tr>
<td>2010</td>
<td>30.78</td>
</tr>
<tr>
<td>2011*</td>
<td>32.09</td>
</tr>
<tr>
<td>2012*</td>
<td>31.83</td>
</tr>
</tbody>
</table>

| National Aeronautics and Space Administration | $18.17 billion |
| 2010                                         | 18.9 |
| 2011*                                        | 19.48 |
| 2012*                                       | 18.17 |

| National Science Foundation                 | $7.91 billion |
| 2010                                         | 6.72 |
| 2011*                                        | 8.6 |
| 2012*                                       | 7.91 |

| National Oceanic and Atmospheric Administration | $5.5 billion |
| 2010                                         | 4.85 |
| 2011*                                        | 5.55 |
| 2012*                                       | 5.5 |

| Department of Energy (Science)              | $5.4 billion |
| 2010                                         | 5.0 |
| 2011*                                        | 5.1 |
| 2012*                                       | 5.4 |

| Defense Advanced Research Projects Agency   | $3.1 billion |
| 2010                                         | 2.99 |
| 2011*                                        | 3.1 |
| 2012*                                       | 3.1 |

| United States Geological Survey             | $1.12 billion |
| 2010                                         | 1.11 |
| 2011*                                        | 1.13 |
| 2012*                                       | 1.12 |

*2011 and 2012 budgets are not yet approved by Congress.

Feb. 14, 2011

Sources: United States Office of Management and Budget, Defense Advanced Research Projects Agency, RAND Corporation

KARL TATE, LiveScience.com
“What?”... Not “How?”
Halla’s Background:

- BSEE, University of Nebraska ‘69
- Control Data Corp ’69 – ’75
- Intel Corp ’75 – ’88
- LSI Logic ’88 – ’96
- National Semiconductor ’96 – ’10
“Eye-Opening” Experiences

• SIA (Semiconductor Industry Association)
• WSC (World Semiconductor Council) Chairmanship
• Leading a delegation to China
• Numerous visits to Washington
• Problems we’ve learned to “admire”
China: Hungry for What We Have
U.S. “Eras” of Innovation

• First was the era of the “Inventors”:
  – Edison, Franklin, Tesla, Jefferson, Lincoln, Watt

• Era of the Big Labs:
  – Bell Labs, Xerox PARC, SRI, Watson

• Era of the VC’s, IPO’s & M&A

• The “Era” we’re heading into…
Different!
Innovation Going Forward:

- Crisis-driven... defined problems to solve ("What")
- Federal, state & industry funded
- Open collaboration of teams; domestic & international
- Co-funding & resources from Industry
FCRP

- Long-term research on ultimate CMOS technology
- Multi-disciplinary, multi-university centers
- Addresses materials, devices, interconnects, circuits and systems
- 35 universities, 200 faculty, 500 students
The Focus Center Academic Talent Pool

Top universities and faculty talent are engaged with the FCRP (35 Universities, over 200 Research Faculty, ~ 500 Students)
Nanotechnology Research Initiative

Established by SIA in 2005

Create new switch using new materials and new assembly methods by 2020 as a successor to CMOS FET

Collaborative effort by US semiconductor companies, 30 universities, and federal, state and local governments
NRI Funded Universities

Over 30 Universities in 18 States

- Notre Dame
- Illinois-UC
- Michigan
- Cornell
- Purdue
- Penn State
- UT-Dallas
- GIT
- SUNY-Albany
- MIT
- GIT
- RPI
- MIT
- UVA
- Harvard
- Columbia
- NCSU

UC Los Angeles
UC Berkeley
UC Irvine
UC Santa Barbara
Stanford
U Denver
Portland State
U Iowa

UT-Austin
UT-Dallas
U. Maryland
Rice
ASU
Notre Dame
Texas A&M
NCSU
Illinois-UC

9/14/2010 2:44 PM
NRI Primary Research Directions

Building Blocks for a New Technology

- NEW DEVICE
  Device with alternative state vector

- NEW WAYS TO CONNECT DEVICES
  Non-charge data transfer

- NEW METHODS FOR COMPUTATION
  Non-equilibrium systems

- NEW METHODS TO MANAGE HEAT
  Nanoscale phonon engineering

- NEW METHODS OF FABRICATION
  Directed self-assembly devices
The “Gifts” of Bell Labs

- Photo Voltaic Cell
- Laser
- MOSFET
- OFDM
- UNIX
- CCD’s
- C & C++
- TDMA & CDMA
- WLAN
- And…
...the Transistor!
Technology Leadership?
October 4, 1957

**The New York Times**

**SOVIET FIRES EARTH SATELLITE INTO SPACE;**
**IT IS CIRCLING THE GLOBE AT 18,000 M. P. H.;**
**SPHERE TRACKED IN 4 CROSSINGS OVER U. S.**

---

*Image of the first satellite, Sputnik, is shown alongside the newspaper clipping.*
The Space Race Drives the Mainframe Race...
Mainframes Gave Birth to DRAM’s
Space Race, Mainframes, Internet, Semiconductors...
Creating U.S. Jobs... Help from Outside

- Wernher Von Braun (The Moon)
- Andy Grove (Intel)
- Jerry Yang (Yahoo)
- Pierre Omidyar (eBay)
- Sergey Brin (Google)
Convergence of the Sciences...
Top Down

1 km

Aircraft Carrier
Boeing 747
Car
Humans

1 m

Laptop

1 mm

Butterfly
Size of a Microprocessor

1 µm

Gnat

Micromachines

1 nm

Wavelength of Visible Light

1-100 nm

Smallest feature in microelectronic chips

Nanostructures & Quantum Devices

1 nm

Proteins

Width of DNA

Size of an atom

Bottom Up

Comparison of Length Scales

“There is plenty of room at the bottom,”
Feynman, 1959
Crisis/Problem Solving Innovation...
ABSTRACT: A method for controlling heat dissipated by a prosthetic retinal device is described. A heat transfer device employs the Peltier heat transfer effect to cool the surface of the retinal device that lies on or behind the inner or outer layer of the retina and towards the iris or cornea of the eye. According to the present invention, a heat pump is formed in a second substrate on the retinal device. The heat pump is controlled by a temperature sensor device that activates the heat pump when a first predetermined temperature limit is exceeded. The temperature sensor device deactivate the heat pump when a temperature of the retina drops below a second predetermined temperature.
Given M2A Camera Pill
From John Kao’s “Innovation Nation”

- Funding for 20 “Innovation Hubs” ($1B each)
- Create “National Innovation Advisor” (Reports to the President)
- “National Innovation Council”
- “Office of Innovation Assessment”
Kao on “Hubs”

• “Enable a network of talent brokers & entrepreneurs to identify National goals, organize leadership teams by field, launch partnerships with business & academia, & lobby for support at every political level – from the West Wing of the White House to city halls across the country”

• Include local “elite high schoolers” as interns

• For example: “Wicked Problems” like digital media, clean technology, agricultural biotechnology, nano-molecular materials
Tesla Motors All-Electric Vehicle

- 200 miles per charge
- 6000 lithium ion batteries
- 25 National Semiconductor PowerWise® circuits
- 0 to 60 mph in 3.9 seconds
Recommended “HUBS” (The “Whats”)

- Alternative Energy
- Medical Instrumentation
- Stop Terrorism
- Manufacturing
- Other?
Fixing the Education Crisis

- Study best practices at home & abroad
- Better pay for teachers & incentives
- Measure & reward the performance of schools
- National standards for science & math instruction
- Retirees from industry as mentors
The Talent?

- Immediately do away with the H1-B visa requirement for graduating PhD’s & “staple the green card…”
- “Opening our borders” to new candidates
- Find the K-12 “elite” & help them all the way through
- A modern-day NDEA…
National Innovation Resource Act (NIRA)

- Modeled after the NDEA
- Motivate education in science & math, etc
- Low-interest loans & scholarships
- Fellowships for graduate students
- Fix K-12
Industry Pull: Access to jobs

- NS Labs
- 30 PhD candidates working on their theses at NSM
- “Womb-to-Tomb”
- Rotation back to academia or into the product lines
- No bureaucracy, out of the mainstream but accountable
NS Labs Contributions

- SolarMagic
- Battery Management
- Array of Sensors
- Audio in Keyboards
- Super Capacitors
- Smart Meters
Going Forward...

- Falling farther behind every day
- What worked before…doesn’t
- New source & method of innovation
- ECEDHA is in the sweet spot of influence
- A “Crisis” gives us a reason to shine!
Thank You!
Bell Labs, 1947: Bardeen, Brattain, Shockley Invent...
The “Forgotten Engineer?”
Gary Kildall, An Innovator’s Innovator:

- First microcontroller assembly language
- First high-level language compiler for a microprocessor (PL/M)
- First floppy disc operating system (CPM)
- First “CD ROM”
- First “smart phone”
- First digital imaging
- Died 1994
Another “Forgotten” Innovator:
Software Meets the Integrated Circuit...