The Next Digital Revolution
and Human Society

Presentation Outline

- Societal-Scale Grand Challenges
- The Key: Disruptive ‘Business Models’
- CITRIS: The Center for Information Technology Research in the Interest of Society
- Research Examples
Bridging the Gaps

4 Billion People
Earning less than $1,500/year

Source: Prof. Prahalad, U Mich.

We are Living in a Global Economy and a Global Society
We Depend Upon One Another—All of Us
and so we must
Empower Poor People Throughout the World
Celebrate & Reconcile Our Many Differences

“Local Globalization”

Source: Prof. Prahalad, U Mich.
In Honor of Tetsuo Kondo
Tokyo, Japan
15th February, 2002

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Info-Bio Technology Research and Societal Grand Challenge Problems

Within the next decade, we will develop a sustainable business model and associated collection of system architectures and component technologies for providing affordable and useful digital services to the four billion people on earth earning less than $1,500/year.

Within the next decade, we will develop and deploy sustainable and affordable technology that will guarantee reliable access to clean drinking water for over 90% of the people and animals on earth.

Within the next decade, we will develop and deploy monitoring and control systems that can reduce both commercial and domestic energy waste by over 90%.

Within the next half century, we will develop and deploy appropriate sustainable, affordable and reliable energy sources for use by all people throughout the world.

Within the next fifteen years, we will improve the average literacy levels in the world by 5 grade-years by making compelling, culturally-relevant, cost-effective and robust digital tutor technology available to any interested group on this planet.

Within the next decade, we will reduce the unemployment rate of people with disabilities by 50% throughout the world.

Within the next decade, we will increase the average duration of time by which and elderly person can live comfortably at home by at least five years.

Within the next decade, we will provide affordable access to all known authored works on line. This will include all contemporary and historical documents, works of art, film, and recorded performances.

Developed by Tom Kalil & Richard Newton
Disruptive Technologies:
A driver of leadership failure and the source of new growth opportunities

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Value Creation in Product Development
... The Way It Used to Be

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Value Creation in Product Development
... The Way It Is Today

Source: Andy Rappaport, TRG, 1996

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**Grameen Phone**  
**A Disruptive Societal-Scale Business Model**

- ‘Village Phone’ is a unique idea that provides modern telecommunication services to the poor people of Bangladesh.
- The goal is to provide telecommunication services to the 100 million rural inhabitants in the 68,000 villages in Bangladesh—the largest wireless pay phone project in the World.

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**Disruptive Business Models & Implementation**  
... A Major Societal Opportunity

<table>
<thead>
<tr>
<th>Product Definition</th>
<th>Product Implementation</th>
<th>Fundamental Technologies</th>
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<td>Markets</td>
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<td>e.g. Microsoft, Cisco</td>
<td>e.g. Xilinx, 3M</td>
<td>Source: Andy Rappaport, TRG, 1996</td>
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</table>

**Source:** Andy Rappaport, TRG, 1996
Disruptive Business Models & Implementation

... A Major Societal Opportunity

Societal ROI

e.g. Grameen Phone

Grameen Bank

e.g. Cellular & Wireless Systems

Product Definition

Product Implementation

Fundamental Technologies

Markets

Technologies

Source: Andy Rappaport, TRG, 1996

Are There Ways to Profitably Serve These 4 Billion Citizens?

Keys to the future:

- New Technology (e.g. societal-scale information systems, global and open communications systems, ultra low-cost electronics)
- New Business Models (e.g. Grameen Phone project)

“Triple Bottom Line”

- Financial ROI
- Environmental ROI
- Societal ROI
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CITRIS
The Center for Information Technology Research
In the Interest of Society

Core Technologies
- Distributed Info Systems
- Micro sensors and actuators
- Human-Computer Interaction
- Prototype Deployment

Applications
- Quality-of-Life Emphasis
- Initially Leverage Existing Expertise on campuses

Foundations
- Security, Policy
- Probabilistic Systems
- Formal Techniques
- Data management
- Simulation

Source: Prof. Jim Demmel
The Best Technology for The World’s Biggest Challenges

- Energy Efficiency
- Transportation Planning
- Monitoring Health Care

The Berkeley Highway Lab

- Twelve cameras with overlapping fields of view covering 1.5 miles of Interstate 880
- Video data are processed to obtain position and speed of every vehicle

Source: Prof. Pravin Varaiya
In Honor of Tetsuo Kondo
Tokyo, Japan
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Lane-Changing Maneuver and Shockwave

Source: Prof. Pravin Varaiya

The Best Technology for The World’s Biggest Challenges

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Wireless Measurement, Diagnosis, and Cure

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The Best Technology
for The World’s Biggest Challenges

Education
Emergency Response
Land and Environment

Source: Profs. Jan Rabaey, David Culler, Al Pisano, and Kris Pister
Microair Vehicles and Smart Dust:
Connecting the Civil and Environmental Infrastructure

Source: Profs. Ron Fearing & Kris Pister

Distributed, Wireless Sensor Networks
A Revolution for Civil Infrastructure & Society

Source: Prof. Steve Glaser
Seismic Monitoring of Housing by Wireless Sensor Motes

$8,000 each

Source: Prof. Steve Glaser

Seismic Monitoring of Housing by Wireless Sensor Motes

$70 each

Source: Prof. Steve Glaser
eMerging Societal-Scale Systems

Information Appliances

MEMS BioMonitoring

"Server"

Scalable, Reliable, Secure Services

"Client"

Source: Professor Randy Katz

Implementation & Deployment of an Oceanic Data Information Utility

- Ubiquitous devices require ubiquitous storage
- 10,000 9Gbyte IBM Microdrives in a single rack provides 90 terabytes/m² (Professors Dave Patterson & Kathy Yellick)
- Confederations of (Mutually Suspicious) Utilities

Source: Professor John Kubiatowicz
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eMerging Societal-Scale Systems

Information Architecture

Source: Professor Randy Katz

The Future of Moore’s Law

Source: Professor Shankar Sastry
**BioNanotechnology & Human Health**

**Cheney’s heart condition**

Doctors performed angioplasty on Vice President Dick Cheney to reopen a mash support, or stent, placed in an artery in November. The stent had narrowed at one end.

- A stent propping open an artery in Cheney’s heart had become 90 percent blocked at one end.
- Doctors threaded a balloon through the stent.
- The balloon was inflated to reopen the clogged area and then removed.

**Cheney’s heart attack history**

- 1978: First heart attack, at age 37.
- 1984: Has mild heart attack.

**Unexpanded GFX Stent**

(AVE-Medtronic)

Source: Professor Kevin Healy

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**Biocomputation & Biomimetic Materials**

**The implant is the medicine**

**It is about Bio-Info-engineering!**

Source: Professor Kevin Healy
Is the End of Moore’s Law an Economic One?

- Silicon is not suited for low-end human-centric consumer appliances
- Baseline costs of traditional chips are high
- Cannot easily integrate human interaction component

The solution: Organic Semiconductors
- “Spray on circuits” – no clean rooms
- Easy to integrate display, computation and sensing

Source: Professor Vivek Subramanian

“Smart Soup”

- Electronic “Bar Code”
  - Passive RF circuit that talk to the outside world... no need for scanners

- Real-time Labeling
  - Develop new generations of reflective display technology for ultra-low power “electronic paper” displays No more incorrect pricing!

- Closed Loop Content Monitoring
  - No more expiration dates... the can knows when it has expired!

Source: Professor Vivek Subramanian
Gecko Adhesive

- Sticks to wet or dry surfaces
- Sticks to rough or smooth surfaces (e.g., concrete or glass)
- Self cleaning
- Leaves no residue
- Reusable
- Can be turned on/off at 10 Hz
- Pull-off 10N/cm²

Goal: artificial nanofabricated structures with gecko adhesive performance

Source: Professor Ron Fearing

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FIGURE 4. REAL RESEARCH AND DEVELOPMENT INVESTMENT BY SOURCE, 1954-1994

CITRIS is a Partnership with Industry

“I believe we are now entering the Renaissance phase of the Information Age, where creativity and ideas are the new currency, and invention is a primary virtue, where technology truly has the power to transform lives, not just businesses, where technology can help us solve fundamental problems.”

Carly Fiorina, CEO, Hewlett Packard Corporation

Future Opportunities and the Challenges Lie at the Boundaries Between Technology and Global Society

We Must Focus Our Attention on Societal-Scale Systems that Will Build Bridges Between People Throughout the World
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