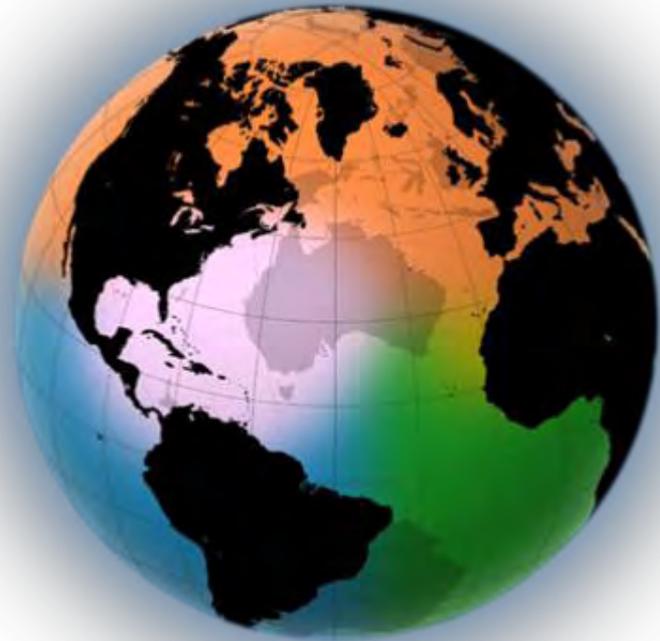


Lifelong learning on a Smarter Planet

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



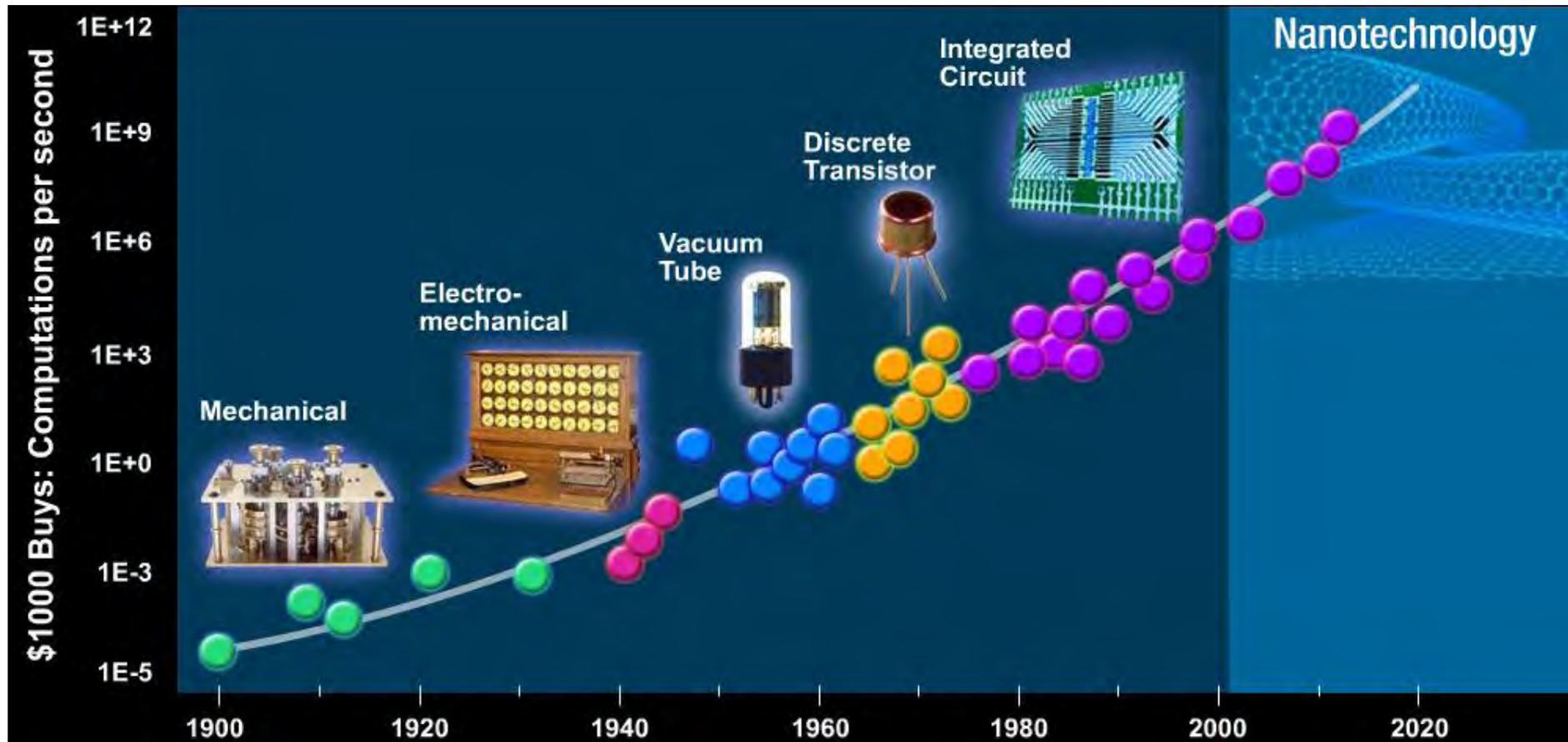
Engineer

There are several reasons it's hard for employers to find qualified engineers, says Jonas Prising, Manpower's president for the Americas. First, employers don't want to hire two or three engineers with a variety of specialties, they want one engineer who is trained in several areas. Another reason is that there are far too few new college graduates in engineering to replace retiring engineers. Also, the Obama administration's pledge to rebuild America's infrastructure is increasing the need for talented engineers.

- 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/IIIE)
- 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)

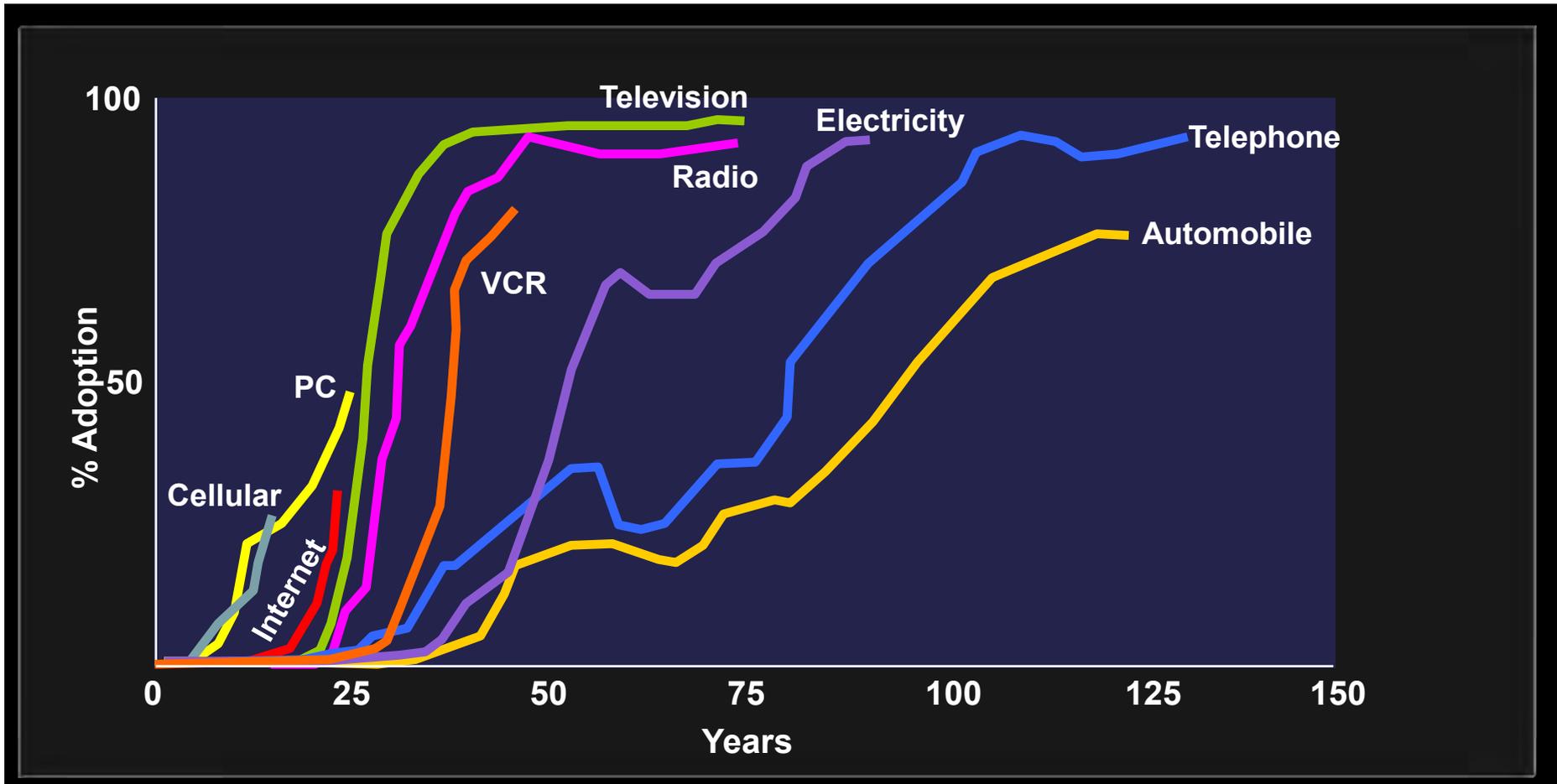
...Obama administration's pledge to rebuild America's infrastructure...
Engineers are needed to build a smarter infrastructure

Information technology (IT) is one driver of change



Source: Kurzweil 1999 – Moravec 1998

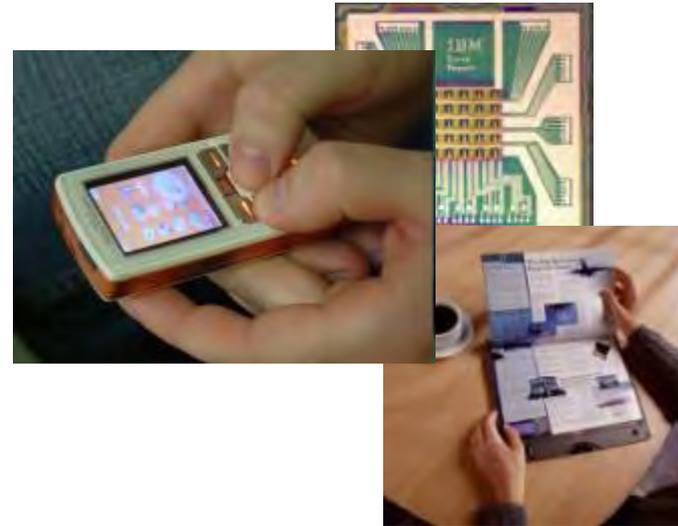
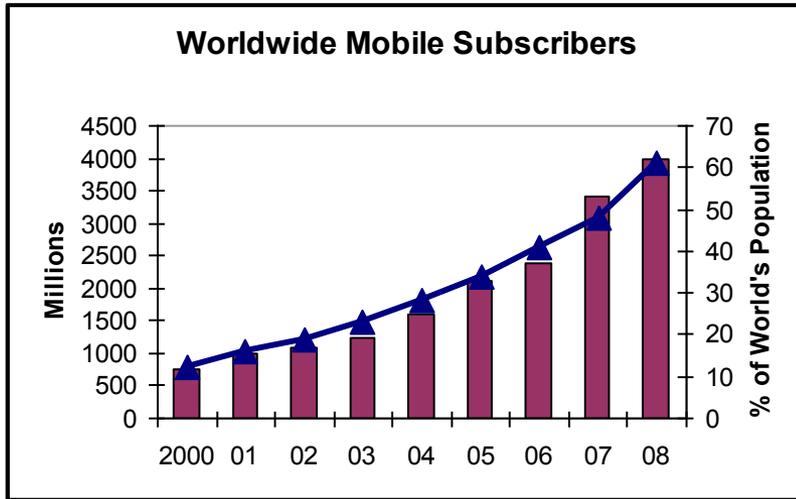
The hallmark of a smarter planet is accelerating change...
As measured by customer adoption rates of innovations





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



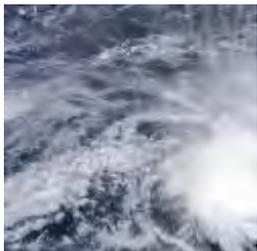
Smart healthcare



Smart energy grids



Smart retail



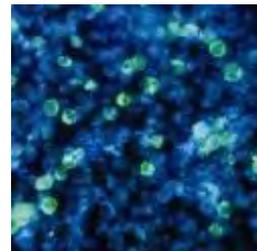
Smart water management



Smart supply chains



Smart countries



Smart weather

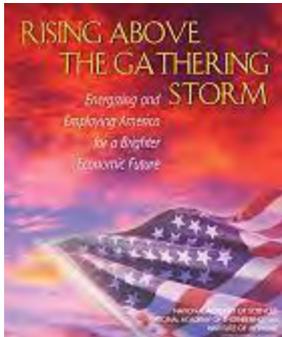


Smart regions



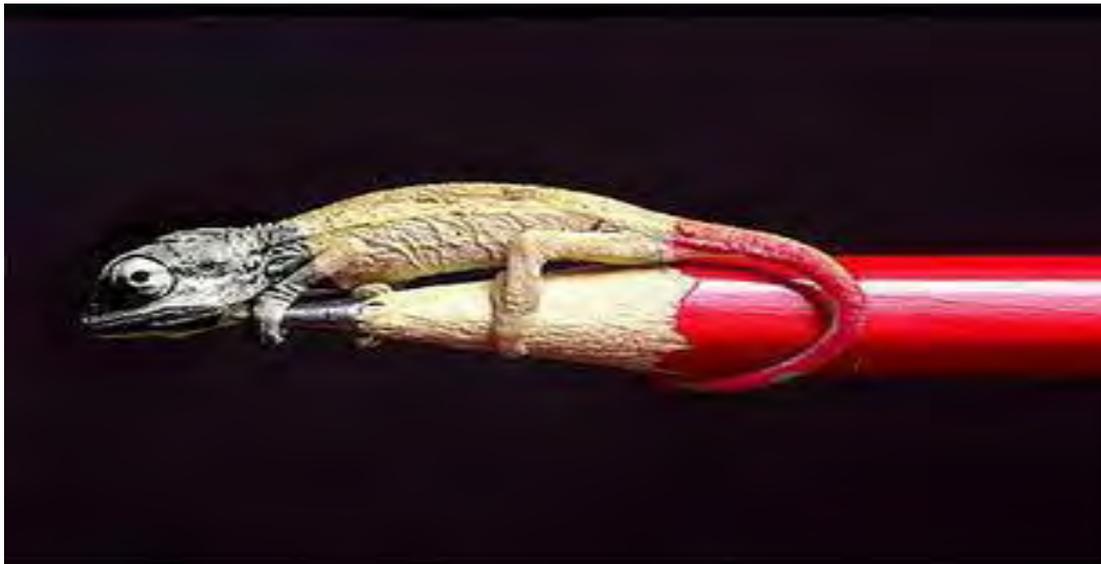
Smart cities

...but this requires workers to become more adaptable



RISING ABOVE THE GATHERING STORM

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



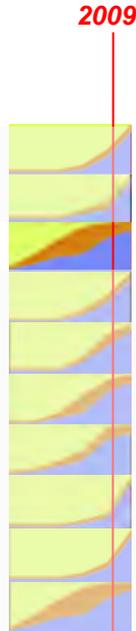
- Service-based positions have increased 23% over the past 40 years, while industrial and agricultural jobs have decreased.
- Human capital has replaced physical capital as the dominant source of organizational value.
- Employees will require lifelong learning to maintain old skills and develop new ones to meet job and project requirements



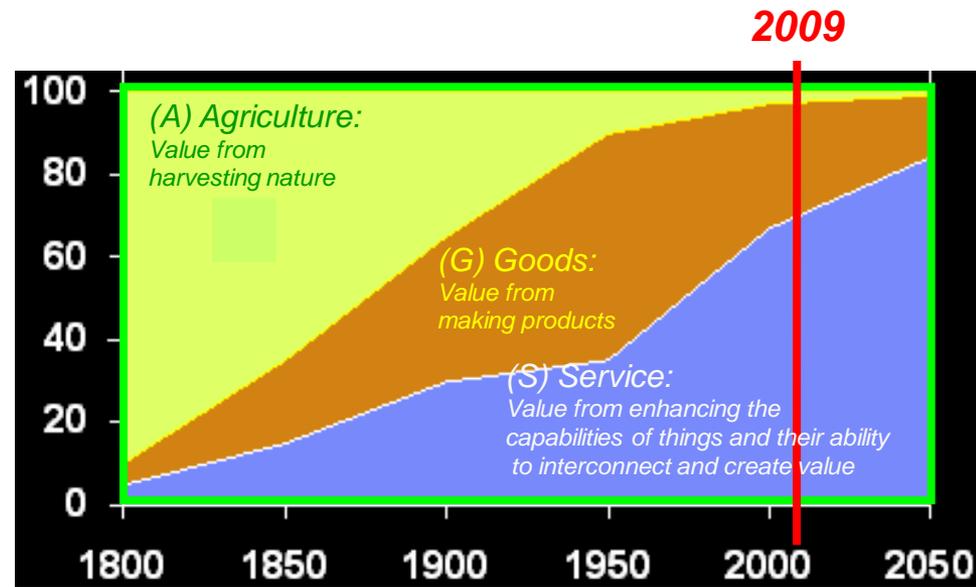
World's Large Labor Forces

A = Agriculture, G = Goods, S = Service

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



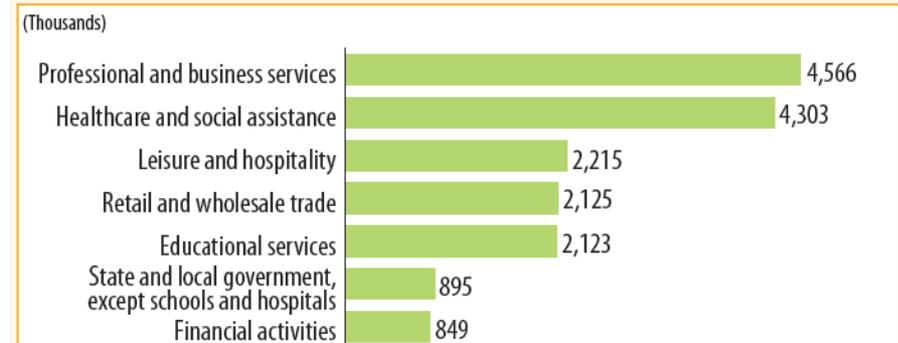
US shift to service jobs



US Bureau of Labor Statistics: Highest growth jobs

Employment change

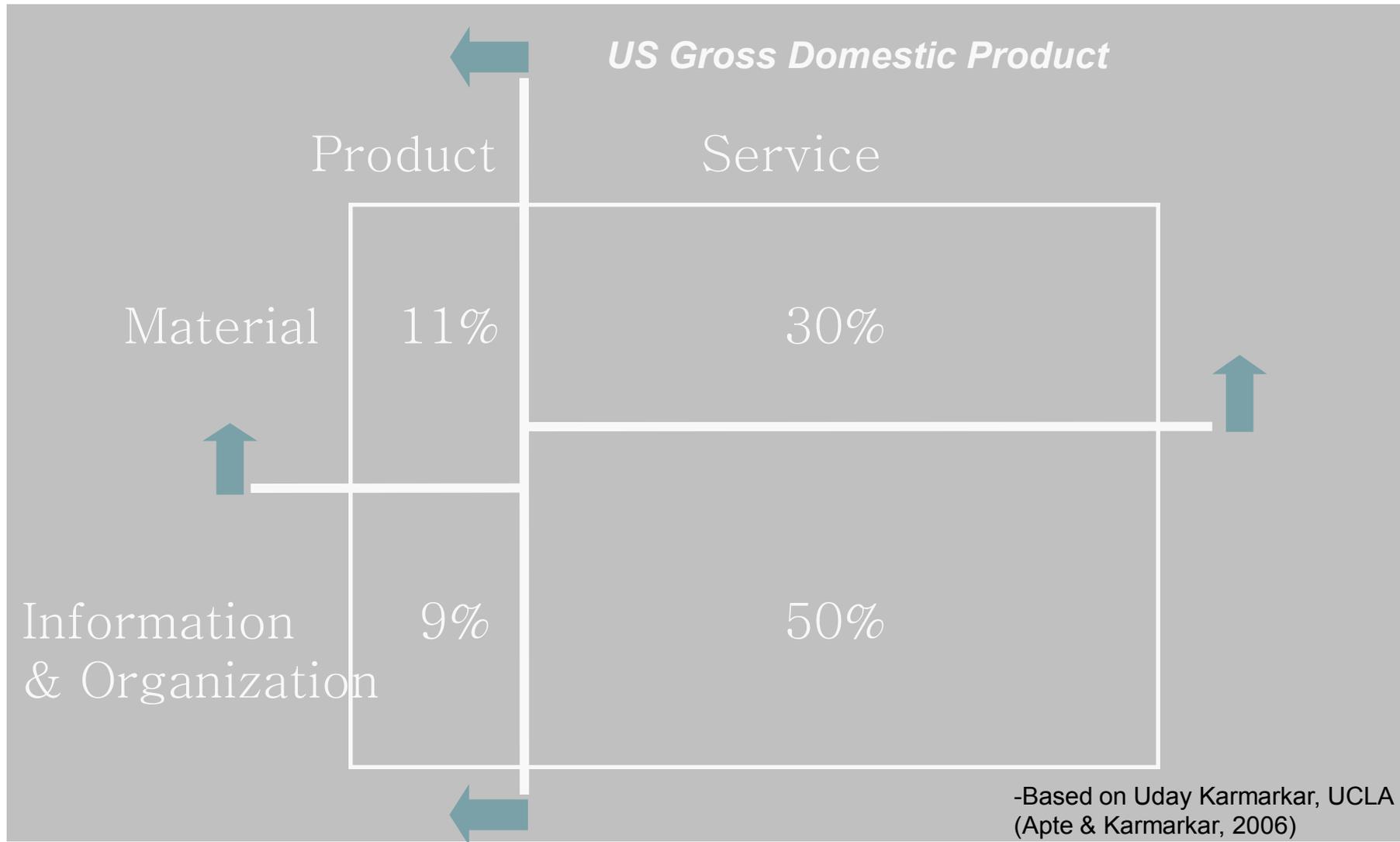
Numeric change in wage-and-salary employment by industry sector, projected 2004-14



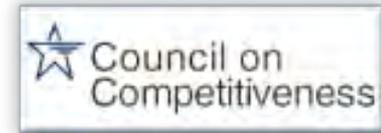
The largest labor force migration in human history is underway, driven by global communications, business and technology growth, urbanization and regional variations in labor and infrastructure costs and capabilities.

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

US GDP shift to service innovation



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

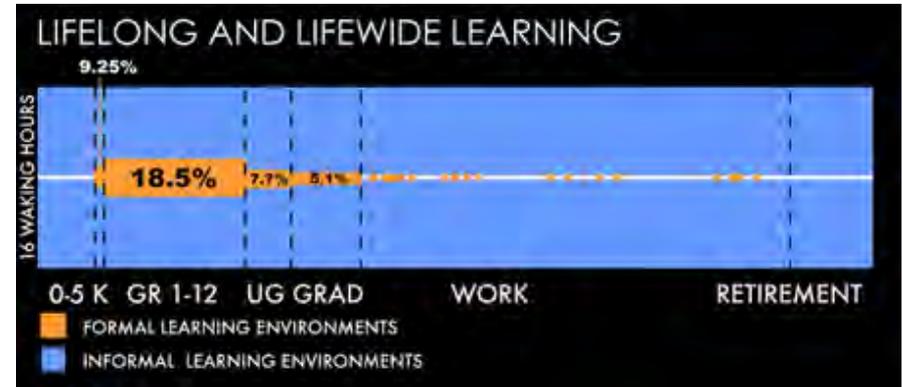
Multi-disciplinary

Global



Learning is also changing....

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



Education's Signposts

Five interrelated signposts have emerged over the last few years directly impacting the rate and direction of change in education.

- 
TECHNOLOGY IMMERSION
 Technology immersion of students
- 
PERSONAL LEARNING PATHS
 Personal and varied learning paths
- 
KNOWLEDGE SKILLS
 Knowledge skills for service-based economies
- 
GLOBAL INTEGRATION
 Global integration of systems, resources, and cultures
- 
ECONOMIC ALIGNMENT
 Education's critical role in a 21st century economy

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.

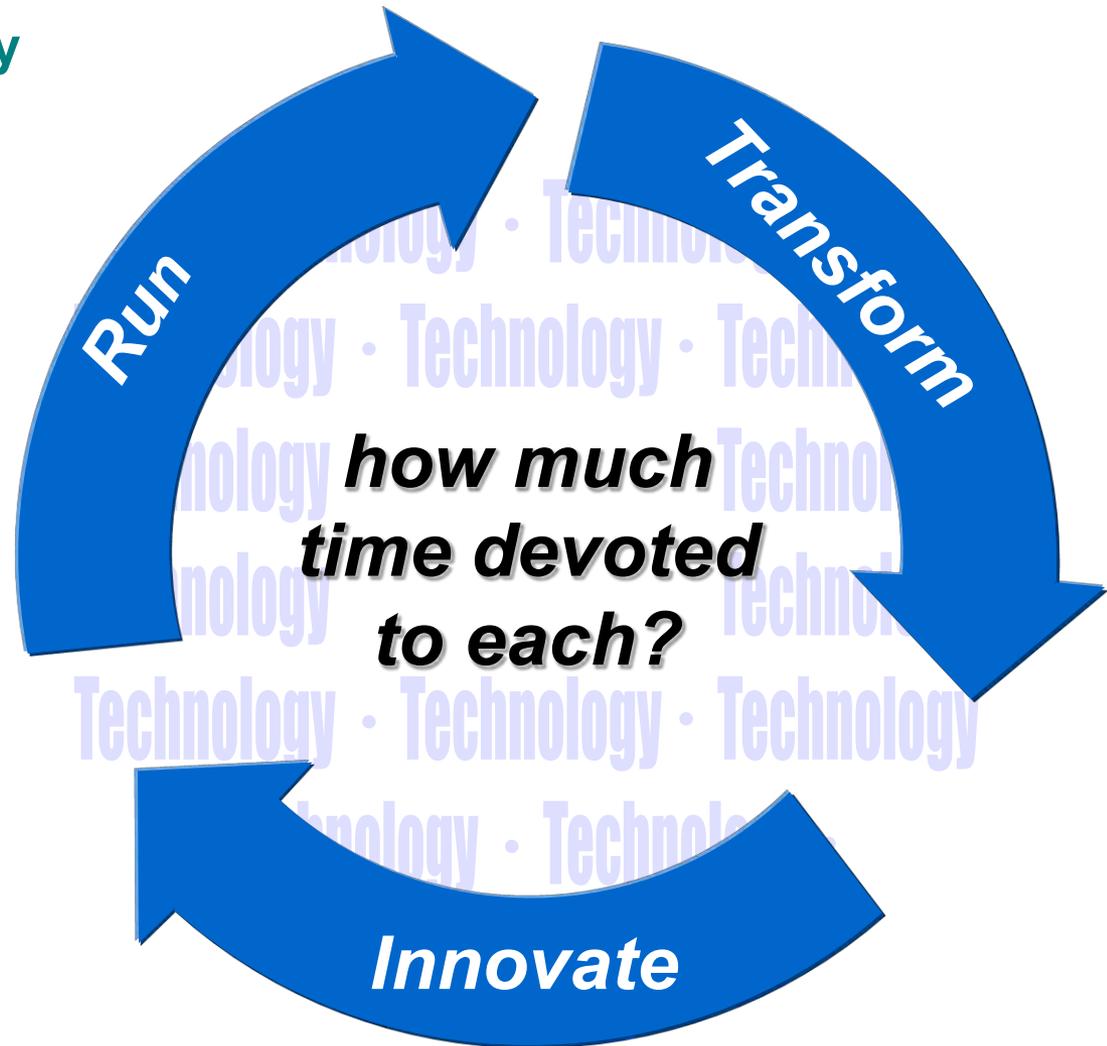
Lifelong learning enables entities to change and adapt as value migrates into new areas of opportunity

▪ 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



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

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
- IBM WebSphere Business Modeler 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

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 -- (IC/As)
- Enterprise Architecture products and services

Smart SOA

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

Top Solutions for Dynamic Infrastructure for Smarter Planet

Reduce
Cost

- **Cloud Computing**
- **Virtualization**
- **Energy Efficiency**
- **Information Infrastructure**

Improve
Service

- **Service Management**
- **Asset Management**
- **Security Management**

Manage
Risk

- **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 Management*
- *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**

*Academic Initiative:
Related Green and Beyond Courseware & Assets*

Smart Systems

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



•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

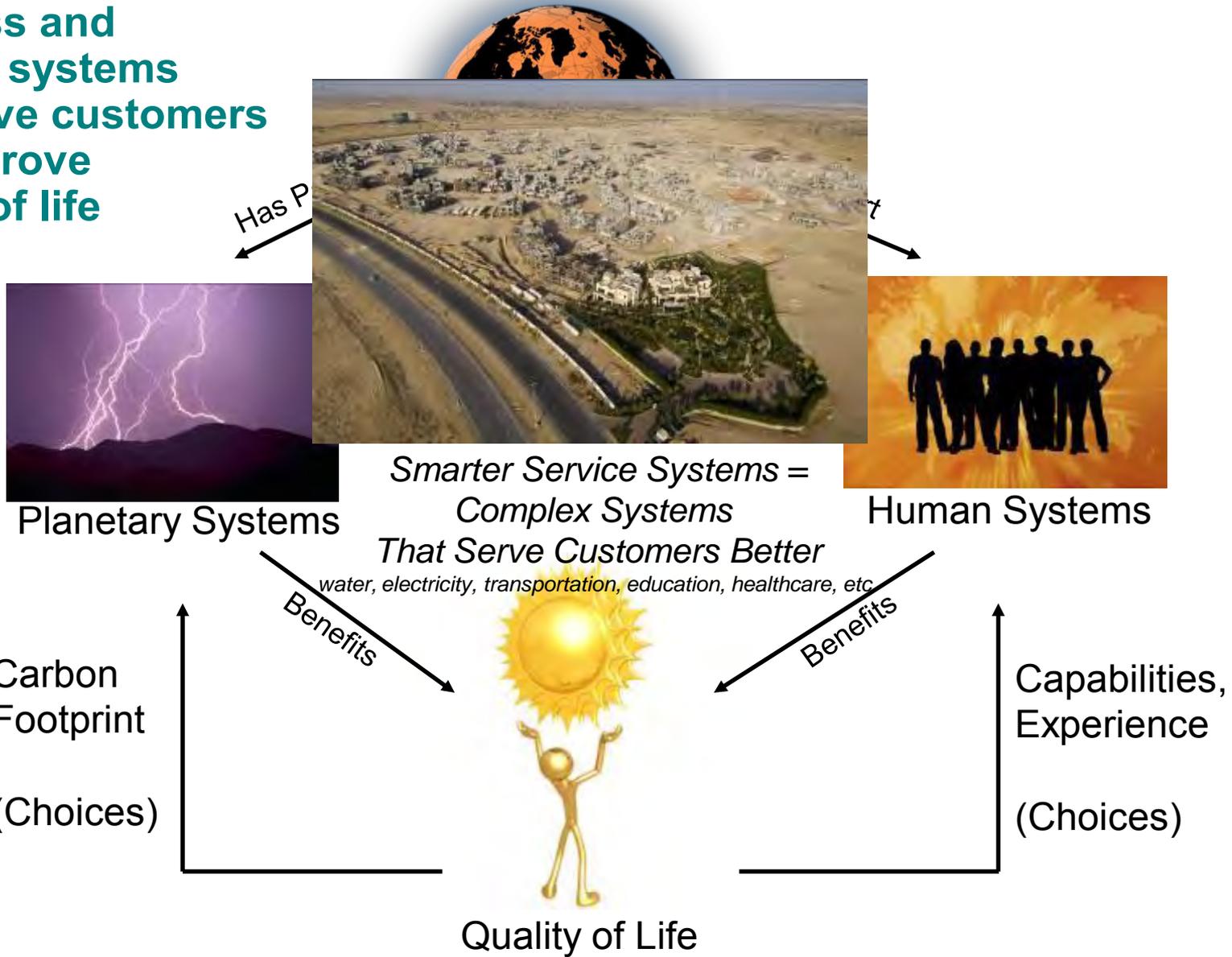
•Telelogic System Architect

Societal Shifts and Corporate Social Responsibility

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

<http://www-304.ibm.com/jct01005c/university/scholars/academicinitiative/>

Business and societal systems that serve customers and improve quality of life



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*

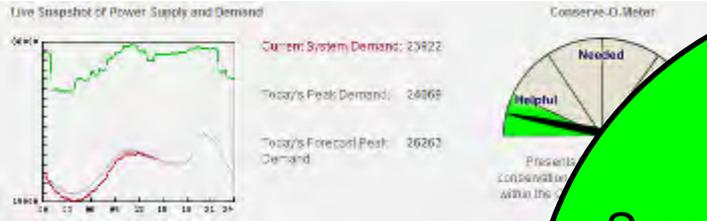


...And that's
a lot to know!



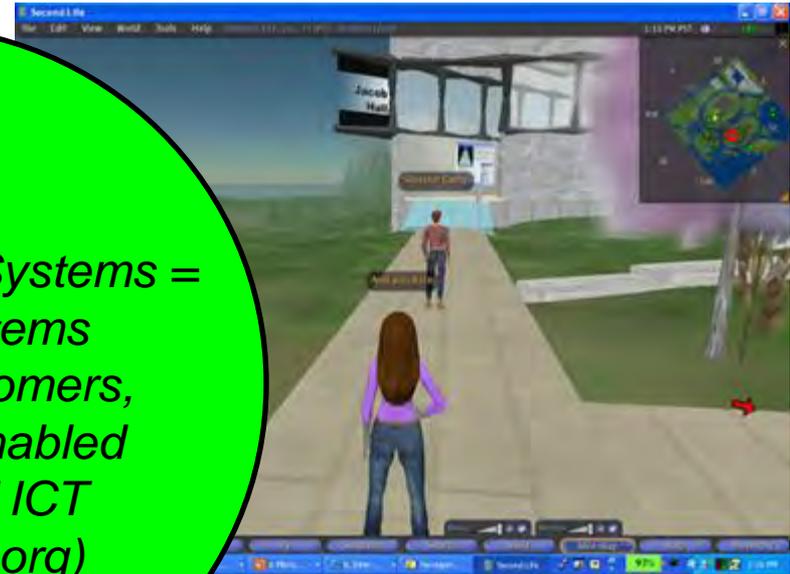
Multiple Approaches to Study Service Systems

Real (Instrumented) World

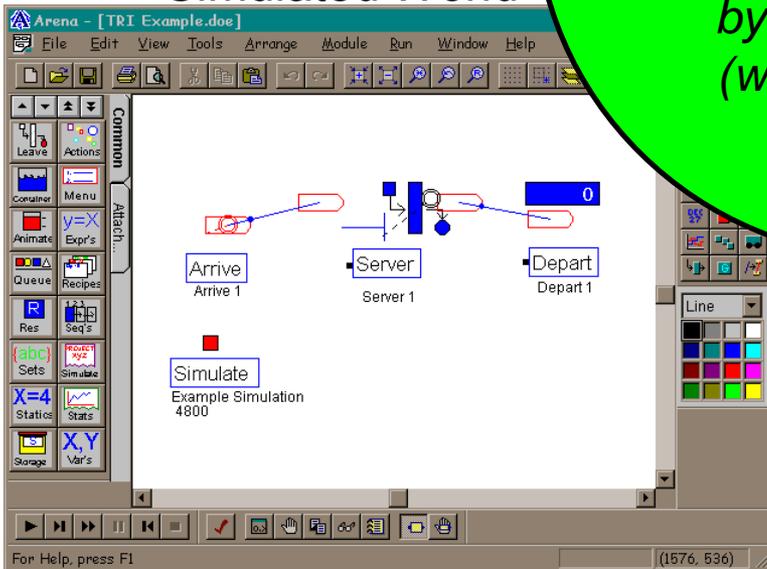


www.caiso.com

Virtual World



Simulated World



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

Mathematical World

$$P(x) = \frac{\lambda^x \cdot e^{-\lambda}}{x!}$$

For $x = 0, 1, 2, 3, 4, \dots$

x = Number of arrivals in a specific period of time

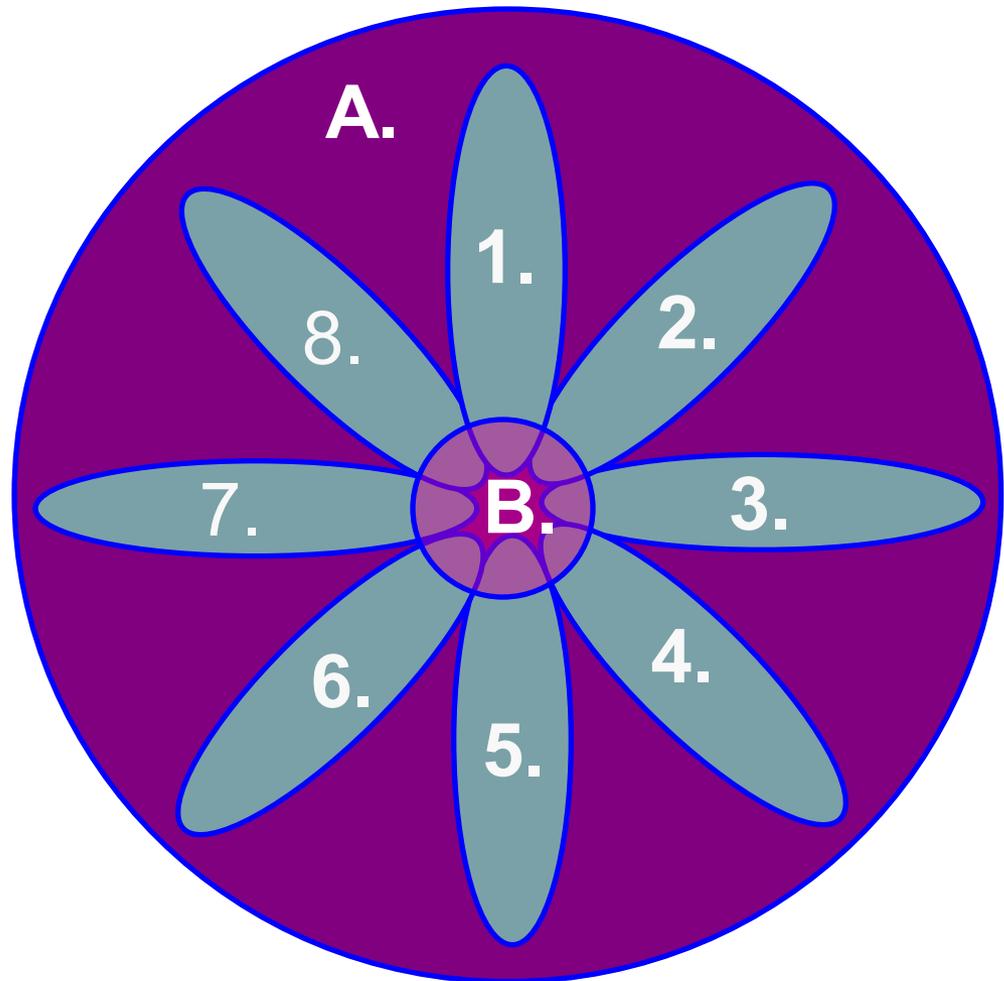
λ = Average number of arrivals for the specific period of time

$e \approx 2.71828\dots$ (Euler's number)

Aren't Service Systems just Social Systems? Related, but...

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

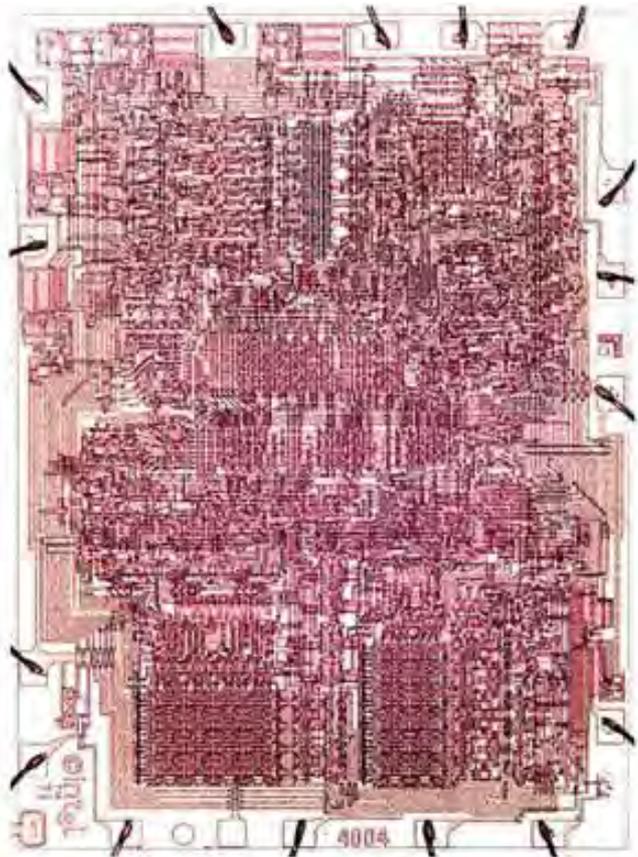
- A. Informal Service Systems
- B. Formal Service Systems
- **1. Social Systems**
 - Human Systems/Sociotechnical Systems
 - Human Cultures
- **2. Technological Systems**
 - Engineered Systems
 - Designed Systems
- **3. Economics Systems**
 - Markets and Organizations
 - Firms or Hierarchies
 - Economic 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

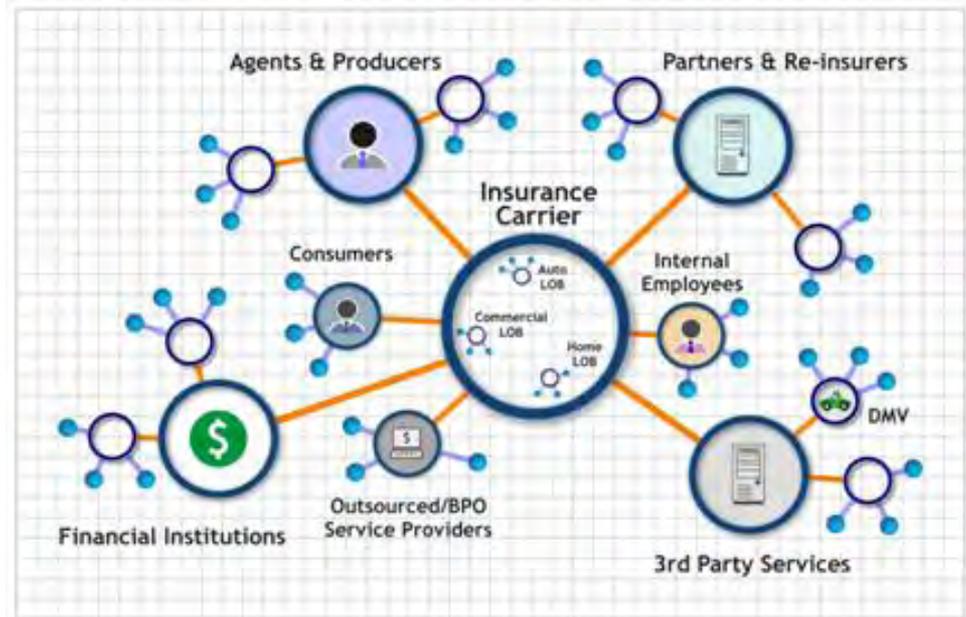
“The goal of science is to make the wonderful and complex understandable and simple – but not less wonderful.” – Herb Simon, The Sciences of the Artificial

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*



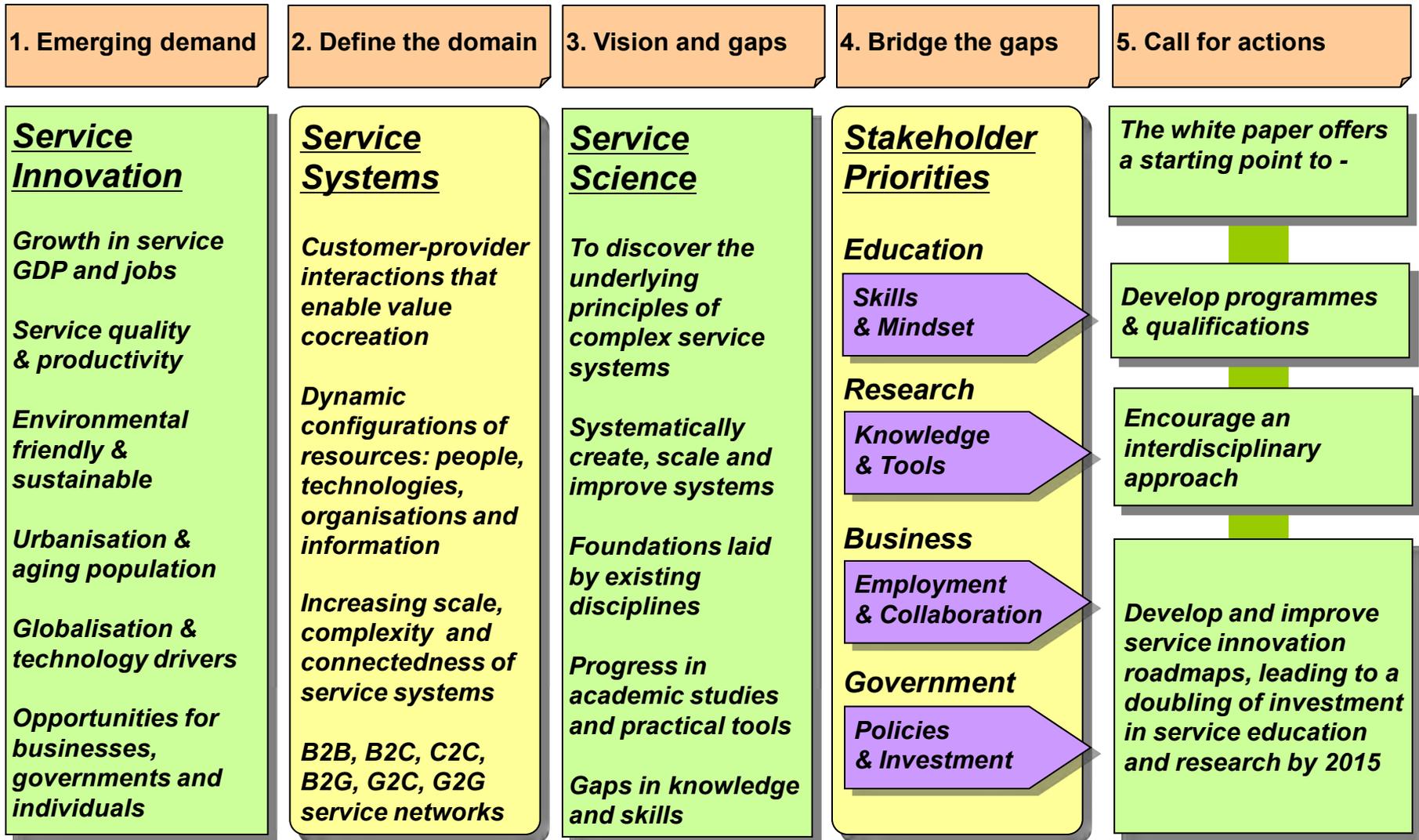
Service System/Network

1. People
2. Technology
3. Shared Information
4. Organizations

connected by value propositions

*More win-win interactions, more value
Requires investment roadmap*

To Get Started On SSME: A Whitepaper for Multiple Stakeholders



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

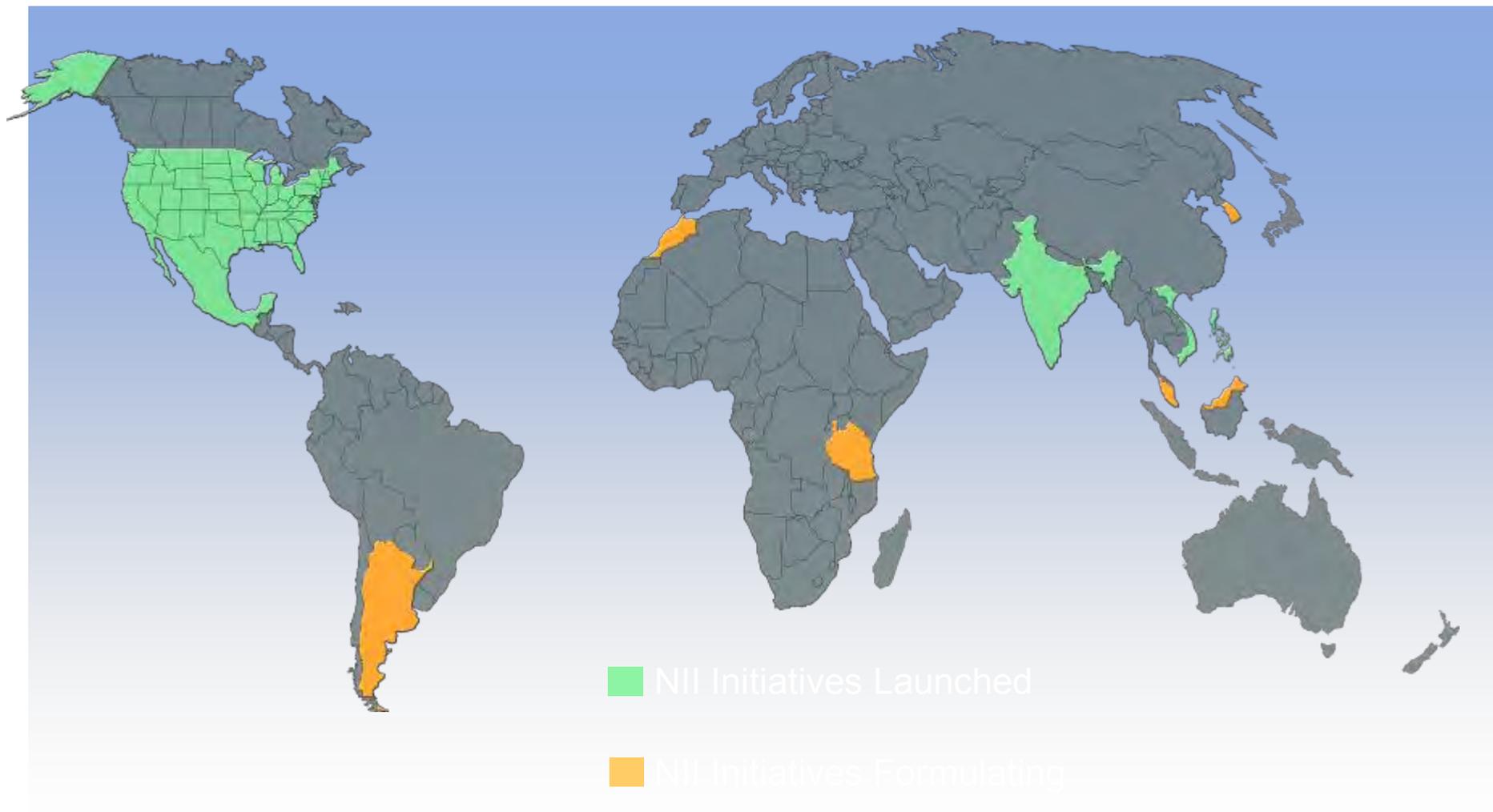
“Succeeding through Service Innovation” Whitepaper: A Framework for Progress

(<http://www.ifm.eng.cam.ac.uk/ssme/>)



Established Innovation Ecosystems

Positioning to Compete in the Global Economy



US Industry Growth: Projected, 2006-2016

Economic News Release

Table 2. The 10 industries with the largest wage and salary employment growth, 2006-2016 (1)

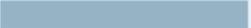
Table 2. The 10 industries with the largest wage and salary employment growth, 2006-2016 (1)
(In thousands)

Industry	Employment		Change	
	2006	2016	Number	Percent
Management, scientific, and technical consulting services	921	1,639	718	77.9
Employment services	3,657	4,348	692	18.9
General medical and surgical hospitals, public and private	4,988	5,679	691	13.9
Elementary and secondary schools, public and private	8,346	8,983	638	7.6
Local government, excluding education and hospitals	5,594	6,206	612	10.9
Offices of physicians	2,154	2,687	534	24.8
Limited-service eating places	4,019	4,548	529	13.2
Colleges, universities, and professional schools, public and private	3,434	3,933	499	14.5
Computer systems design and related services .	1,278	1,768	489	38.3
Home health care services	867	1,348	481	55.4

1 Data are from the National Employment Matrix.

World's Largest Labor Forces (2005)

- Source: www.nationmaster.com

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

Service industries: a geographical appraisal

48 Service Industries

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

<i>Developing countries</i>	<i>1960</i>		<i>1970</i>		<i>1980</i>	
	<i>GDP¹</i>	<i>LF²</i>	<i>GDP</i>	<i>LF</i>	<i>GDP</i>	<i>LF</i>
Latin America and Caribbean (middle)	48.1	33.6	48.8	38.6	51.0	42.4
Latin America and Caribbean (low)	46.5	21.7	47.5	27.1	51.3	30.9
Asia (middle)	43.9	19.8	44.4	24.2	45.7	28.1
Asia (lower)	32.2	15.5	34.1	19.1	39.8	22.6
India	39.6	14.6	32.6	17.2	38.1	20.6
Africa and Middle East (oil)	23.1	20.0	18.8	25.3	29.6	29.9
Africa and Middle East (middle)	37.5	17.9	36.7	21.6	44.4	25.4
Africa (low)	32.1	7.3	38.2	9.6	42.4	11.4
China	—	9.8	—	11.9	22.0	14.1
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.

developed and less developed countries

<i>Country and year</i>	<i>Share in total labourforce (%)</i>		
	<i>Agriculture</i>	<i>Industry</i>	<i>Services</i>
Great Britain			
1851–61	21.6	56.9	21.5
1921	7.2	56.9	35.9
1961	3.7	55.0	41.3
Change 1851–1961	– 16.0	0.0	+ 16.0
Netherlands			
1849	45.4	29.4	25.2
1960	11.0	50.5	38.5
Change 1849–1960	– 34.4	+ 21.1	+ 13.3
Sweden			
1860	64.0	18.8	17.2
1910	48.3	32.2	19.5
1960	13.8	52.7	33.5
Change 1860–1960	– 50.2	+ 33.9	+ 16.3
Japan			
1872	85.8	5.6	8.6
1920	54.6	25.4	20.0
1964	27.6	37.4	35.0
Change 1872–1964	– 58.2	+ 31.8	+ 26.4
United States			
1839	64.3	16.2	19.5
1929	19.9	38.8	41.3
1965	5.7	38.0	56.3
Change 1839–1965	– 55.9	+ 21.0	+ 34.9
India			
1881	74.4	14.6	11.0
1961	73.5	13.1	13.4
Change 1881–1961	– 2.2	+ 0.6	+ 1.6
Egypt			
1907	71.2	14.1	14.7
1960	58.3	15.6	26.1
Change 1907–60	– 12.9	+ 1.5	+ 11.4

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.

Ibid

Table 2.3 Labourforce in agriculture, industry and services, 1950–70

Region	Year	Sector(%)			Total (thousands)
		Agriculture	Industry	Services	
World	1950	64.3	16.3	19.3	1,100,150
	1960	57.7	20.1	22.2	1,297,400
	1970	51.0	22.9	26.1	1,508,613
	Change, 1950–70 (%)	+ 8.5	+ 92.6	+ 85.1	
More developed regions ¹	1950	37.6	30.4	32.0	397,436
	1960	28.1	34.6	37.3	441,798
	1970	18.3	37.6	44.1	487,930
	Change, 1950–70 (%)	– 40.2	+ 51.9	+ 68.9	
Less developed regions ²	1950	79.5	8.4	12.2	199,714
	1960	72.9	12.7	14.4	855,602
	1970	66.6	16.0	17.5	1,020,684
	Change 1950–70 (%)	+ 21.6	+ 175.9	+ 109.3	

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.

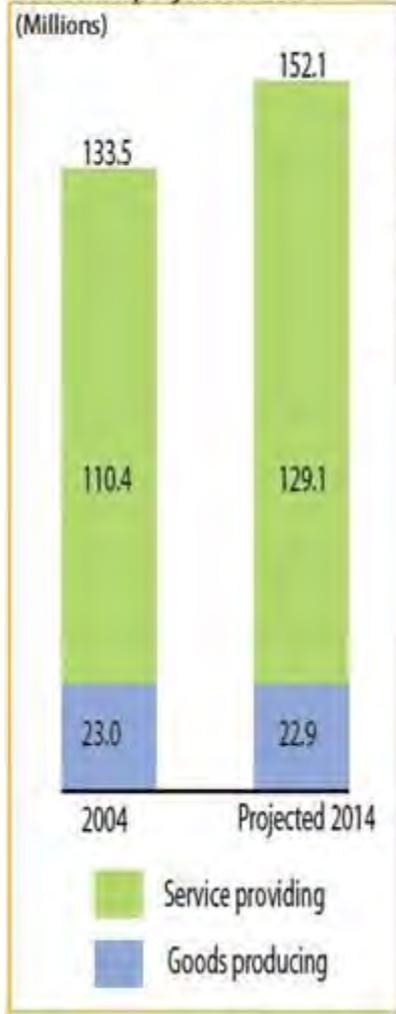
Ibid

Table 2.4 Labourforce in agriculture, industry and services: continental comparisons, 1970

<i>Continent</i>	<i>Sector (%)</i>			<i>Total (thousands)</i>
	<i>Agriculture</i>	<i>Industry</i>	<i>Services</i>	
Africa	71.5	11.3	17.2	136,653
Latin America	40.8	21.8	37.4	89,166
North America	4.1	34.2	61.7	95,764
Asia	64.8	17.5	17.8	859,730
Europe	20.8	40.5	38.8	201,428
Eastern Europe	34.9	37.8	27.6	53,231
Western Europe	9.8	44.5	45.7	62,560
Oceania	23.7	30.4	46.0	8,184
USSR	25.7	37.7	36.7	117,688

Source: Kuznets, 1971, table 3, 41–8.

Numeric wage-and-salary employment by industry type, 2004 and projected 2014



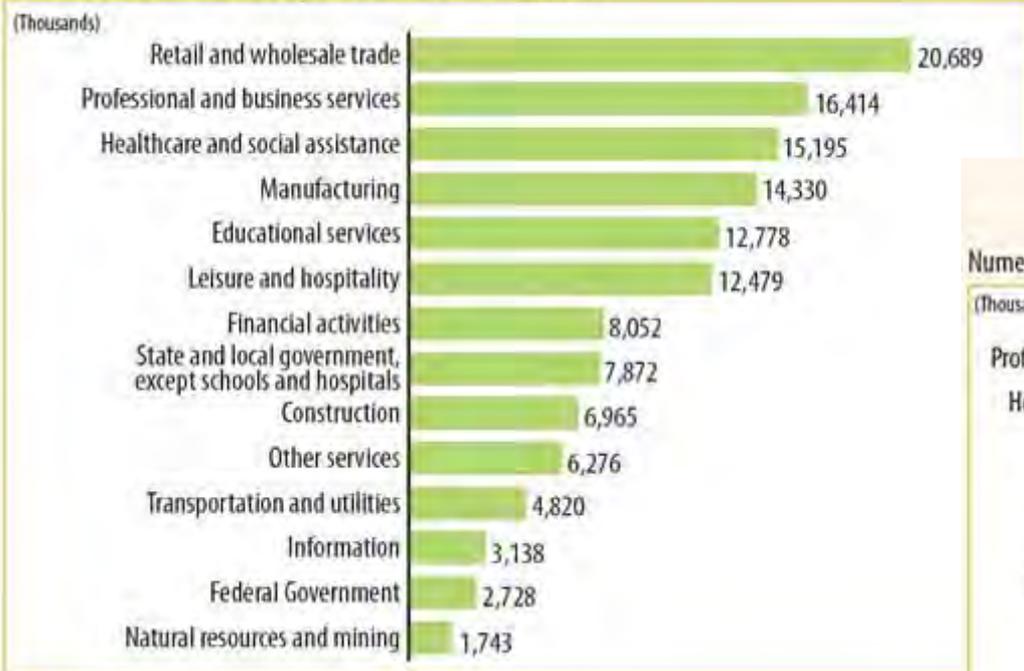
Service-providing industries are projected to account for most job growth, generating almost 19 million new jobs between 2004 and 2014. This is due, in part, to increased demand for services and the difficulty of automating service tasks.

“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.”

US Bureau of Labor Statistics.
<http://www.bls.gov/opub/ooq/2005/winter/art03.pdf>



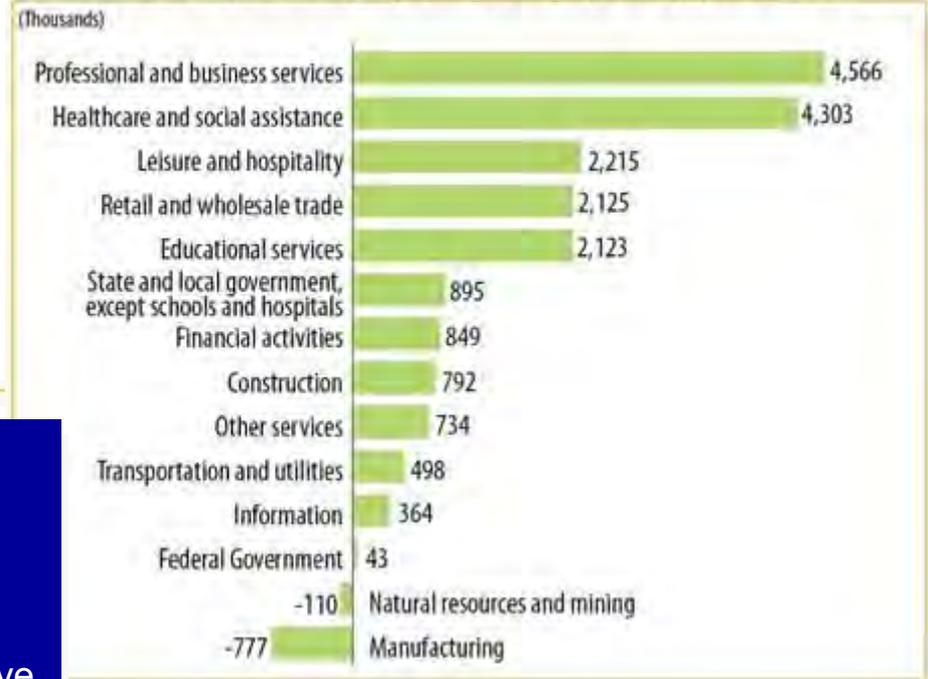
Numeric wage-and-salary employment by industry sector, 2004



US Bureau of Labor Statistics.
<http://www.bls.gov/opub/ooq/2005/winter/art03.pdf>

Employment change

Numeric change in wage-and-salary employment by industry sector, projected 2004-14



“... 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

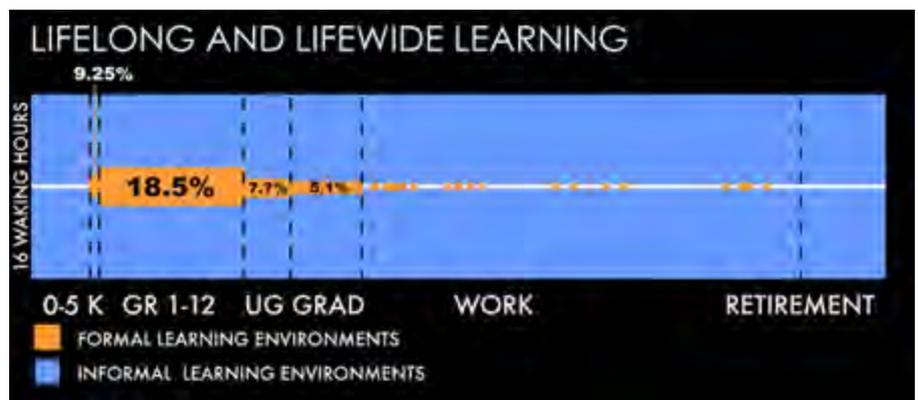
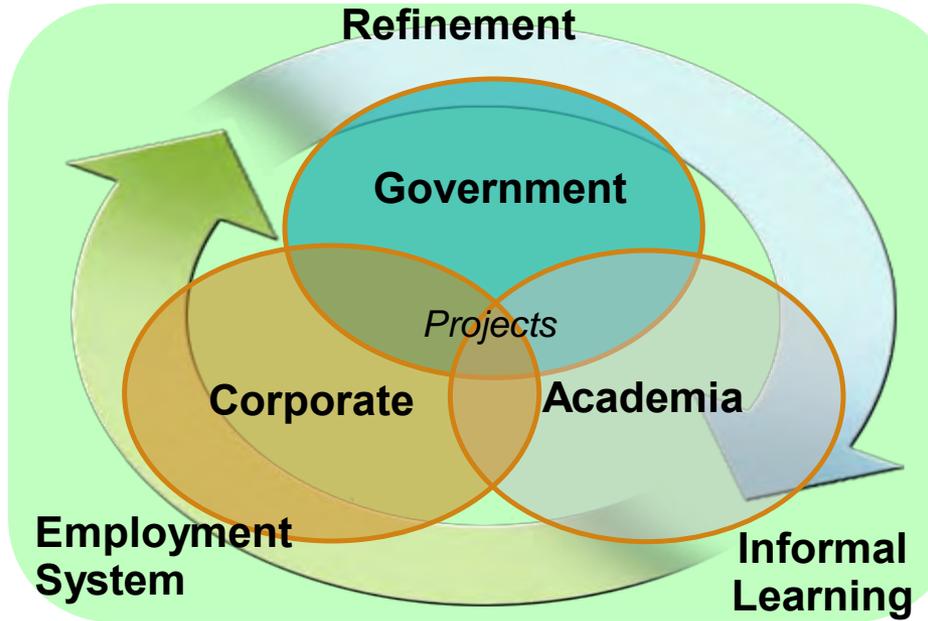
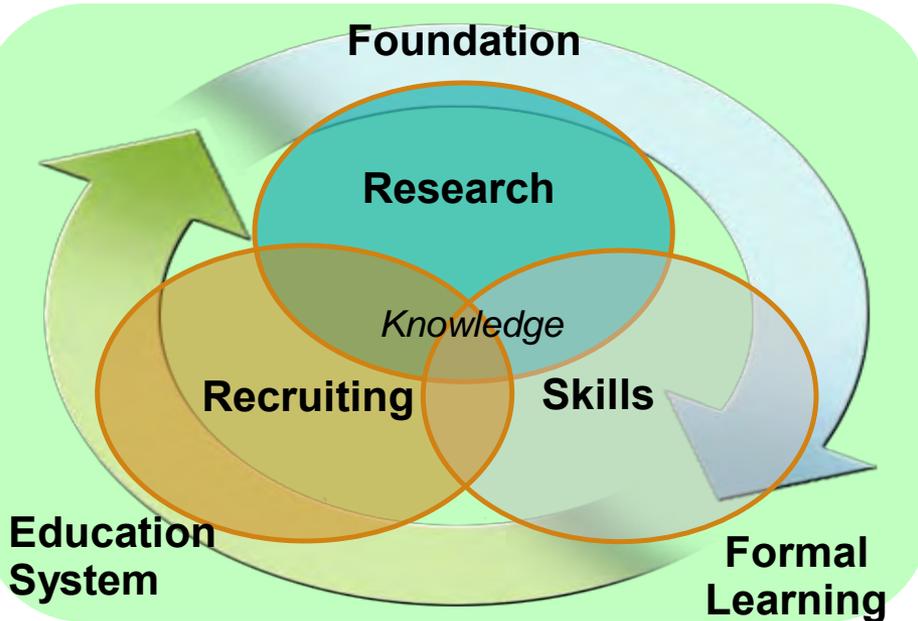
“Services is an understudied field”

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

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.”

National Academy of Engineering (2003). "The Impact of Academic Research on Industrial Performance"

Two Dominant Worlds of 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