Technology and Innovation in the Service Economy

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<table>
<thead>
<tr>
<th>Focus</th>
<th>Industrial Economy</th>
<th>Information &amp; Service Economy</th>
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<tbody>
<tr>
<td></td>
<td>Natural and engineered physical objects</td>
<td>People, information and services based organizational systems,</td>
</tr>
</tbody>
</table>
The Industrial Revolution
A technology and science based revolution
Innovations in the Industrial Economy
Over past two centuries we have achieved major improvements in the productivity and quality of physically engineered systems.
Information & Service Economy

Physically Engineered Systems

Natural & Biological Systems

People, Services-based Organizational Systems
Technology and Market Environment in the 21st Century

- Digital technology revolution, the Internet, globalization, ...
- Focus on services, people, market-facing innovation, ...
- Convergence of world’s physical & digital infrastructures, ...
- Highly complex, unpredictable, emergent systems ...
Accelerating Advances in Digital Technologies

Digital technologies are to the 21st century as steam power was to the Industrial Revolution.

Source: Kurzweil 1999 – Moravec 1998
The Internet: Industrial Information & Service Economy
Mid-1990s
New capabilities are enabling us to re-think how to apply technology, science and innovation to complex organizational systems and the very way the world works.

Huge amounts of information
Billions of mobile devices; trillions of sensors
Massive computational power and storage capacity
High bandwidth, wireless networks
Growth of Services Economy in US

**Agriculture:** Value from harvesting nature

**Industry:** Value from making products

**Services:** Value from the tasks that people perform for each other
US Economy – *The CIA World Factbook*

- **GDP composition by sector**
  - 1.2% Agriculture
  - 19.2% Industry
  - 79.6% Services

- **Labor force – by occupation**
  - 0.6% Agriculture: Farming, forestry, fishing
  - 22.6% Industry: Manufacturing, extraction, transp, crafts
  - 76.8%: Services
    - 35.5% Managerial, professional and technical
    - 24.8% Sales and office
    - 16.5% Other services
<table>
<thead>
<tr>
<th>Country</th>
<th>Agriculture</th>
<th>Industrial</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>1.2%</td>
<td>19.2%</td>
<td>79.6%</td>
</tr>
<tr>
<td>UK</td>
<td>1%</td>
<td>23%</td>
<td>76%</td>
</tr>
<tr>
<td>Germany</td>
<td>0.9%</td>
<td>30.1%</td>
<td>69%</td>
</tr>
<tr>
<td>Spain</td>
<td>3.6%</td>
<td>28.9%</td>
<td>67.5%</td>
</tr>
<tr>
<td>Brazil</td>
<td>5.5%</td>
<td>28.7%</td>
<td>65.8%</td>
</tr>
<tr>
<td>Mexico</td>
<td>4%</td>
<td>26.6%</td>
<td>69.5%</td>
</tr>
<tr>
<td>Russia</td>
<td>4.6%</td>
<td>39.1%</td>
<td>56.3%</td>
</tr>
<tr>
<td>India</td>
<td>17.2%</td>
<td>29.1%</td>
<td>53.7%</td>
</tr>
<tr>
<td>China</td>
<td>11.3%</td>
<td>48.6%</td>
<td>40.1%</td>
</tr>
<tr>
<td>World</td>
<td>4%</td>
<td>32%</td>
<td>64%</td>
</tr>
</tbody>
</table>
IBM’s Revenue Mix

Sensitivity Case: Revenue Mix

**Shifting Business Mix**

<table>
<thead>
<tr>
<th>External Segment Revenue ($B)</th>
<th>2000**</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software</td>
<td>13</td>
<td>33</td>
</tr>
<tr>
<td>Services</td>
<td>38</td>
<td>59</td>
</tr>
<tr>
<td>Financing</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Hardware</td>
<td>38</td>
<td>19</td>
</tr>
</tbody>
</table>

\* Sum of external segment revenue
\* Excludes Enterprise Investments; includes HDD

**Annuity vs. Transactional**

Estimated 2008 Revenue Mix

- 50% Transactional
- 50% Annuity

- One time software license charge
- Consulting
- Systems Integration
- ITS Services
- Used equipment sales
- Hardware sales
- Monthly license charge
- Services & support
- Outsourcing
- Maintenance
- Business Process Services
- Leasing
Real-time Information access, analysis and optimization

*The world's physical and digital infrastructure are converging*
By 2011, the world will be 10 times more instrumented than it was in 2006. Internet connected devices will leap from 500M to 1 Trillion.
Smart Planet

Leverage all these advances in IT to infuse intelligence into the way everything works

The world is becoming **INSTRUMENTED.**

The world is becoming **INTERCONNECTED.**

All things are becoming **INTELLIGENT.**
Some emerging “smart” applications

- Smart traffic systems
- Smart oil fields
- Smart food systems
- Smart healthcare
- Smart energy grids
- Smart retail

- Smart water management
- Smart supply chains
- Smart countries
- Smart weather
- Smart regions
- Smart cities
Smart Cities as a System of Systems

EDUCATION • TRANSPORTATION • SOCIAL SERVICES • UTILITIES • ENERGY • HEALTHCARE • COMMUNICATIONS

RETAIL • AUTOMOTIVE • FINANCE • MANUFACTURING • FOOD • POSTAL SERVICE • MEDIA • DEFENSE • CUSTOMS
Highly complex, unpredictable, emergent systems
Advanced Analytics, Modeling and Optimization

- **Stochastic Optimization**: How can we achieve the best outcome including the effects of variability?
- **Optimization**: How can we achieve the best outcome?
- **Predictive modeling**: What will happen next if?
- **Simulation**: What could happen ... ?
- **Forecasting**: What if these trends continue?
- **Alerts**: What actions are needed?
- **Query/drill down**: What exactly is the problem?
- **Ad hoc reporting**: How many, how often, where?
- **Standard Reporting**: What happened?

**Degree of Complexity**

**Competitive Advantage**

- **Descriptive**
- **Predictive**
- **Prescriptive**

Based on: Competing on Analytics, Davenport and Harris, 2007
Breaking the Petaflop Barrier
World’s Most Powerful Supercomputer

- One thousand trillion calculations per second
- Designed to safeguard nuclear stockpile
  - Commercial applications include financial modeling, energy and human genome research
- Hybrid format delivers world-leading efficiency
Breaking the Exascale Barrier
1,000,000,000,000,000,000 operations/second
100-fold improvements in energy efficiency

Simulation game-changers will accelerate the timeline for meeting serious energy and environmental challenges

Leverage expertise in applied mathematics, computational methods and algorithms and apply them to science and engineering problems throughout DOE

- Optimization and control of nation’s power grid through advanced simulation
- Advances to boost building energy-efficiency
- Simulation-based discovery of cost-effective photovoltaic materials
- Innovative design of combustion devices able to burn advanced bio-fuels
- Effective carbon sequestration strategies
- Simulation-based analysis and control of water resources
- Improved nuclear reactor safety
- Increased fidelity of extreme climate event prediction
- Mitigation of large-scale instabilities in advanced fusion devices
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<td></td>
</tr>
<tr>
<td>physical objects</td>
<td>systems,</td>
<td></td>
</tr>
<tr>
<td>Design Objectives</td>
<td>Production oriented, product excellence, competitive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>costs,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consumption oriented, market-facing, positive customer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>experience,</td>
<td></td>
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Front Stage: Market Facing, People, Services

Back Stage: Labs, Manufacturing, Production
Positive customer experience

Product excellence and competitive costs
New Cloud Apps → Quality of User Experience, Massive Scalability

- Business, Consumer and Government Services
- Social Networks, Visual Immersive, Interactive Apps
- Smart Applications, Real-time Information
- People, Devices, Sensors
Cloud = Internet-based Computing

Cloud Computing
- Web 2.0
- Grid Computing
- E-business
- E-mail
- World Wide Web

Internet
- TCP-IP
- Unix-based Workstations
- Personal Computer

Distributed Client-Server
- Supercomputers
- Mainframe

Centralized Computing
Cloud Computing: a consumption and delivery model for services, apps, information, 

**Consumption Model:**
The Mass Customization of Services

**Delivery Model:**
The Industrialization of Services
Cloud Computing

Consumption model: focused on the overall end user experience
- Standardized service offerings
- Rapidly provisioned
- Flexibly priced
- Ease of access
- Self-service

Delivery model: focused on overall infrastructure management
- Virtualized resources
- Managed as a single large resource
- Delivering services with elastic scaling
- Economies of scale
- Deploy technology advances
## The Changing Nature of Research and Innovation

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<td><strong>Design Objectives</strong></td>
<td>Production oriented, product excellence, competitive costs</td>
<td>Consumption oriented, market-facing, positive customer experience,</td>
</tr>
<tr>
<td><strong>Organization and Culture</strong></td>
<td>Siloed within disciplines, narrow, deep, proprietary</td>
<td>Multi-disciplinary, holistic, broad, collaborative, open</td>
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Multidisciplinary Skills: Technical + Business + Social

“Classic” Science and Engineering
T-Shaped Professionals

Deep Expert Thinking and Broad Skills in Business, Communications, Organization

- Economics and Social Sciences
- Business Anthropology and Design
- Organizational Change & Learning
- Business and Management
- Science and Engineering
- Complex Engineering Systems
- IT and Information Systems
- Math and Operations Research
Open Standards

- Linux
- WAP
- SOAP
- WSDL
- SMTP
- POP/iMAP
- TCP/IP
- WAP
- Globus
- NNTP
- XML
- IRC
- HTTP/HTML
- SQL
- Web Services
- OGSA
Collaborative Innovation and Social Networks

*Web 2.0, new collaborative tools and platforms*
Collaborative Innovation

- **Open Source communities**
  - 10s of thousands of programmers worldwide collaborating on

- **Untold numbers worldwide contributing to/collaborating on**
  - Blogs, Wikis . . .
Participatory Governance

Management team for ideas selection and execution

Distributed, collaborative approach for ideas generation
Information & Service Economy

- **Highly Complex Systems**
  - People, organizations, markets
  - Lots of variations, frequent changes
  - Unpredictable, emergent behavior

- **Key Design Objectives**
  - Positive customer experience
  - Consumption oriented
  - Market-facing innovation

- **Organization**
  - Multi-disciplinary: technology, management, social, ...
  - Collaborative
  - Open
Key Challenge in the 21st Century
Leverage technology, science and innovation to make major improvements in the productivity and quality of services, organizations and the very way the world works.
Technology and Innovation in the Service Economy

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