Lifelong learning on a Smarter Planet

Dr. Nicholas Donofrio
IBM Fellow Emeritus
June 17th, 2009

The world is becoming more instrumented, interconnected, and intelligent further breaking down the wall that divides formal and informal learning.

Individuals, enterprises, cities and nations can build capabilities, improve competitiveness and expand opportunities for value co-creation (service).
The 10 Hardest Jobs to Fill in America: #1 Engineer

Short history of engineering professional associations

- 1852 Civil Engineering (ASCE)
- 1880 Mechanical Engineering (ASME)
- 1884 Electrical Engineering (AIEE/IEEE)
- 1907 Ag & BioEngineering (ASAE/ASABE)
- 1908 Chemical Engineering (AICE)
- 1948 Industrial Engineering (ASIE/IIE)
- 1948 Computing Machinery (ACM)
- 1954 Nuclear Engineering (ANS)
- 1955 Environmental Engineering (AAEE)
- 1963 Aerospace Engineering (AIAA)
- 1963 Biomedical Engineering (BMES)
- 1985 Genetic Technologists (AGT)
- 1992 Financial Engineering (IAFE)
- 1993 Software Engineering (JCESEP)
- 2007 Service Engineering (SRII)

...Obama administration’s pledge to rebuild America’s infrastructure...

*Engineers are needed to build a smarter infrastructure*
Information technology (IT) is one driver of change

Source: Kurzweil 1999 – Moravec 1998
The hallmark of a smarter planet is accelerating change...
As measured by customer adoption rates of innovations
Technology immersion of today’s students

Innovations in the consumer marketplace are driving rapid adoption of new technologies for communication, entertainment and learning.

Over 4 billion individuals now have access to mobile technologies worldwide – representing over 60% of the population.

Social networking sites, virtual worlds, and mass collaboration technologies allow crowd sourcing to gain insights.
The World is Getting Smarter…
Instrumented, Interconnected, Intelligent

Smart traffic systems
Intelligent oil field technologies
Smart food systems
Smart healthcare
Smart energy grids
Smart retail

Smart water management
Smart supply chains
Smart countries
Smart weather
Smart regions
Smart cities
...but this requires workers to become more adaptable

Throughout modern economies, advantages accrue to individuals, governments, and companies that are adaptable, forward-looking, knowledgeable, and innovative.
A service-based economy is another driver of change

- Service-based positions have increased 23% over the past 40 years, while industrial and agricultural jobs have decreased.

- Human capital has replaced physical capital as the dominant source of organizational value.

- Employees will require lifelong learning to maintain old skills and develop new ones to meet job and project requirements.
**World’s Large Labor Forces**
*A = Agriculture, G = Goods, S = Service*

<table>
<thead>
<tr>
<th>Nation</th>
<th>Labor %</th>
<th>A %</th>
<th>G %</th>
<th>S %</th>
<th>40yr Service Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>25.7</td>
<td>49</td>
<td>22</td>
<td>29</td>
<td>142%</td>
</tr>
<tr>
<td>India</td>
<td>14.4</td>
<td>60</td>
<td>17</td>
<td>23</td>
<td>35%</td>
</tr>
<tr>
<td>U.S.</td>
<td>5.1</td>
<td>1</td>
<td>23</td>
<td>76</td>
<td>23%</td>
</tr>
<tr>
<td>Indonesia</td>
<td>3.5</td>
<td>45</td>
<td>16</td>
<td>39</td>
<td>34%</td>
</tr>
<tr>
<td>Brazil</td>
<td>3.0</td>
<td>20</td>
<td>14</td>
<td>66</td>
<td>61%</td>
</tr>
<tr>
<td>Russia</td>
<td>2.4</td>
<td>10</td>
<td>21</td>
<td>69</td>
<td>64%</td>
</tr>
<tr>
<td>Japan</td>
<td>2.2</td>
<td>5</td>
<td>28</td>
<td>67</td>
<td>45%</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1.6</td>
<td>70</td>
<td>10</td>
<td>20</td>
<td>19%</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2.1</td>
<td>63</td>
<td>11</td>
<td>26</td>
<td>37%</td>
</tr>
<tr>
<td>Germany</td>
<td>1.4</td>
<td>3</td>
<td>33</td>
<td>64</td>
<td>42%</td>
</tr>
</tbody>
</table>

CIA Handbook, International Labor Organization
Note: Pakistan, Vietnam, and Mexico now larger LF than Germany

The largest labor force migration in human history is underway, driven by global communications, business and technology growth, urbanization and regional variations in labor and infrastructure costs and capabilities.


<table>
<thead>
<tr>
<th>Industry Sector</th>
<th>Employment Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional and business services</td>
<td>4,566 (Thousands)</td>
</tr>
<tr>
<td>Healthcare and social assistance</td>
<td>4,303</td>
</tr>
<tr>
<td>Leisure and hospitality</td>
<td>2,215</td>
</tr>
<tr>
<td>Retail and wholesale trade</td>
<td>2,125</td>
</tr>
<tr>
<td>Educational services</td>
<td>2,123</td>
</tr>
<tr>
<td>State and local government, except schools and hospitals</td>
<td>895</td>
</tr>
<tr>
<td>Financial activities</td>
<td>849</td>
</tr>
</tbody>
</table>
US GDP shift to service innovation

- Based on Uday Karmarkar, UCLA (Apte & Karmarkar, 2006)
Innovation Defined

Innovation resides at the intersection of invention and insight, leading to the creation of social and economic value.

National Innovation Initiative
# National Innovation Initiative

## Talent
- Develop a diverse, world class, next-generation of innovators
- Establish a National Innovation Prize
- Make the US a magnet for the best global talent

## Investment
- Help markets place top value on long-term innovation strategies
- Establish incentives to increase early-stage investment in small-business innovation
- Invest to accelerate innovation in the services economy

## Infrastructure
- Create world-class infrastructures, including transportation, information, healthcare and energy
- Drive regulatory and legal systems to better support innovation and entrepreneurship
- Build a system that protects the rewards of IP, but that also encourages open collaboration

Establish innovation metrics for the knowledge economy, not the industrial economy
The changing nature and scope of innovation

Open
Collaborative
Multi-disciplinary
Global
Learning is also changing....

Formal is a small fraction
Informal is dominant
Signposts show wall breaking down

Five signposts of educational trends can be perceived as challenges to traditional institutions – or – as opportunities for meaningful and long-lasting systemic transformation to systems of education.

How an educational system responds to these trends will determine not only its value to its students but ultimately, its long-term value to society.

An investigation into each of these areas is useful for understanding the direction and rate of change, as well as to developing realistic and actionable strategies for education policy, investments and programs.
Lifelong learning enables entities to change and adapt as value migrates into new areas of opportunity

- **Three types of entities**
  - Individuals
  - Enterprises
    - Businesses
    - Non-profits
  - Regional Authorities
    - Cities
    - Nations

- **Three types of change**
  - Run = use existing capabilities and improve with practice
  - Transform = adopt a new best practice
  - Innovate = create a new best practice

**how much time devoted to each?**
Adaptable, Forward-Looking, Knowledgeable, Innovative

Economics and Social Sciences
Business Anthropology
Organizational Change & Learning
Business and Management

Science and Engineering
Industrial and Systems Engineering
Computer Science & Info. Systems
Math and Operations Research
The Bottom Line:

*Engineering work viewed as a series of service projects for customers requires lifelong learning to build capabilities, improve competitiveness and expand opportunities*

“A large and growing percentage of engineers now work as contract technical experts, hiring out for a particular job at a particular company, then moving on when it is finished. They may be independent consultants or they may work for consulting firms, but either way they don't have the long-term stability that joining a traditional manufacturing firm used to provide.”

Lifelong Learning for Engineers: Riding the Whirlwind
Ernest T. Smerdon
Volume: 26, Number: 1/2 - Winter 1996
Backup

- **Top Solutions for Smarter Planet**
  - Hot areas for lifelong learning
- **Smarter Planet and SSME**
  - Service Science Management and Engineering
  - Becoming more T-shaped and adaptable for lifelong learning
- **Service industries**
  - A geographical appraisal
  - Top 10 industries for job growth, projected 2006-2016
- **Outline of this presentation**
The Changing Nature and Scope of Innovation

Open Collaborative

Product and Services Innovation
Process Innovation
Business Model Innovation
Societal Innovation

Multi-disciplinary Global
Network Ubiquity
Everyone and Everything is Connected

A million businesses
A billion people
A trillion devices
Top Solutions for New Intelligence for Smarter Planet

Information Management
- Information on Demand
- Information Agenda
- Information Infrastructure

Predictive Capability
- Business Intelligence
- Business Event Processing
- Analytics Solutions
- Telelogic and Cognos

Engaging the Value Chain
- Industry Specific Assets (IA, MRO, Telelogic)
- CRM, SCM and HR Transformation
- Sensor and Actuator
- Information Integration

Business Optimization
- Business Optimization Solutions
- Business Process Management
- Smart SOA
- Information On Demand, Information Agenda
- Information Infrastructure SW and Services

Academic Initiative
Related New Intelligence Courseware
- Designing SOA Solutions with the IBM SOA Foundation
- Information Management Basics
- Architecting the Data Warehouse
- Relational Database Design
- Changing Business with Data Insight
- IBM Informix Dynamic Server Administration
- SQL & Database basics
- Teaching Business Process Management with Innov8
- Teaching Business Process Modeling
- Introduction to IBM DB2
- Advanced Data Warehouse Workshop: Multi-Dimensional Modeling
- DB2 for z/OS Fundamentals
- DB2 Family Fundamentals
- DB2 SQL Workshop
- Designing SOA Solutions with the IBM SOA Foundation
- Getting Started with SOA
- Implementation Technologies for Service Oriented Designs
- The Value of Service Oriented Architecture
- IBM WebSphere Business Modeler- Process Simulation and Analysis
- Using IBM WebSphere Business Modeler for BPM
Top Solutions for Smart Work for Smarter Planet

Agile Business Model
- Industry business solutions and Industry frameworks
- Business Model Innovation services
- SOA strategy services
- Smart SOA INsight series

Connected Customers
- Collaboration software and services
- RFID, sensors, actuators, consulting services
- Web 2.0 products and service
- Consulting services for CRM and SCM
- Collaborative Software Development
- WebSphere Commerce
- Mobility & Contact Center Solutions

Dynamic Business Processes
- Key Agility Indicators
- BPM Suite and consulting services
- WebSphere Business Events
- Component Business Modeling services -- (KAIs)
- Enterprise Architecture products and services

Smart SOA
- Smart SOA and SOA solution services
- Application Infrastructure
- Connectivity and Integration
- SOA Sandbox

Academic Initiative
Related Smart Work Courseware
• Designing SOA Solutions with the IBM SOA Foundation
• Assessment Assets for Service Oriented Architecture (SW707)
• Developing Applications with a Service-Oriented Architecture
• Getting Started with SOA
• Implementation Technologies for Service Oriented Designs
• Service Oriented Architecture Design Patterns
• The Value of Service Oriented Architecture
• Fundamentals of IBM Lotus Domino 8 Application Development
• Using IBM Lotus Notes 8 Mail, Calendar, and Contacts
• IBM WebSphere Portal v6.0: Administration 1&2
• IBM WebSphere Business Modeler: Process Simulation and Analysis
• IBM WebSphere Enterprise Service Bus: Implementing an ESB
• IBM WebSphere Business Modeler, Monitor and Process Server for BPM
• IBM WebSphere Commerce V6.0 Hands-on Training for Developers
• Programming XML with Java 1.4
• Teaching Business Process Management with Innov8
• Developing Supply Chains to support Service Operations
• Introduction to XML and Related Technologies
• Teaching Business Process Modeling
Top Solutions for Dynamic Infrastructure for Smarter Planet

- Cloud Computing
- Virtualization
- Energy Efficiency
- Information Infrastructure
- Service Management
- Asset Management
- Security Management
- Business Resiliency
- Express Mid-Market Offerings
- Strategic Outsourcing

Academic Initiative:
Related Dynamic Infrastructure Courseware
• Foundations in IT Services I and II
• IBM Tivoli Netcool/Proviso 4.4.3 System Administration and Performance
• IBM Tivoli Asset Management for IT 7.1 Implementation
• IBM Tivoli Access Manager for Enterprise Single Sign-On Workshop
• IBM Tivoli Business Services Manager 4.1 for Implementers
• IBM Tivoli Composite Appl. Mgr for RTT 6.1 - Install Monitor Deploy
• IBM Tivoli Composite Application Manager for Response Time 6.2 Implement and Admin Workshop
• IBM Tivoli Federated Identity Manager 6.1 - Deployment and Administration
• IBM Tivoli Monitoring 6.2 for Implementers
• IBM Tivoli Netcool/Impact 4.0 - Administration and Implementation
• IBM Tivoli Netcool/OMNibus 7.1 - User
• IBM Tivoli Netcool/Realtime Active Dashboards 3.0 Fundamentals
• IBM Tivoli Network Performance Reporting 3.X User
• IBM Tivoli Provisioning Manager 5.1 - Operations Management Workshop
• Service Desk Management Using IBM Maximo 6 for IT
• Work Management in IBM Maximo 6 for Enterprise Asset Management
• An Introduction to the Mainframe - Large Scale Commercial Computing
• An Introduction to the Mainframe - z/OS Basics
• Linux on System z
• Teaching Enterprise Systems
Top Solutions for Green and Beyond for Smarter Planet

Finding the Value in Green

- Data Center Assessment and Design Services
- Green IT
- Software for a Greener World

Smart Systems

- Intelligent Utility Network and Metering
- Intelligent Transportation
- Consumer Driven Supply Chain
- Intelligent Oilfields, Manufacturing Productivity

Societal Shifts and Corporate Social Responsibility

- CSR and Sustainability
- Carbon Management
- Reputation Management Services
- Ethical Supply Chain Monitoring

Academic Initiative: Related Green and Beyond Courseware & Assets

- An Introduction to the Mainframe - z/OS Basics
- IBM’s Software for Greener World
- Lotus Quickr 8.1
- IBM Content Collector, Filenet
- Information Agenda for Energy & Utilities
- IBM Tivoli Usage and Accounting Manager; IBM Tivoli Monitoring for Energy Management Accounting
- Rational Test Lab Manager Managing
- Lotus Notes; Domino 8.5
- SmartSOA Sandbox Accelerating
- IBM FileNet Business Process Manager,
- IBM FileNet Content Manager
- Lotus Forms & Lotus Forms Turbo
- Telelogic System Architect

http://www-304.ibm.com/jct01005c/university/scholars/academicinitiative/
Business and societal systems that serve customers and improve quality of life

**Smarter Service Systems** = Complex Systems That Serve Customers Better

- Water, electricity, transportation, education, healthcare, etc.

**Quality of Life**

**Capabilities, Experience**

**Carbon Footprint**

(Choices)
What is different about SSME?

Broad Communication Skills and Practical Experiences

Supported by Deep Knowledge in an area of:

- Science
- Or Management
- Or Engineering
- Or Design of Service Systems

SSME creates T-Shaped Professionals

…And that’s a lot to know!
Multiple Approaches to Study Service Systems

**Real (Instrumented) World**

www.caiso.com

**Virtual World**

Focus: Smarter Service Systems = complex systems that serve customers, increasingly enabled by advanced ICT (www.thesrii.org)

**Simulated World**

Mathematical World

\[
P(x) = \frac{\lambda^x e^{-\lambda}}{x!}
\]

For \( x = 0, 1, 2, 3, 4, \ldots \)

\( \lambda = \) Average number of arrivals for the specific period of time

\( e \approx 2.71828 \ldots \) (Euler’s number)
Aren’t Service Systems just Social Systems? Related, but…

Service Systems = Social + Technological + Economic + Legal + …

- A. Informal Service Systems
- B. Formal Service Systems

1. Social Systems
   - Human Systems/Sociotechnical Systems
   - Human Cultures

2. Technological Systems
   - Engineered Systems
   - Designed Systems

3. Economics Systems
   - Markets and Organizations
   - Firms or Hierarchies
   - Economic Institutions
   - Gray Markets

4. Legal Systems
   - Legislative, Judicial, Executive Separation
   - Norms, Sanctions, Punishments

5. Political Systems
   - Governed Systems
   - Value Systems

6. Organizational Systems
   - Managed Systems
   - Open Source Communities
   - Virtual Organizations

7. Information Systems
   - Linguistic Systems
   - Mathematical Systems
   - Physical Symbol Systems

8. Ecological and Geographic Systems
   - Nature’s Service and Systems
   - Evolved Spatial Systems

Service systems are dynamic human-centered value-cocreation systems

“The goal of science is to make the wonderful and complex understandable and simple – but not less wonderful.” – Herb Simon, The Sciences of the Artificial
Our Vision – A Moore’s Law for service system improvements as service system become increasingly enabled by ICT advances

Computational System
More transistors, more powerful
Requires investment roadmap

Service System/Network
1. People
2. Technology
3. Shared Information
4. Organizations
connected by value propositions
More win-win interactions, more value
Requires investment roadmap
Stakeholder Priorities

Education
- Skills & Mindset
- Develop programmes & qualifications

Research
- Knowledge & Tools
- Encourage an interdisciplinary approach

Business
- Employment & Collaboration

Government
- Policies & Investment
- Develop and improve service innovation roadmaps, leading to a doubling of investment in service education and research by 2015

Service Innovation
- Growth in service GDP and jobs
- Service quality & productivity
- Environmental friendly & sustainable
- Urbanisation & aging population
- Globalisation & technology drivers
- Opportunities for businesses, governments and individuals

Service Systems
- Customer-provider interactions that enable value cocreation
- Dynamic configurations of resources: people, technologies, organisations and information
- Increasing scale, complexity and connectedness of service systems

Service Science
- To discover the underlying principles of complex service systems
- Systematically create, scale and improve systems
- Foundations laid by existing disciplines
- Progress in academic studies and practical tools
- Gaps in knowledge and skills

The white paper offers a starting point to -

Glossary of definitions, history and outlook of service research, global trends, and ongoing debate

“Succeeding through Service Innovation” Whitepaper: A Framework for Progress
(http://www.ifm.eng.cam.ac.uk/ssme/)
Established Innovation Ecosystems

Positioning to Compete in the Global Economy
## Economic News Release

### Table 2. The 10 industries with the largest wage and salary employment growth, 2006-2016 (*)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Employment 2006</th>
<th>Employment 2016</th>
<th>Change Number</th>
<th>Change Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management, scientific, and technical consulting services ..................</td>
<td>921</td>
<td>1,639</td>
<td>718</td>
<td>77.9</td>
</tr>
<tr>
<td>Employment services</td>
<td>3,657</td>
<td>4,348</td>
<td>692</td>
<td>18.9</td>
</tr>
<tr>
<td>General medical and surgical hospitals, public and private ..................</td>
<td>4,988</td>
<td>5,679</td>
<td>691</td>
<td>13.9</td>
</tr>
<tr>
<td>Elementary and secondary schools, public and private ........................</td>
<td>8,346</td>
<td>8,983</td>
<td>638</td>
<td>7.6</td>
</tr>
<tr>
<td>Local government, excluding education and hospitals ..........................</td>
<td>5,594</td>
<td>6,206</td>
<td>612</td>
<td>10.9</td>
</tr>
<tr>
<td>Offices of physicians</td>
<td>2,154</td>
<td>2,657</td>
<td>533</td>
<td>24.8</td>
</tr>
<tr>
<td>Limited-service eating places</td>
<td>4,019</td>
<td>4,548</td>
<td>529</td>
<td>13.2</td>
</tr>
<tr>
<td>Colleges, universities, and professional schools, public and private ......</td>
<td>3,434</td>
<td>3,933</td>
<td>499</td>
<td>14.5</td>
</tr>
<tr>
<td>Computer systems design and related services</td>
<td>1,278</td>
<td>1,768</td>
<td>490</td>
<td>38.3</td>
</tr>
<tr>
<td>Home health care services</td>
<td>867</td>
<td>1,348</td>
<td>481</td>
<td>55.4</td>
</tr>
</tbody>
</table>

* Data are from the National Employment Matrix.
# World’s Largest Labor Forces (2005)

- **Source:** [www.nationmaster.com](http://www.nationmaster.com)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Countries</th>
<th>Amount</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td># 1</td>
<td>China:</td>
<td>776,047,400</td>
<td>2005</td>
</tr>
<tr>
<td># 2</td>
<td>India:</td>
<td>435,035,700</td>
<td>2005</td>
</tr>
<tr>
<td># 3</td>
<td>United States:</td>
<td>155,462,400</td>
<td>2005</td>
</tr>
<tr>
<td># 4</td>
<td>Indonesia:</td>
<td>107,214,600</td>
<td>2005</td>
</tr>
<tr>
<td># 5</td>
<td>Brazil:</td>
<td>91,313,050</td>
<td>2005</td>
</tr>
<tr>
<td># 6</td>
<td>Russia:</td>
<td>73,229,580</td>
<td>2005</td>
</tr>
<tr>
<td># 7</td>
<td>Japan:</td>
<td>66,592,120</td>
<td>2005</td>
</tr>
<tr>
<td># 8</td>
<td>Bangladesh:</td>
<td>63,868,780</td>
<td>2005</td>
</tr>
<tr>
<td># 9</td>
<td>Pakistan:</td>
<td>56,532,190</td>
<td>2005</td>
</tr>
<tr>
<td># 10</td>
<td>Nigeria:</td>
<td>47,868,360</td>
<td>2005</td>
</tr>
<tr>
<td># 11</td>
<td>Vietnam:</td>
<td>44,041,490</td>
<td>2005</td>
</tr>
<tr>
<td># 12</td>
<td>Mexico:</td>
<td>42,262,110</td>
<td>2005</td>
</tr>
<tr>
<td># 13</td>
<td>Germany:</td>
<td>40,991,820</td>
<td>2005</td>
</tr>
</tbody>
</table>
## Service Industries

**Table 3.3** Contribution of services to GDP and labourforce in developing countries, 1960–80

<table>
<thead>
<tr>
<th>Developing countries</th>
<th>1960</th>
<th>1970</th>
<th>1980</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GDP</td>
<td>LF</td>
<td>GDP</td>
</tr>
<tr>
<td>Latin America and Caribbean (middle)</td>
<td>48.1</td>
<td>33.6</td>
<td>48.8</td>
</tr>
<tr>
<td>Latin America and Caribbean (low)</td>
<td>46.5</td>
<td>21.7</td>
<td>47.5</td>
</tr>
<tr>
<td>Asia (middle)</td>
<td>43.9</td>
<td>19.8</td>
<td>44.4</td>
</tr>
<tr>
<td>Asia (lower)</td>
<td>32.2</td>
<td>15.5</td>
<td>34.1</td>
</tr>
<tr>
<td>India</td>
<td>39.6</td>
<td>14.6</td>
<td>32.6</td>
</tr>
<tr>
<td>Africa and Middle East (oil)</td>
<td>23.1</td>
<td>20.0</td>
<td>18.8</td>
</tr>
<tr>
<td>Africa and Middle East (middle)</td>
<td>37.5</td>
<td>17.9</td>
<td>36.7</td>
</tr>
<tr>
<td>Africa (low)</td>
<td>32.1</td>
<td>7.3</td>
<td>38.2</td>
</tr>
<tr>
<td>China</td>
<td>—</td>
<td>9.8</td>
<td>—</td>
</tr>
</tbody>
</table>

| All developing countries             | 39.1    | 14.5    | 39.0    | 17.7    | 44.2    | 21.0    |

**Notes:**
1. Gross domestic product.
2. Proportion of total labour force in service industries which are defined as commerce, transport and communications, public and private services.

**Source:** Hopkins, 1983, 461–78.
<table>
<thead>
<tr>
<th>Country and year</th>
<th>Share in total labourforce (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture</td>
<td>Industry</td>
</tr>
<tr>
<td>Great Britain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1851–61</td>
<td>21.6</td>
<td>56.9</td>
</tr>
<tr>
<td>1921</td>
<td>7.2</td>
<td>56.9</td>
</tr>
<tr>
<td>1961</td>
<td>3.7</td>
<td>55.0</td>
</tr>
<tr>
<td>Change 1851–1961</td>
<td>-16.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Netherlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1849</td>
<td>45.4</td>
<td>29.4</td>
</tr>
<tr>
<td>1960</td>
<td>11.0</td>
<td>50.5</td>
</tr>
<tr>
<td>Change 1849–1960</td>
<td>-34.4</td>
<td>+21.1</td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1860</td>
<td>64.0</td>
<td>18.8</td>
</tr>
<tr>
<td>1910</td>
<td>48.3</td>
<td>32.2</td>
</tr>
<tr>
<td>1960</td>
<td>13.8</td>
<td>52.7</td>
</tr>
<tr>
<td>Change 1860–1960</td>
<td>-50.2</td>
<td>+33.9</td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1872</td>
<td>85.8</td>
<td>5.6</td>
</tr>
<tr>
<td>1920</td>
<td>54.6</td>
<td>25.4</td>
</tr>
<tr>
<td>1964</td>
<td>27.6</td>
<td>37.4</td>
</tr>
<tr>
<td>Change 1872–1964</td>
<td>-58.2</td>
<td>+31.8</td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1839</td>
<td>64.3</td>
<td>16.2</td>
</tr>
<tr>
<td>1929</td>
<td>19.9</td>
<td>38.8</td>
</tr>
<tr>
<td>1965</td>
<td>5.7</td>
<td>38.0</td>
</tr>
<tr>
<td>Change 1839–1965</td>
<td>-55.9</td>
<td>+21.0</td>
</tr>
<tr>
<td>India</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1881</td>
<td>74.4</td>
<td>14.6</td>
</tr>
<tr>
<td>1961</td>
<td>73.5</td>
<td>13.1</td>
</tr>
<tr>
<td>Change 1881–1961</td>
<td>-2.2</td>
<td>+0.6</td>
</tr>
<tr>
<td>Egypt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1907</td>
<td>71.2</td>
<td>14.1</td>
</tr>
<tr>
<td>1960</td>
<td>58.3</td>
<td>15.6</td>
</tr>
<tr>
<td>Change 1907–60</td>
<td>-12.9</td>
<td>+1.5</td>
</tr>
</tbody>
</table>

**Notes:**
Agriculture = agriculture, forestry, hunting and fishing.
Industry = mining and quarrying, manufacturing, construction, electricity, gas and water, transport and communication.
Services = Trade, banking, insurance, finance and real estate, ownership of dwellings, public administration and defence, and other services.

**Source:** Kuznets, 1971, extracted from table 38, 250–3.
Table 2.3  Labourforce in agriculture, industry and services, 1950–70

<table>
<thead>
<tr>
<th>Region</th>
<th>Year</th>
<th>Sector (%)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Agriculture</td>
<td>Industry</td>
<td>Services</td>
<td></td>
</tr>
<tr>
<td>World</td>
<td>1950</td>
<td>64.3</td>
<td>16.3</td>
<td>19.3</td>
<td>1,100,150</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>57.7</td>
<td>20.1</td>
<td>22.2</td>
<td>1,297,400</td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>51.0</td>
<td>22.9</td>
<td>26.1</td>
<td>1,508,613</td>
</tr>
<tr>
<td>Change, 1950–70 (%)</td>
<td></td>
<td>+8.5</td>
<td>+92.6</td>
<td>+85.1</td>
<td></td>
</tr>
<tr>
<td>More developed regions</td>
<td>1950</td>
<td>37.6</td>
<td>30.4</td>
<td>32.0</td>
<td>397,436</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>28.1</td>
<td>34.6</td>
<td>37.3</td>
<td>441,798</td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>18.3</td>
<td>37.6</td>
<td>44.1</td>
<td>487,930</td>
</tr>
<tr>
<td>Change, 1950–70 (%)</td>
<td></td>
<td>−40.2</td>
<td>+51.9</td>
<td>+68.9</td>
<td></td>
</tr>
<tr>
<td>Less developed regions</td>
<td>1950</td>
<td>79.5</td>
<td>8.4</td>
<td>12.2</td>
<td>199,714</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>72.9</td>
<td>12.7</td>
<td>14.4</td>
<td>855,602</td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>66.6</td>
<td>16.0</td>
<td>17.5</td>
<td>1,020,684</td>
</tr>
<tr>
<td>Change 1950–70 (%)</td>
<td></td>
<td>+21.6</td>
<td>+175.9</td>
<td>+109.3</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1 More developed regions: Japan; Southern Africa; temperate South America; North America; Eastern Europe, Northern Europe, Southern Europe and Western Europe; Australia and New Zealand; and Soviet Union.
2 Less developed regions: China and other East Asia; eastern South Asia; middle South Asia; western South Asia; Eastern, Middle, Northern and Western Africa; Caribbean; Middle America mainland; tropical South America; Melanesia; Polynesia; and Micronesia.

Source: Adapted from International Labour Office 1977, table 3, 40.
Table 2.4 Labourforce in agriculture, industry and services: continental comparisons, 1970

<table>
<thead>
<tr>
<th>Continent</th>
<th>Sector (%)</th>
<th></th>
<th></th>
<th>Total (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture</td>
<td>Industry</td>
<td>Services</td>
<td></td>
</tr>
<tr>
<td>Africa</td>
<td>71.5</td>
<td>11.3</td>
<td>17.2</td>
<td>136,653</td>
</tr>
<tr>
<td>Latin America</td>
<td>40.8</td>
<td>21.8</td>
<td>37.4</td>
<td>89,166</td>
</tr>
<tr>
<td>North America</td>
<td>4.1</td>
<td>34.2</td>
<td>61.7</td>
<td>95,764</td>
</tr>
<tr>
<td>Asia</td>
<td>64.8</td>
<td>17.5</td>
<td>17.8</td>
<td>859,730</td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>34.9</td>
<td>37.8</td>
<td>27.6</td>
<td>53,231</td>
</tr>
<tr>
<td>Western Europe</td>
<td>9.8</td>
<td>44.5</td>
<td>45.7</td>
<td>62,560</td>
</tr>
<tr>
<td>Oceania</td>
<td>23.7</td>
<td>30.4</td>
<td>46.0</td>
<td>8,184</td>
</tr>
<tr>
<td>USSR</td>
<td>25.7</td>
<td>37.7</td>
<td>36.7</td>
<td>117,688</td>
</tr>
</tbody>
</table>

“Service-providing industries are projected to account for most job growth, generating almost 19 million new jobs between 2004 and 2014. This is due, in part, to increased demand for services and the difficulty of automating service tasks.”

“... accounted for more than 20 million jobs.”

“Employment in professional and business services is projected to increase by nearly 4.6 million jobs.

Growth in this sector is led by providers of administrative support services and consulting services.”
Service Education, Research, and Innovation

“Our economy is increasingly dependent on services, yet our innovation processes remain oriented to products.”

Stefan Thomke
from Harvard Business Review, April 2003

“Services dominate economic activity in developed economies, and yet understanding of innovation in this sector remains very limited…… At this early stage, academic research about innovation in services is not well defined.”

Henry Chesbrough
from Financial Times, October 2004

“Services account for more than 80 percent of the U.S. gross domestic product, employ a large and growing share of the science and engineering workforce, and are the primary users of information technology. … [The] academic research enterprise has not focused on or been organized to meet the needs of service businesses. Major challenges to services industries that could be taken up by universities include: (1) the adaptation and application of systems and industrial engineering concepts, methodologies, and quality-control processes to service functions and businesses; (2) the integration of technological research and social science, management, and policy research; and the (3) the education and training of engineering and science graduates prepared to deal with management, policy, and social issues.”


“Our economy is increasingly dependent on services, yet our innovation processes remain oriented to products.”

Stefan Thomke
from Harvard Business Review, April 2003

“Services dominate economic activity in developed economies, and yet understanding of innovation in this sector remains very limited…… At this early stage, academic research about innovation in services is not well defined.”

Henry Chesbrough
from Financial Times, October 2004

“Services is an understudied field”

Matthew Realff, Director, NSF SSE Program
from NY Times article April 18, 2006
Academia Dissects the Service Sector, but Is It a Science? - Steve Lohr
Two Dominant Worlds of Learning

Foundation
- Research
- Knowledge
- Recruiting
- Skills
- Education System
- Formal Learning

Refinement
- Government
- Projects
- Corporate
- Academia
- Employment System
- Informal Learning

Lifelong and Life-wide Learning
Outline

- Hardest jobs to fill in America – Engineers
- Smarter Planet and accelerating change
- Importance of being adaptable
- Drivers of change
  - Information technology progress
  - Service-based economy progress
- National Innovation Initiative
  - Innovation defined
  - Talent, investment, infrastructure
- Learning is also changing
  - Formal and informal learning
- Lifelong learning = entities change
  - Four types of entities (individuals, enterprises, cities/regions, nations)
  - Three types of change (run-transform-innovate)
- Bottom line
  - Engineering work as a series of service projects for customers
  - Requires lifelong learning approach to compete