Service Science, Management, and Engineering (SSME):

A Next Frontier in Education, Employment, Innovation, and Economic Growth

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National Academy of Sciences, Keck Center| Washington, DC | March 29, 2007
Committee on Enhancing the Master's Degree in the Natural Sciences

What industry wants from the academy…
(based on informal email survey of IBM colleagues *)

- Depth (deep discipline knowledge and problem solving expertise)
  - Strong professional affiliation, conferences, publications
- Breadth (multidisciplinary vocabulary & appreciation of value)
- Practical Experience (Internships, completed projects, patents)
  - Ability to use tools of trade effectively
- Communications (multidisciplinary vocabulary, value propositions)
- Teaming (multidisciplinary vocabulary & appreciation, interpersonal)
- Project Management (schedules, deadlines, budgets, resources)
- People Management (leadership, motivation, cultural, diversity)
- Strategic Planning (market, competition, opportunity insights)
- Problem solving via informatics/computation
- Problem solving via social networks/open forums
- Flexible, adaptive, and entrepreneurial (idea to deployment)
- Produced on demand (custom designed to meet business need)

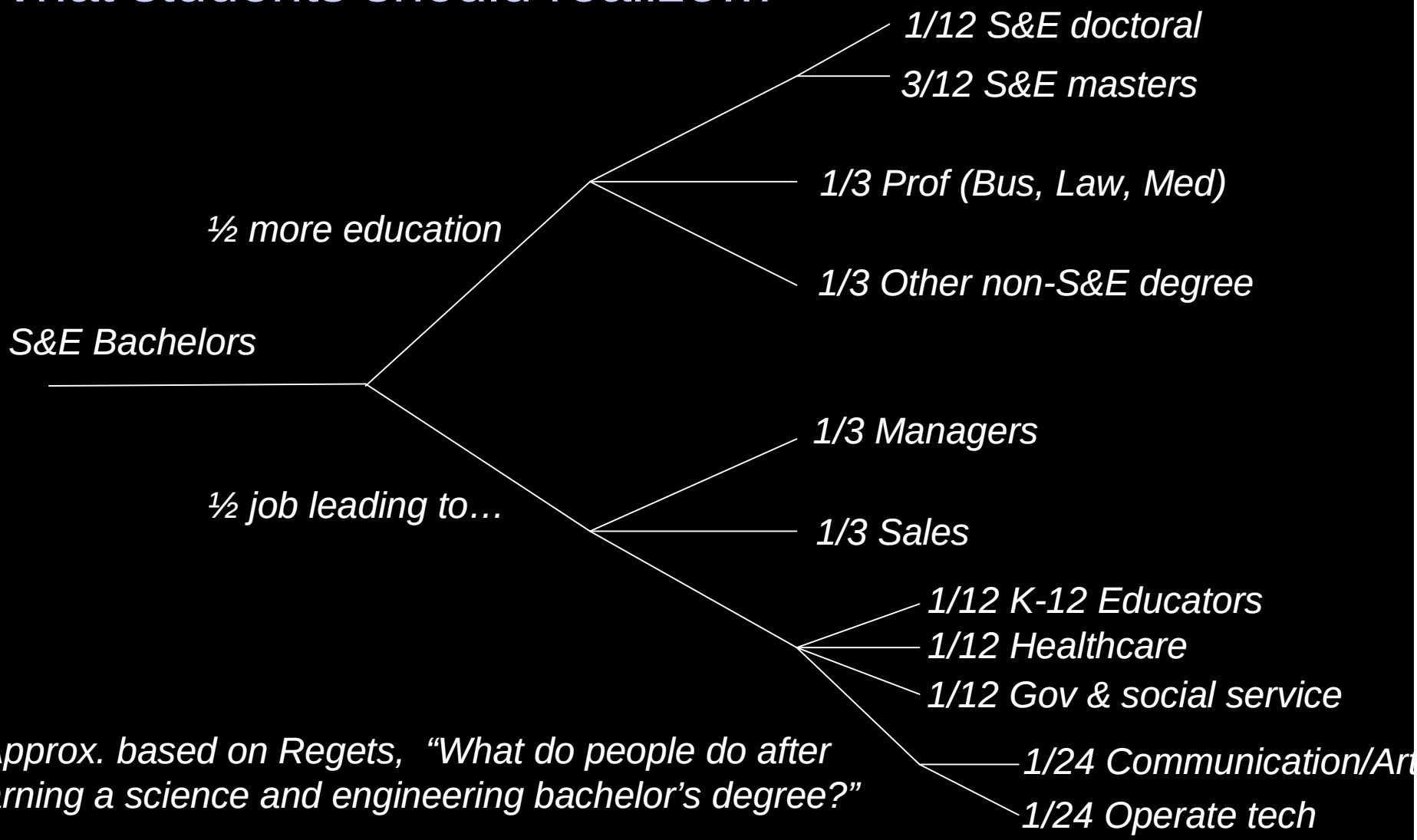
** Note the informal survey was of IBM Research professional 3/21/07*

Validation of employers expressed strong preference in Teitelbaum's "A New Science Degree to Meet Industry Needs"

- Broad understanding of relevant disciplines at the graduate level and sufficient flexibility in their research interests to move smoothly from one research project to another as business opportunities emerge
- Capabilities and experience in the kind of interdisciplinary teamwork that prevails in corporate R&D
- Skills in computational approaches
- Skills in project management that maximize prospects for on-time completion
- The ability to communicate the importance of research projects to nonspecialist corporate managers
- The basic business skills needed to function in a large enterprise

Professional Science Master (PSM) is
very much in the right direction from industry perspective

What students should realize…



Approx. based on Regets, "What do people do after earning a science and engineering bachelor's degree?"

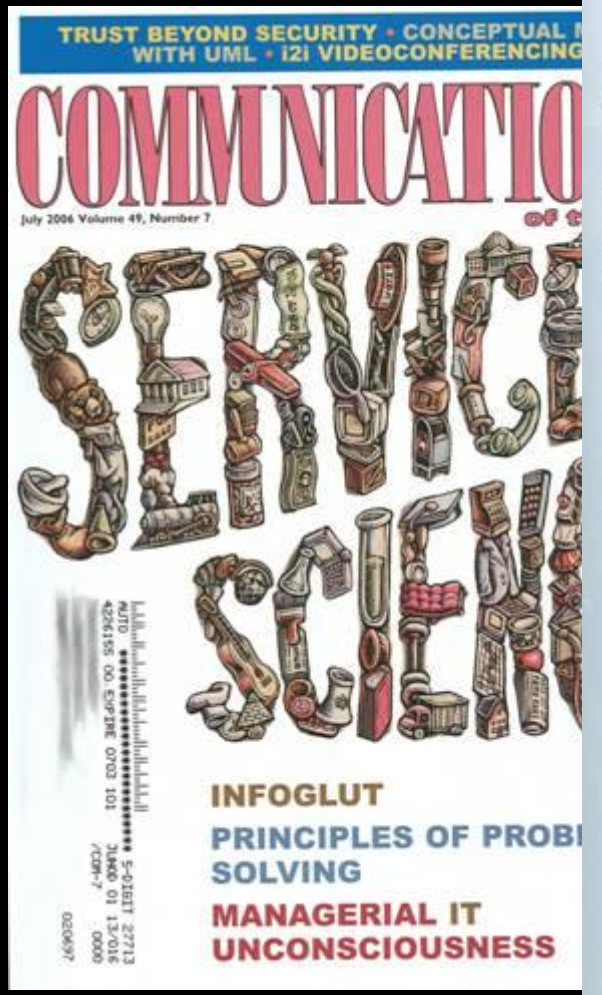
Systemic Problems: What we need to solve…

- Lack of large scale data collection about people's educational and professional trajectories across complete lifespan
  - what are the transition probabilities between different job/professional roles
- Ad hoc mechanisms for
  - tuning academy service efforts to industry needs and opportunities
  - transforming curricula to stay in touch with latest advances in discipline knowledge (faculty and research interests)
  - exploiting e-learning systems for continuous improvement
  - industry and project experience to complement classroom education
  - projecting future needs
- No continuous improvement mechanism to year over year decrease the amount of time it takes to educate students on standard content
- Too much emphasis on preparing for a job, and too little emphasis on preparing to be an innovator and entrepreneur

Service scientists are both broad and deep – T-shaped.

"Need I-shaped, T-shaped, π-shaped people… " – Stuart Feldman (Oct. 6, 2006)

Communications of the ACM, July 2006



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Services Science

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16th Annual AMA Frontiers in Service Conference

2007

October 4 - 7

At San Francisco's
Westin St Francis

IBM

Robert H. Smith School of Business
Leaders for the Digital Economy

American Marketing Association
MarketingPower.com

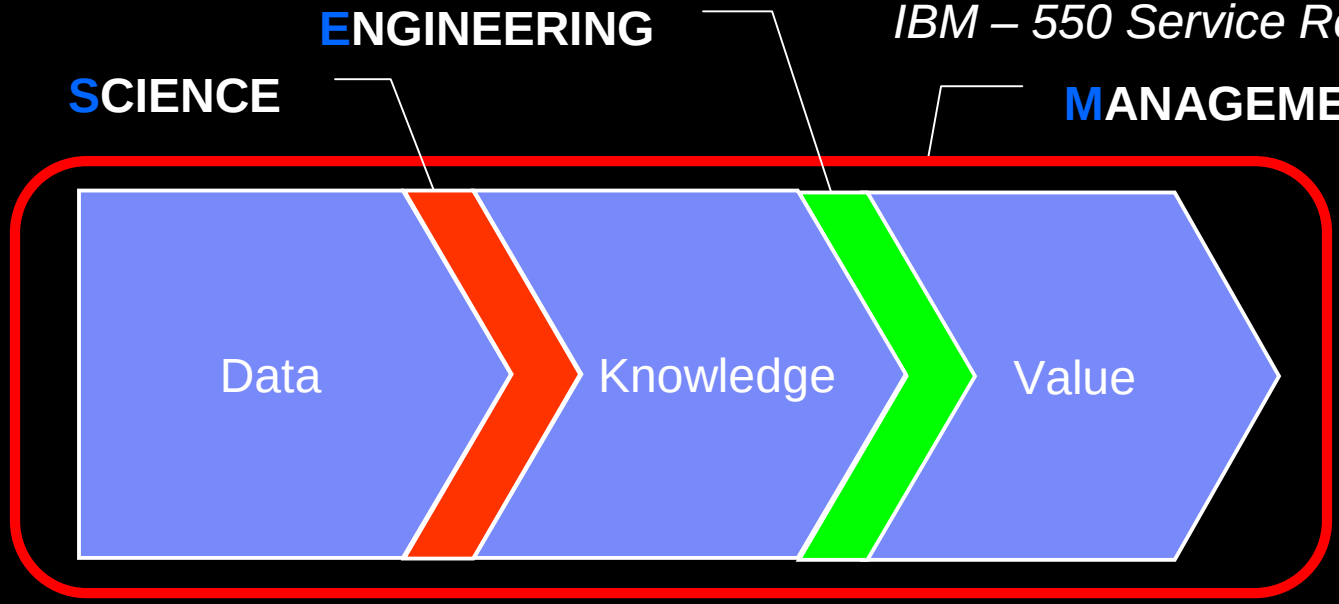
What is SSME, really?

- **An urgent "call to action"**
- **A proposed academic discipline**
- **A proposed research area**

Study of SERVICE Systems

Related activities to date include:

ACM, IEEE, INFORMS SIGs forming
38 Programs, 22 Countries
Over 100 conference and journal papers
>100 Press, >10,000 Web site mentions
Germany - $87M Innovation with Services
European Union - NESSI $100M pending
China – 5 Year Plan "Modern Services"
Japan - $30M Service Productivity
US - NSF SEE $4M plus other
IBM – 550 Service Researchers WW



Slide based on that of Ravi Nemana, UC Berkeley SSME Director

Why is SSME so important?

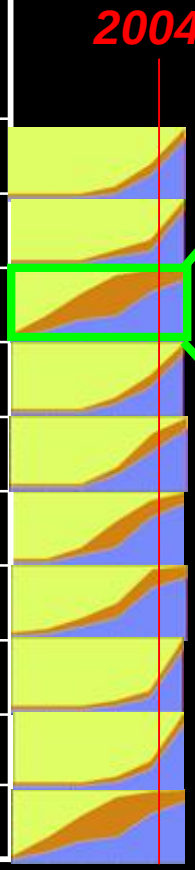
Service innovation driving GDP growth.

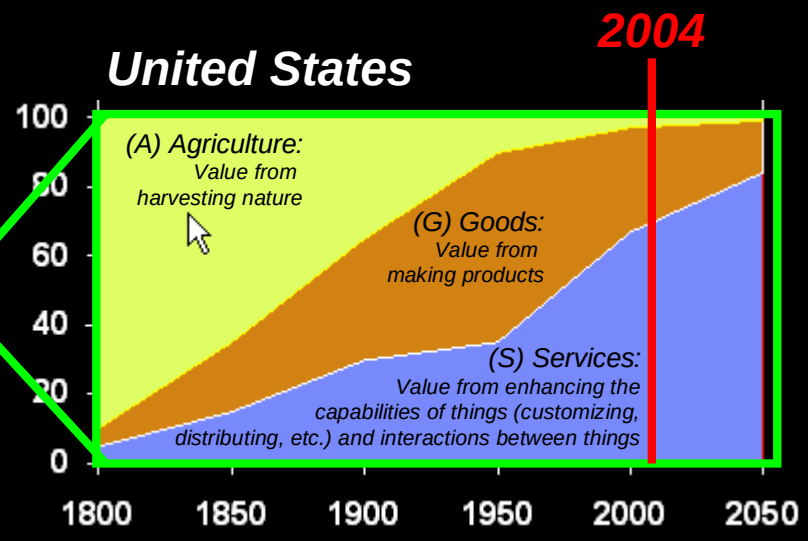
Top Ten Nations by Labor Force Size

(about 50% of world labor in just 10 nations)

A = Agriculture, G = Goods, S = Services

Nation	% ww Labor	% A	% G	% S	25 yr % delta S
China	21.0	50	15	35	191
India	17.0	60	17	23	28
U.S.	**4.8**	**3**	**27**	**70**	**21**
Indonesia	3.9	45	16	39	35
Brazil	**3.0**	**23**	**24**	**53**	**20**
Russia	**2.5**	**12**	**23**	**65**	**38**
Japan	**2.4**	**5**	**25**	**70**	**40**
Nigeria	2.2	70	10	20	30
Banglad.	2.2	63	11	26	30
Germany	**1.4**	**3**	**33**	**64**	**44**

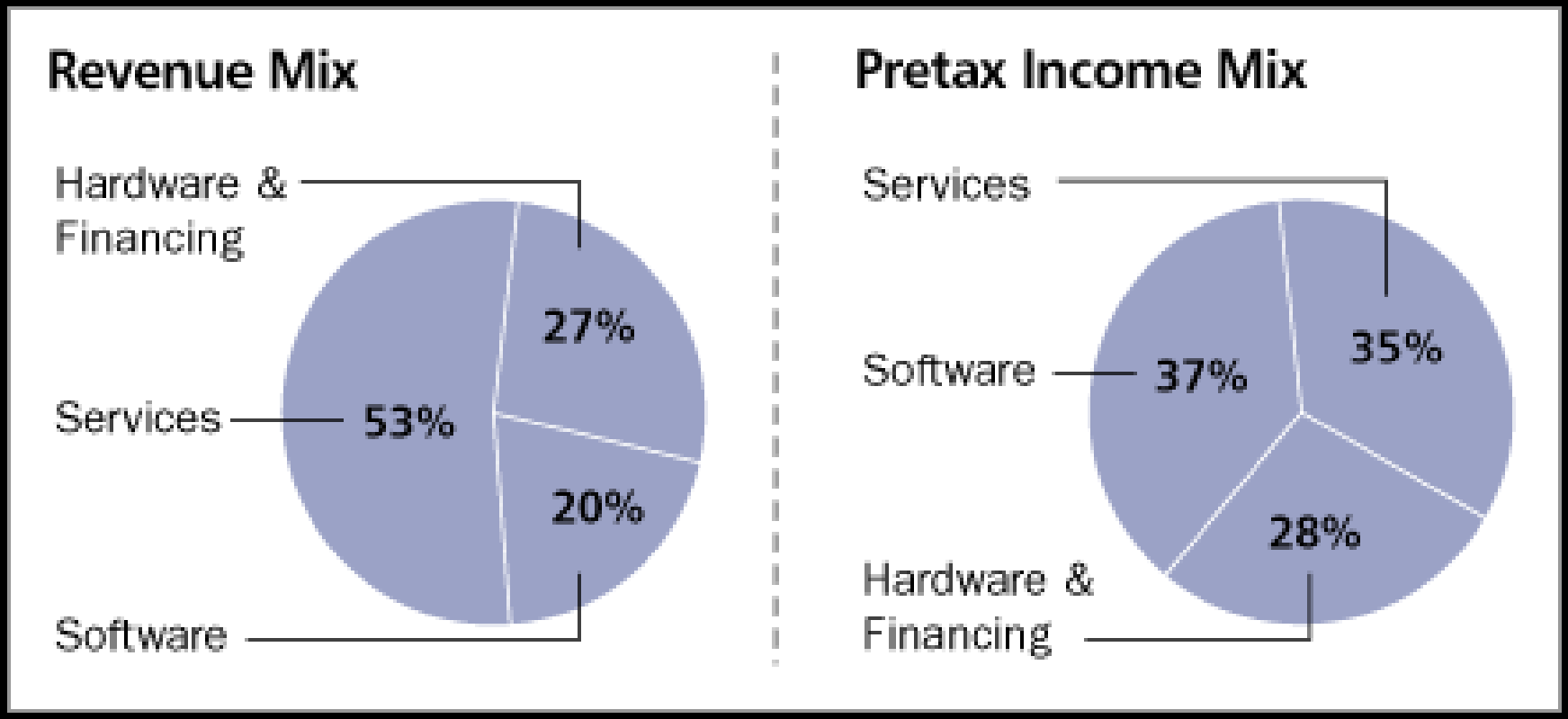




The largest labor force migration in human history is underway, driven by global communications, business and technology growth, urbanization and low cost labor.

>50% (S) services, >33% (S) services

IBM Revenue and PTI Profits Mix

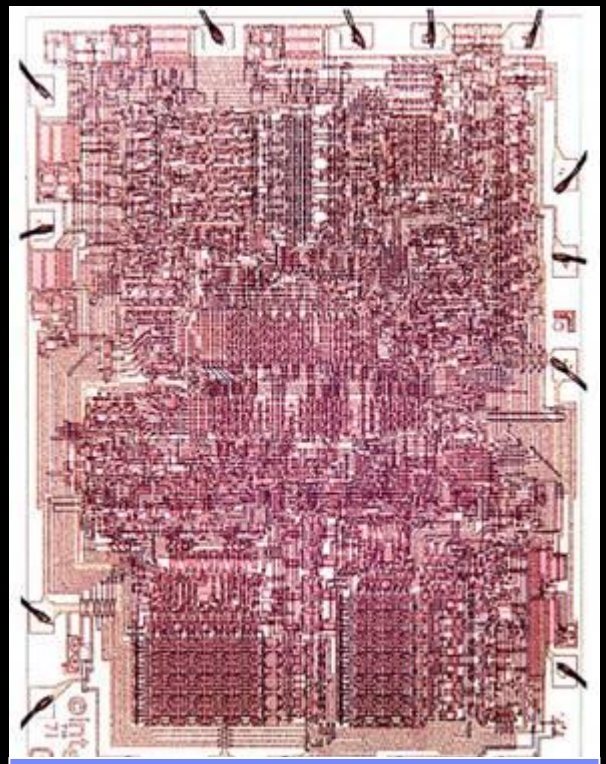


Fundamental Service Science Challenge:

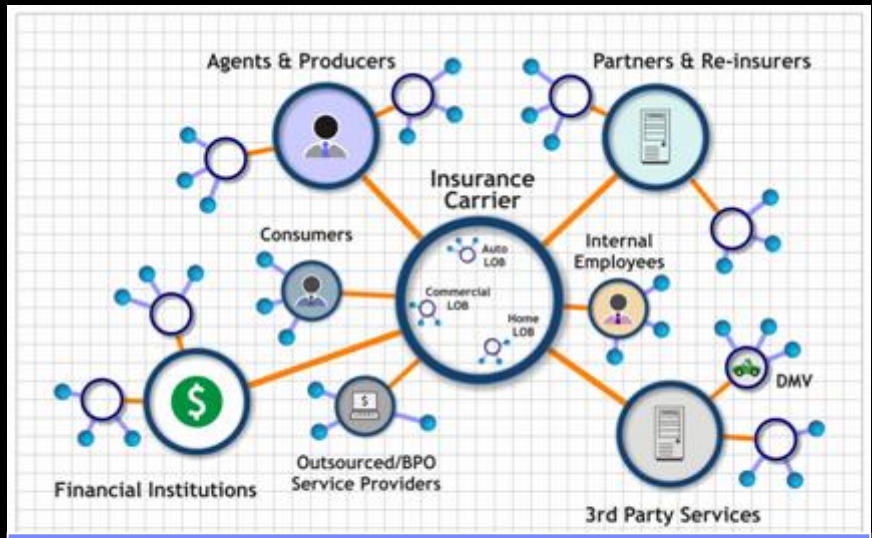
Scaling & learning curves are different for IT manufacturing and IT services

How to invest to make progress (efficiency effectiveness, and sustainable growth)?

How to invest to make progress?

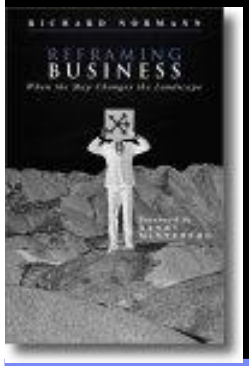


Computational System



Service System (Value Creating System)

1. *People (division of labor, multi-tasking)*
2. *Technology*
3. *Value Propositions Connecting Internal and External Service Systems*
4. *Shared Information (language, laws, measures)*

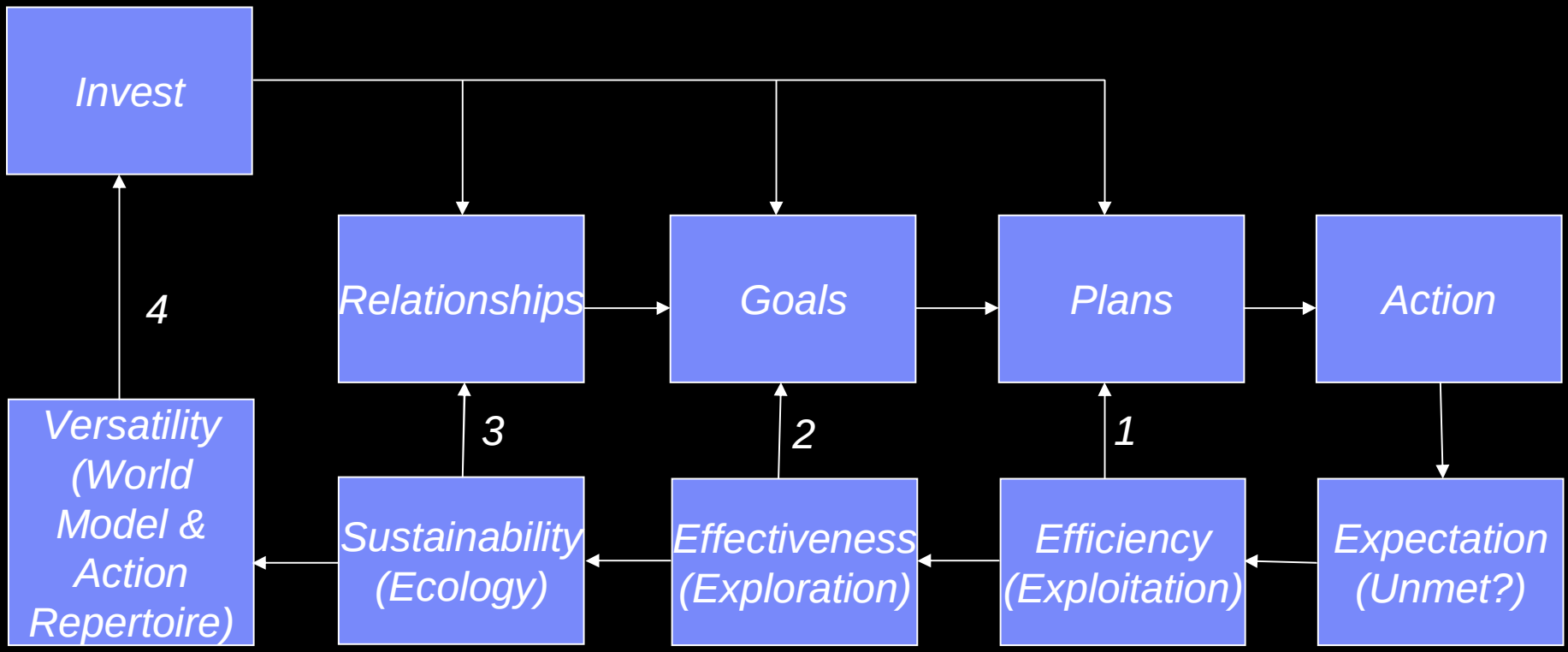


Moore's Law
Higher density transistor configurations

Normann's Law?
Higher density value co-creation configurations

Reframing Business: When the Map Changes the Landscape
Richard Normann

Quadruple Loop Learning of Service Systems

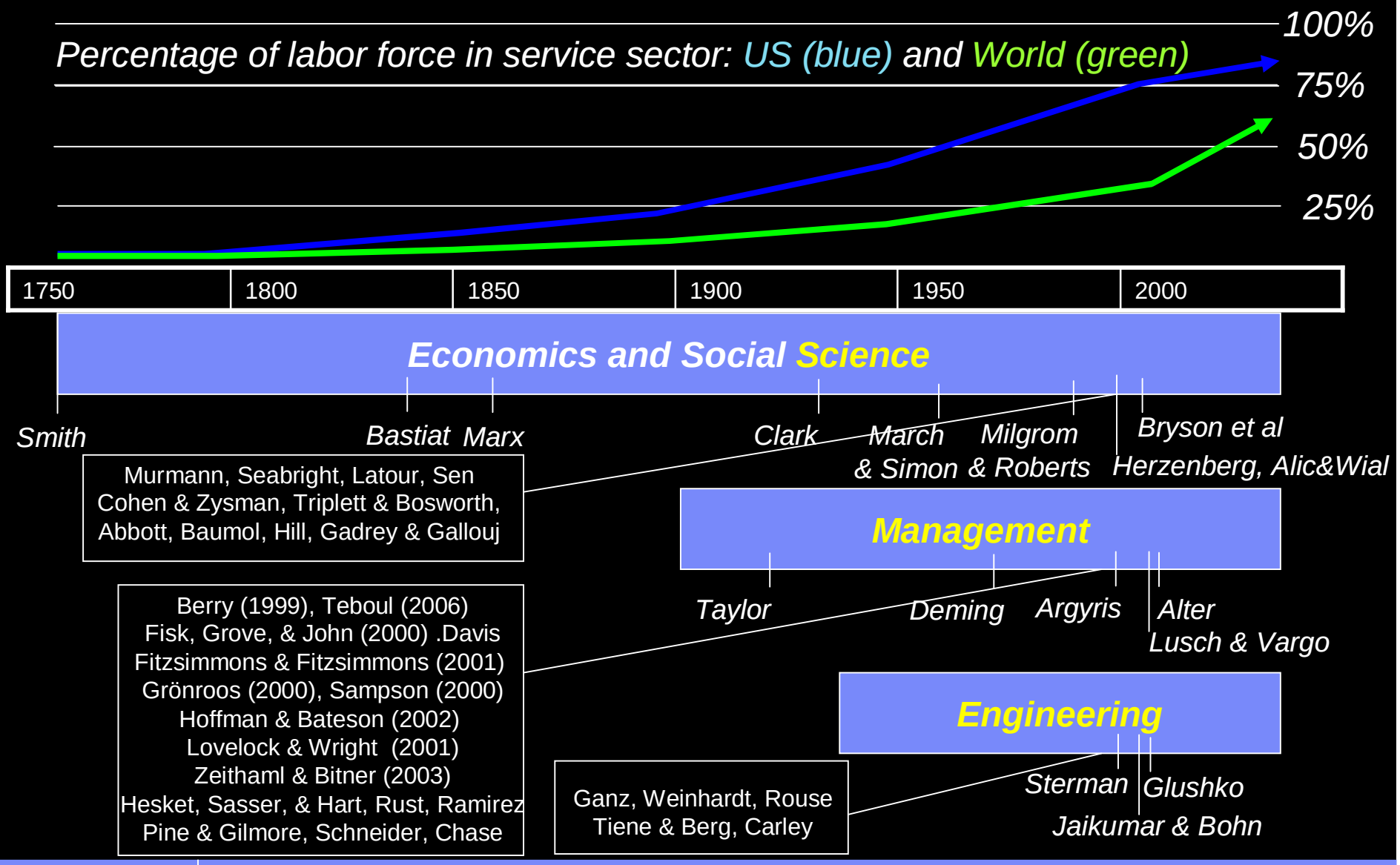


Service actions have quantitative, qualitative, and serendipity components. (Measurable experiential constructs and their relationships)

How do service systems learn and evolve?

Category	Change	Direction			
Efficiency	Communication and Transportation Costs	=	-	+	?
Efficiency	Transaction Costs (Trust, Coase, North, etc.)	=	-	+	?
Effectiveness	World Model Fidelity (sense, store, compute, etc.)	=	-	+	?
Effectiveness	Number of Services Accessible	=	-	+	?
Effectiveness	Capabilities/Skills of People (learning curves)	=	-	+	?
Efficiency & Effectiveness	Time Costs/Quality of Experience (waste, boredom, stress, etc.)	=	-	+	?
Versatility & Sustainability	Innovation Rates (versus compliance rates)	=	-	+	?
Versatility & Sustainability	Self Sufficiency (versus interconnectedness)	=	-	+	?
All	Number of People (professions, salaries, ages, diversity, etc.)	=	-	+	?

SSME: Growing Body of Knowledge about Service



Service is value co-creation

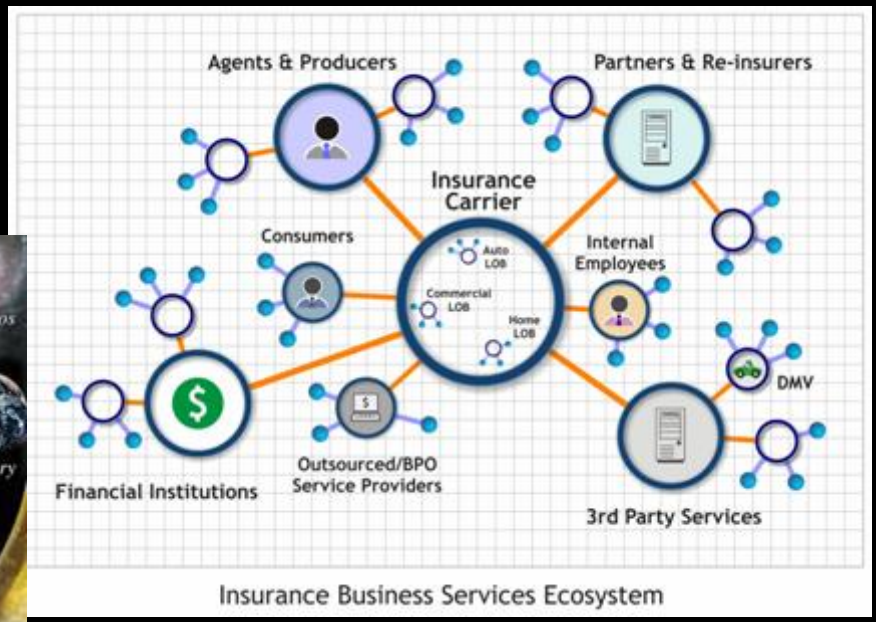
Lose-win (coercion)	Win-win (service: value coproduction)
Lose-Lose (war: value codestruction)	Win-Lose (loss lead)

Provider

Customer/Client

- Provider and customer interact to coproduce value
- Value is achieving desired change or the prevention/undoing of unwanted change
- Changes can be physical, mental, or social (= collective mental states – common or distributed knowledge)
- Value is in the eye of the beholder, and may include complex subjective intangibles, bartered – knowledge intensive
- Boundary of service experience in space and time may be complex

A service system is a type of complex system



Insurance Business Services Ecosystem

"People-Oriented, Services-Intensive, Market-Facing Complex Systems – *complex systems* and *services* – are very similar areas around which we are framing the very complicated problems of business and societal systems that we are trying to understand."
– Irving Wladawsky-Berger, IBM VP Innovation (Oct. 9, 2006)

Progression of phenomena: Emergence of Complex Systems

Culture

People with mental models

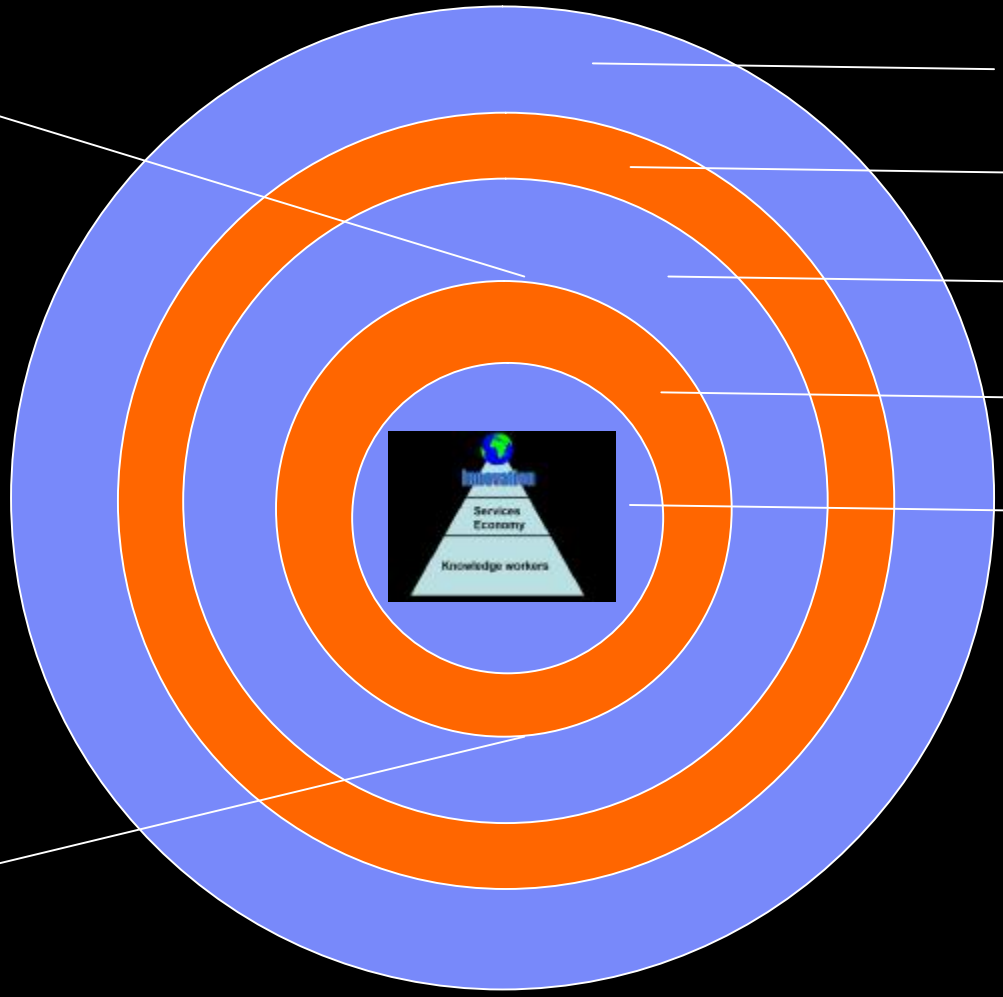
Language

Trust

Tools & Technology

Organizations And Institutions

Value Co-Creation (Service)



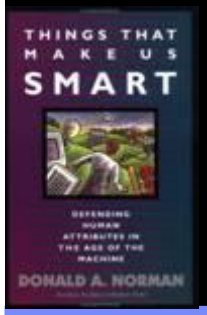
Physical System
Physics

Chemical System
Chemistry

Biological System
Biology

Human System
Anthropology

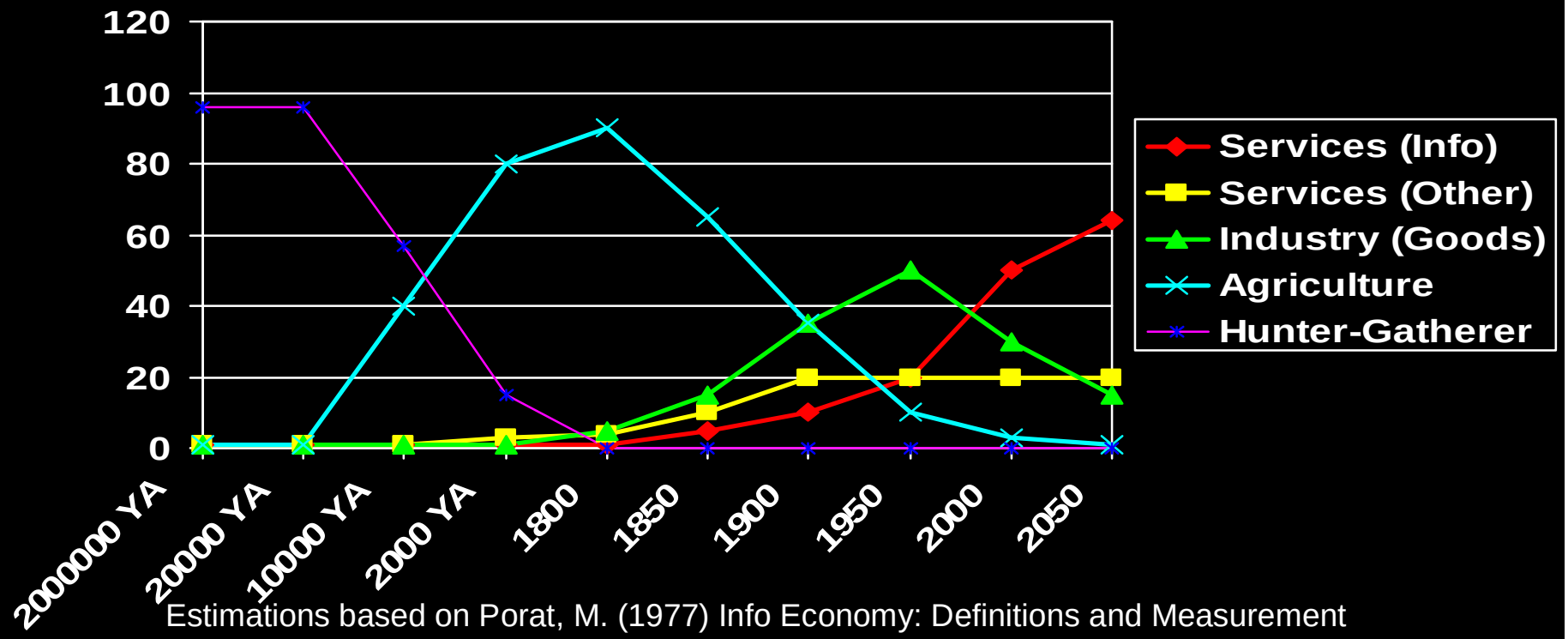
Service System
Service Science



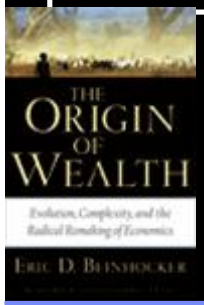
Things That Make Us Smart by Donald A. Norman

How did the service systems come to be?

Estimated world (pre-1800) and then U.S. Labor Percentages by Sector



Estimations based on Porat, M. (1977) Info Economy: Definitions and Measurement

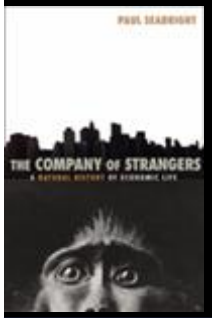


The Origin of Wealth
by Eric D. Beinhocker

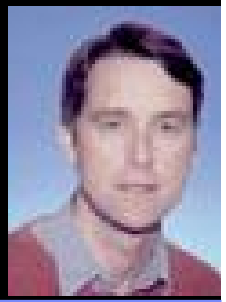
The Pursuit of Organizational Intelligence,
by James G. March
Exploitation vs exploration

10,000 years ago – Agriculture & Cities

- **Evolution of Trust:** Human beings are the only species in nature to have developed an elaborate division of labor between strangers. Even something as simple as buying a shirt depends on an astonishing web of interaction and organization that spans the world. But unlike that other uniquely human attribute, language, our ability to cooperate with strangers did not evolve gradually through our prehistory. Only 10,000 years ago--a blink of an eye in evolutionary time--humans hunted in bands, were intensely suspicious of strangers, and fought those whom they could not flee. Yet since the dawn of agriculture we have refined the division of labor to the point where, today, we live and work amid strangers and depend upon millions more. Every time we travel by rail or air we entrust our lives to individuals we do not know. What institutions have made this possible?

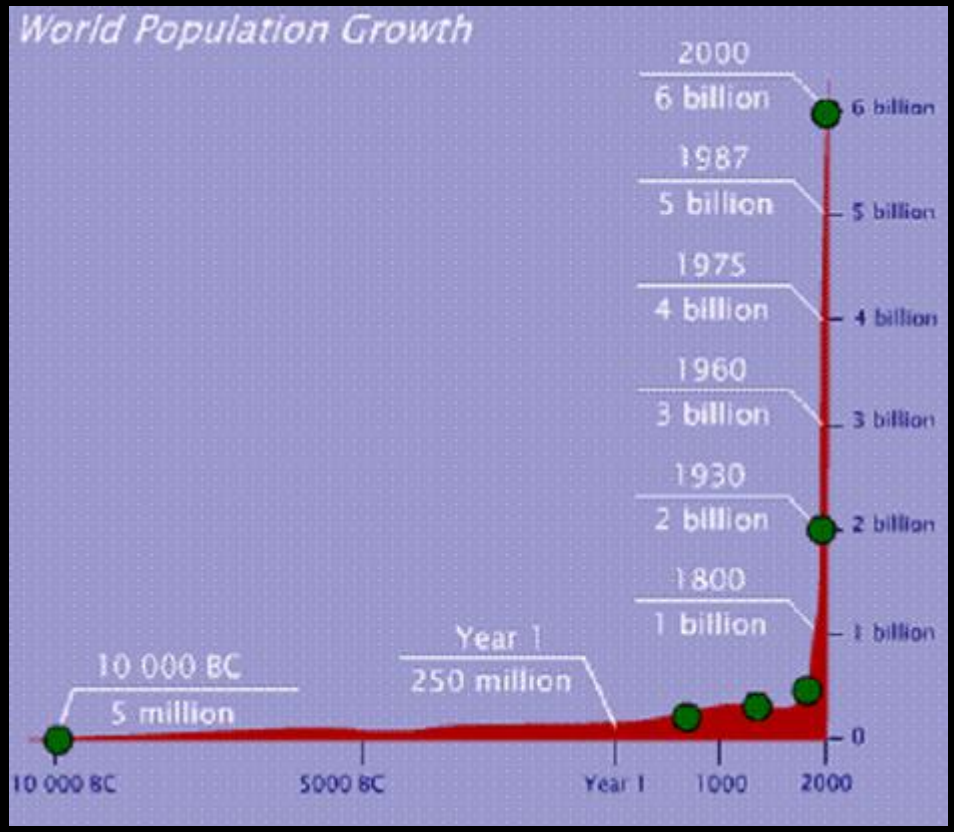


The Company of Strangers : A Natural History of Economic Life
by Paul Seabright

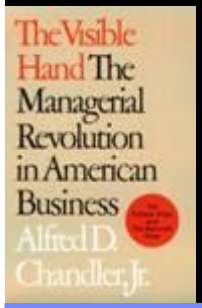


200 years ago – Railroads/Telegraphs & Businesses

Effects of Agriculture, Colonial Expansion & Economics, Scientific Method, Industrialization & Politics, Education, Healthcare & Information Technologies, etc.



Rise of the modern managerial firm



The Visible Hand: The Managerial Revolution in American Business
by Alfred Dupont Chandler

Modern service systems tend to give rise to top ten lists…
(a kind of shared information; intangible value = reputation/brand)

- People – Fortune: Most wealthy, Fellows, etc.
- Families – Local Communities: Mother of the year
- Cities – Newsweek: Most livable cities
- Nations – OECD: Quality of life
- Universities – Business Week: Top B-Schools
- Businesses – Business Week: Best employers
- And more Hospitals, Call Centers, Data Centers, etc.

People

- "All the information workers observed experienced a high level of fragmentation in the execution of their activities. People averaged about three minutes on a task and about two minutes on any electronic device or paper document before switching tasks."

  Gloria Mark and Victor M. Gonzalez, authors of "Research on Multi-tasking in the Workplace"

Families

- "The family is the natural and fundamental group unit of society and is entitled to protection by society and the State".
  - Article 16(3) of the Universal Declaration of Human Rights
- “Developing a Family Mission Statement”
  - Stephen R. Covey, author of **The 7 Habits of Highly Effective Families**
- “In the agricultural age, work-life-and-family blended seamlessly.”
  - IBM GIO 1.0

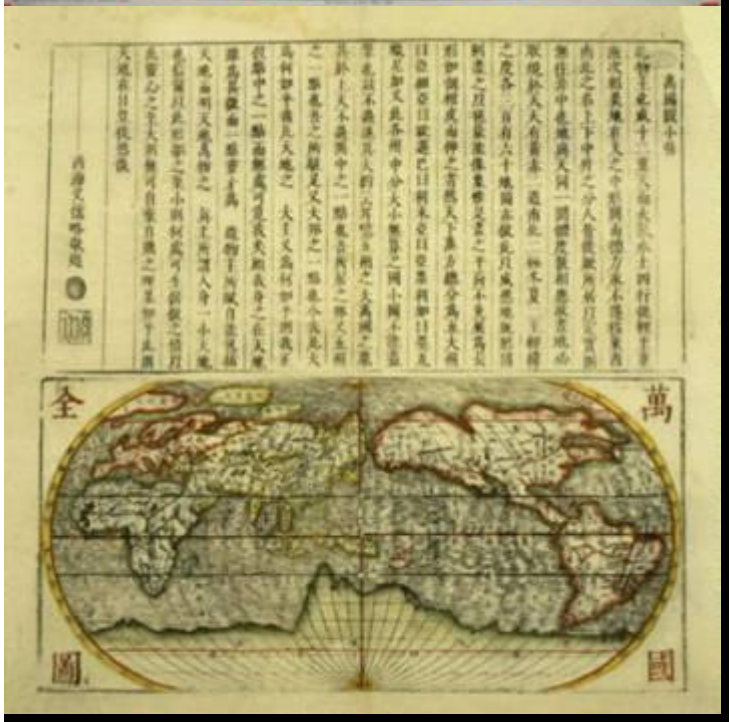
Cities

- "Cities are the defining artifacts of civilisation. All the achievements and failings of humanity are here… We shape the city, and then it shapes us. Today, almost half the global population lives in cities."

  John Reader, author of **Cities**

- IBM Releases ``IBM and the Future of our Cities'' Podcast

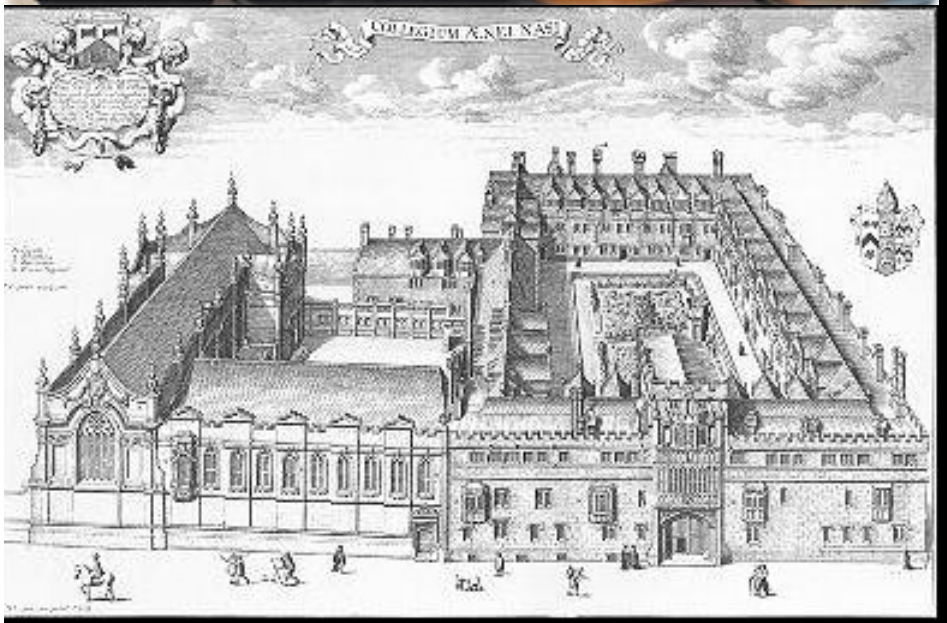
  IBM Press Release 2005



Nations

- "Understanding economic change including everything from the rise of the Western world to the demise of the Soviet Union requires that we cast a net much broader than purely economic change because it is a result of changes in (1) the quantity and quality of human beings; (2) in the stock of human knowledge particularly as applied to human command over nature; and (3) the institutional framework that defines the deliberate incentive structure of a society."

  Douglass C. North, author of **Understanding the Process of Economic Change**



Universities

- "The contemporary American university is in fact a knowledge conglomerate in its extensive activities, and this role is costly to sustain."

  Roger L. Geiger, author of **Knowledge and Money: Research Universities and the Paradox of the Marketplace**

Businesses

- "…of the 100 entities with the largest Gross National Product (GNP), about half were multi-national corporations (MNCs)… The MNCs do not exist on traditional maps."

  Alfred Chandler and Bruce Mazlish, authors of **Leviathans**

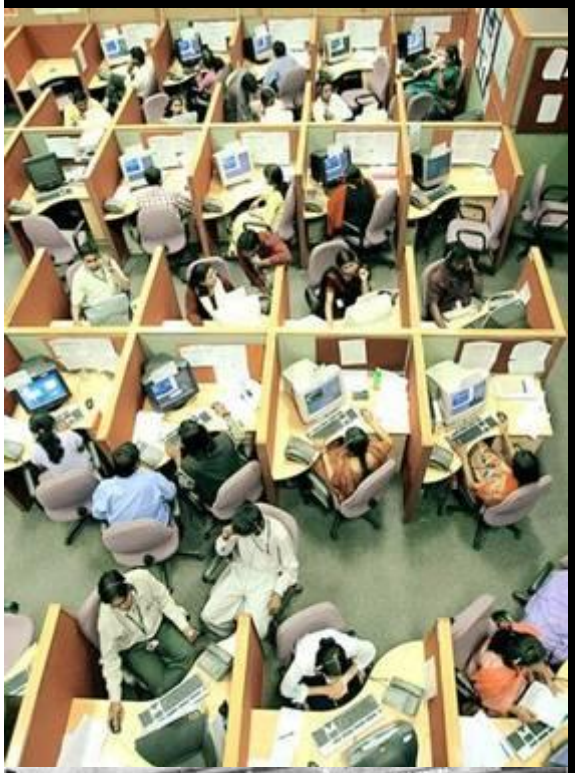
- "The corporation has evolved constantly during its long history. The MNC of the late twentieth century … were very different from the great trading enterprises of the 1700s. The type of business organization that is now emerging -- the globally integrated enterprise -- marks just as big a leap. "

  Sam Palmisano, CEO IBM in ***Foreign Affairs***

Hospitals

- "Modern medicine is one of those incredible works of reason: an elaborate system of specialized knowledge, technical procedures, and rules of behavior."

  Paul Starr, author of **The Social Transformation of American Medicine**

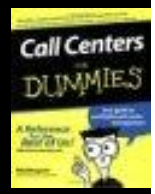


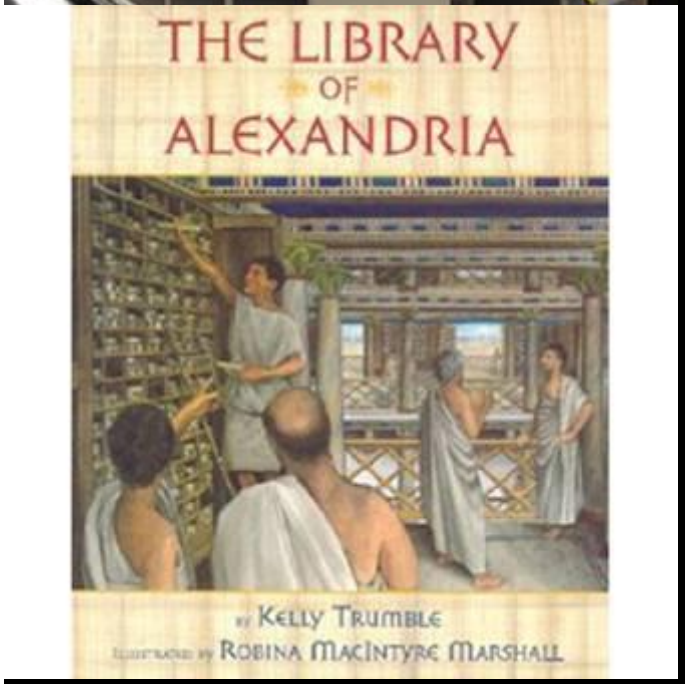
A LONG-DISTANCE TELEPHONE EXCHANGE.
Radio-telephone switchboard circa 1930. From the left the first four stations are to London, the next Ship to Shore, Buenos Aires, and Rio de Janeiro.

Call Centers

- "Call Centers For Dummies helps put a value on customer relations efforts undertaken in call centers and helps managers implement new strategies for continual improvement of customer service."

  Réal Bergevin, author of **Call Centers For Dummies**





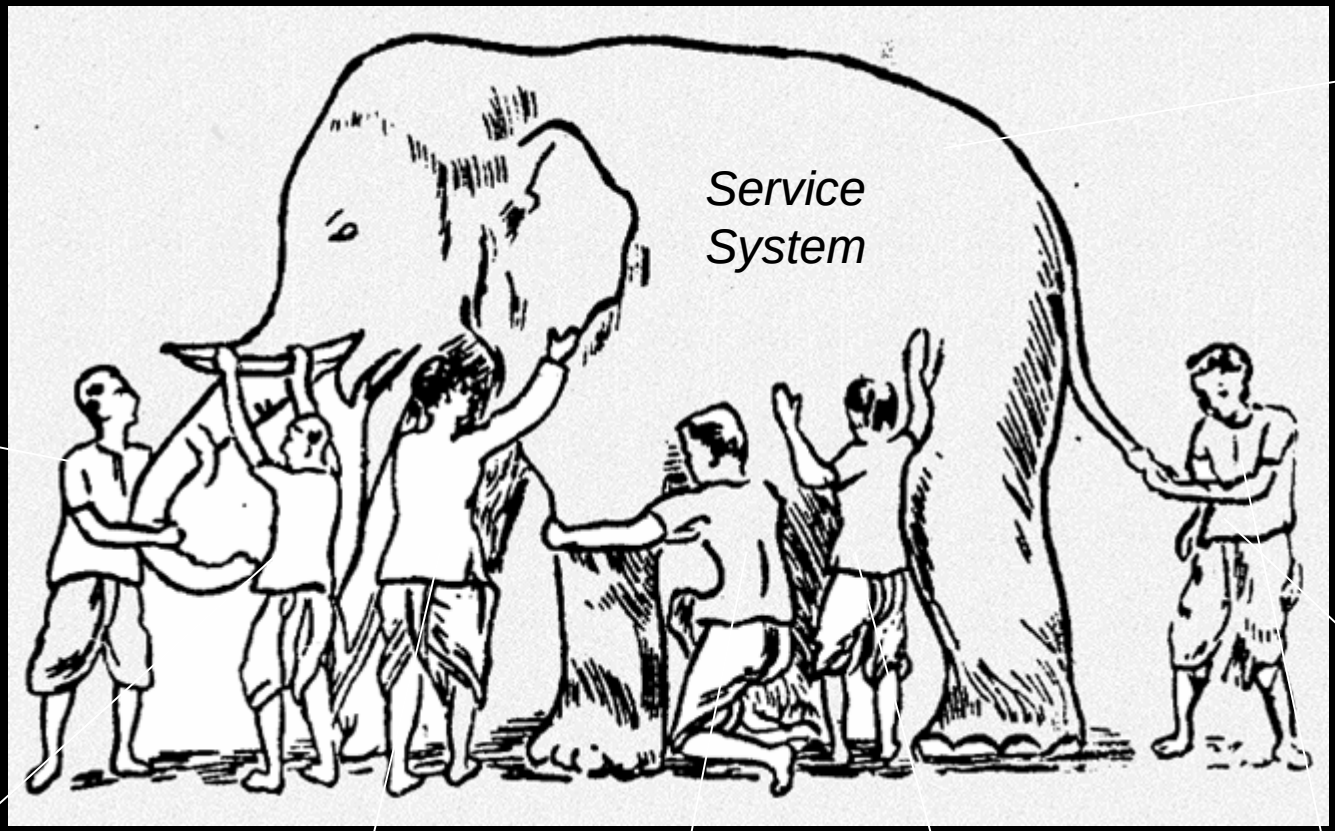
Data Centers

- "All data centers are unique, but they all share the same mission: to protect your company's valuable information."

  Douglas Alger, author of **Build the Best Data Center Facility for Your Business**

"Service science is just _____"

Need to unbundle and rebundle knowledge from existing disciplines



Service Management
Operations
Marketing
Engineering
Quality
Design

OR/IE
MS

Information Science (i-schools)

CS/AI Multiagent Systems

Economics & Law Game Theory

MIS

Anthropology & Psychology

Organization Theory

The challenge – need shared vocabulary and understanding of what a service system is – a type of complex adaptive system

- Operations Research and Industrial Engineering
  - More realistic models of people
- Computer Science and Electrical Engineering, Information Systems
  - Software and systems that adaptively/autonomously change with business strategy
- Economics and Business Strategy, Service Management & Operations
  - Better models of scaling and innovation to improve economic efficiency
- Law and Political Economy
  - Better models of social innovation – in what way is passing a law innovation
- Complex Systems and Systems Engineering
  - Better model of robustness and fragility of service systems (sustainability)

- Service systems are value co-creation configurations of people, technology, internal and external service systems connected by value propositions, and shared information (language, laws, measures, models, etc.)
  - Examples: People, families, cities, businesses, nations, global economy, etc.

What is science?

- Data – the language of nature (empirical framework)
- Model – measurable experiential constructs and relationships (theoretical framework)
- Analytics – fit data to model, explain variance (analytical framework)
- Take Action – interact with world and iterate (engineering and design frameworks)

Can we create CAD (Computer Aided Design) tools for service systems?

Can we create Service System Ecology Simulators to glimpse evolutionary trajectories?

1. $\nabla \cdot D = \rho$
2. $\nabla \times H = J + (\partial D/\partial t)$
3. $\nabla \cdot B = 0$
4. $\nabla \times E = -(\partial B/\partial t)$,

where
- D = electric displacement
- ρ = electric charge density
- H = magnetic field strength
- J = electric current density
- B = magnetic flux density
- E = electric field strength.

Under what conditions do value propositions exist between service systems to justify service-for-service exchanges?

- Assume service system A and B (imagine two people, family-clans, cities, nations, or businesses) each produce two same kinds of service, each have demand for ten performances of the services each day, and each have different costs of producing the services for self-service consumption

  - Case 1 – complementary superior performance
    - Costs
      - A = 1 4, B = 3 2
    - Self Service
      - A: 10 + 40 = 50
      - B: 30 + 20 = 50
    - Over produce best by one and exchange
      - A: 11 + 36 = 47
      - B: 27 + 22 = 49

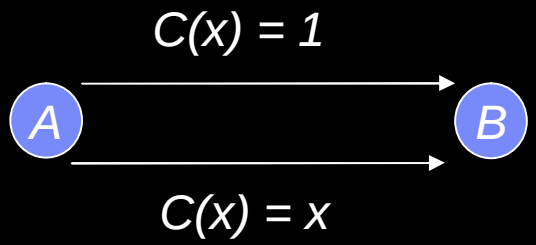
  - Case 2 – one with strictly superior performance, namely A
    - Costs
      - A = 1 2, B = 4 3
    - Self Service
      - A: 10 + 20 = 30
      - B: 40 + 30 = 70
    - Over produce best by one and exchange
      - A: 11 + 18 = 29
      - B: 36 + 33 = 69

- Surprisingly, in Case 2, it still makes sense to exchange service for service as well!
- Of course, this ignores transaction costs associated with the exchange…
- What happens when the cost decreases with experience/learning/innovations?
- What about trading the skill to perform a service, rather than simply performances?

Under what conditions are compliance laws innovative in a service system of selfish optimizers?

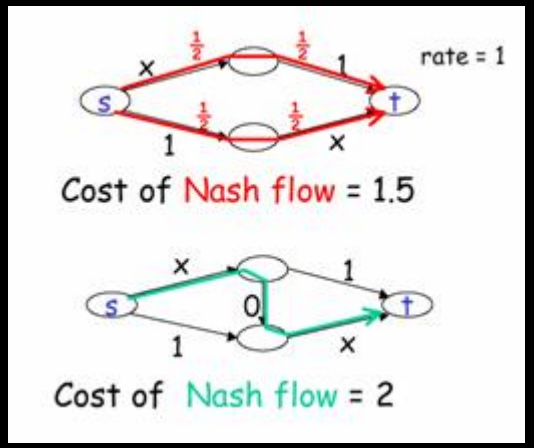
- Pigou's Example

  A population of commuters must drive from point A to point B. There are two roads. The first road always takes one hour. The second road takes time proportional to the amount of traffic (all = 1). If everyone takes the second road, the time is one hour. All drivers take the second road, it is never worse than one hour, and maybe better.



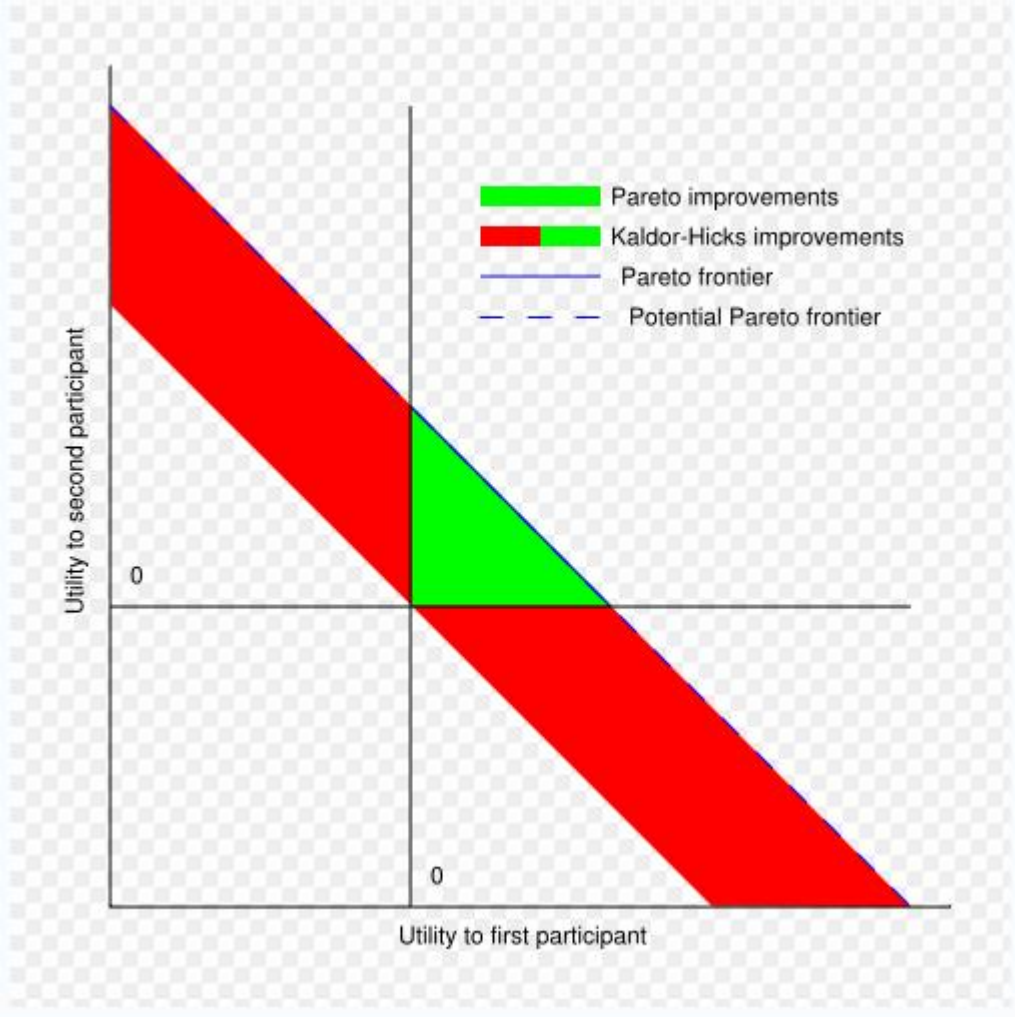
- Braess's Paradox

  Two roads with composed of two parts. First road has constant one hour plus one hour max if congested. Second road has one hour max if congested plus one hour. Traffic splits so everyone gets from point A to point B in 90 minutes. However, by adding a zero cost interchange connecting the two midpoints, now everyone takes the two connected congested routes, and now every takes 120 minutes!



A law that mandates odd and even license plates take different routes on different days, if backed up with sampling and tickets/fines, could yield better results.

Law and Economics

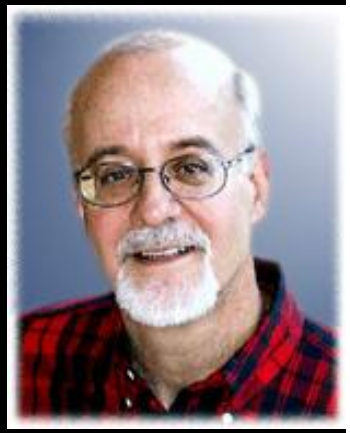


- Problem: Almost any business strategy or societal policy change will be viewed negatively by some stakeholder
- Pareto Efficiency
  - Can anyone be improved, without making someone else worse off?
- Kaldor-Hicks Efficiency
  - Can anyone be improved, such that anyone made worse off can be adequately compensated for their lose?

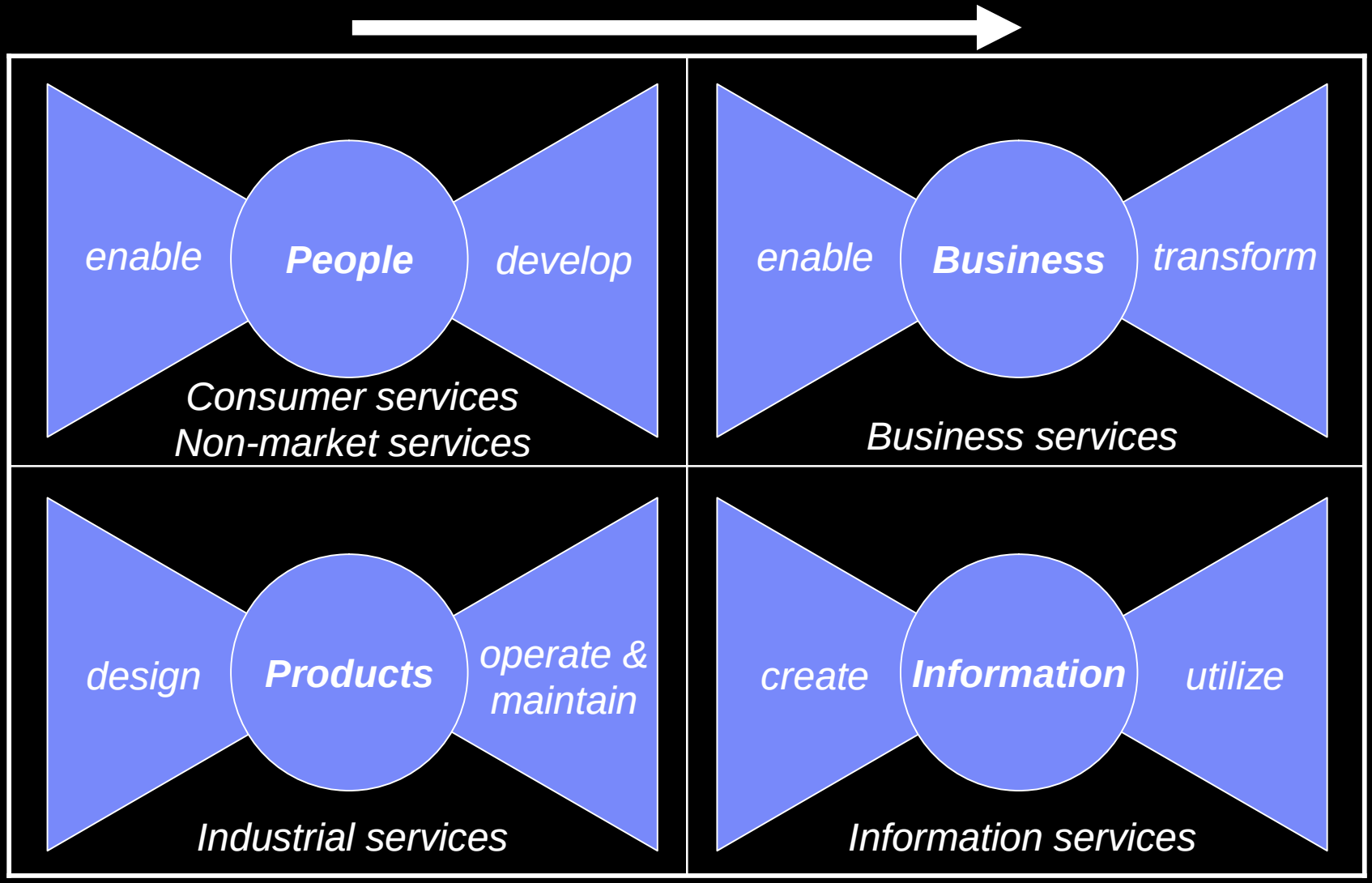
Shared Information: Reasoning about Knowledge

- Formalization of shared mental models of the world
  - Model of social world as multiple agents with shared knowledge/information, interacting based on that knowledge
- Common Knowledge Defined (everyone knows…)
- Distributed Knowledge (collectively we know…)
- "Muddy Children Problem"
- Percentage Total Info: Less in memory, more on line

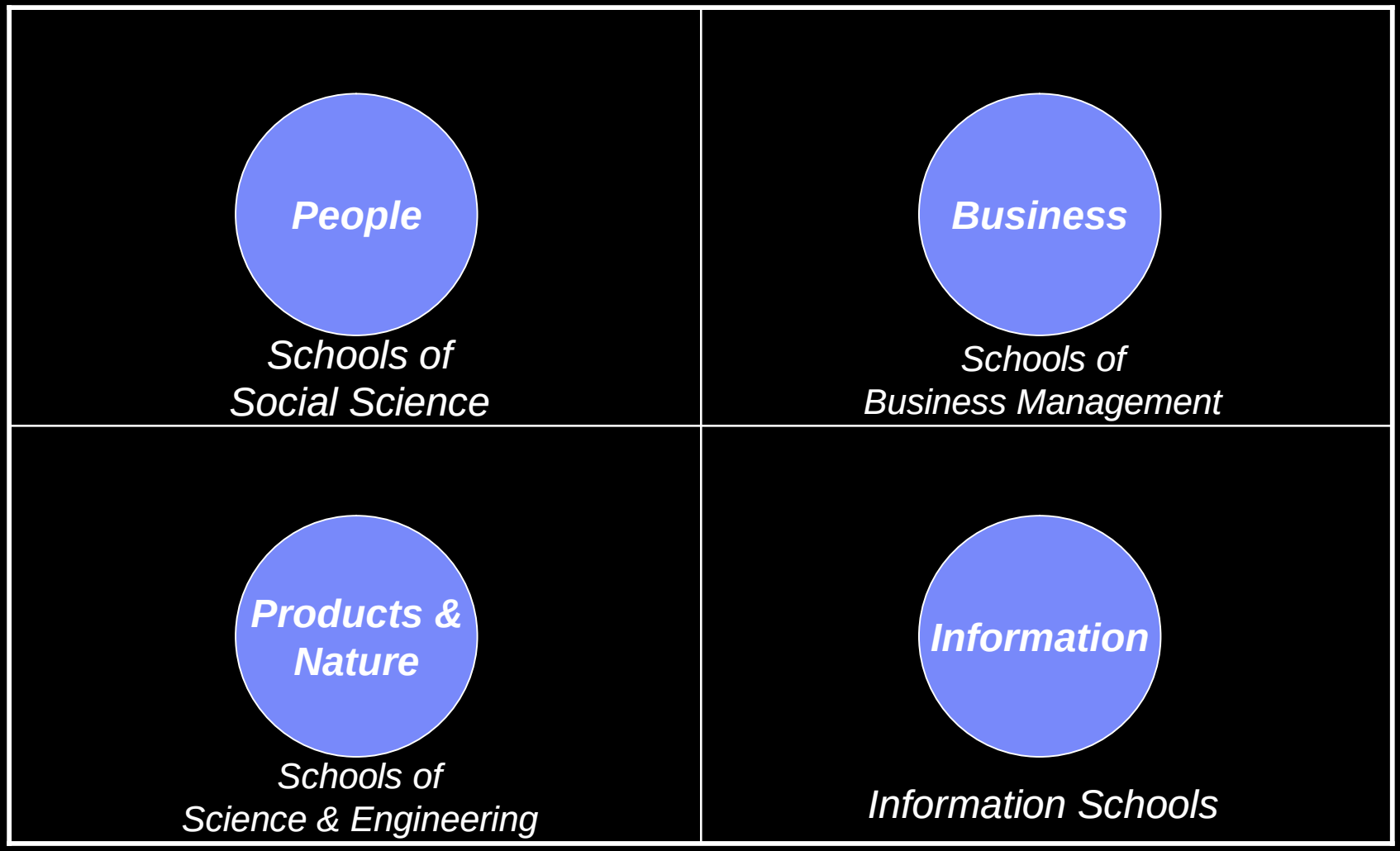
Reasoning About Knowledge
by Ronald Fagin, Joseph Y. Halpern, Yoram Moses, Moshe Y. Vardi



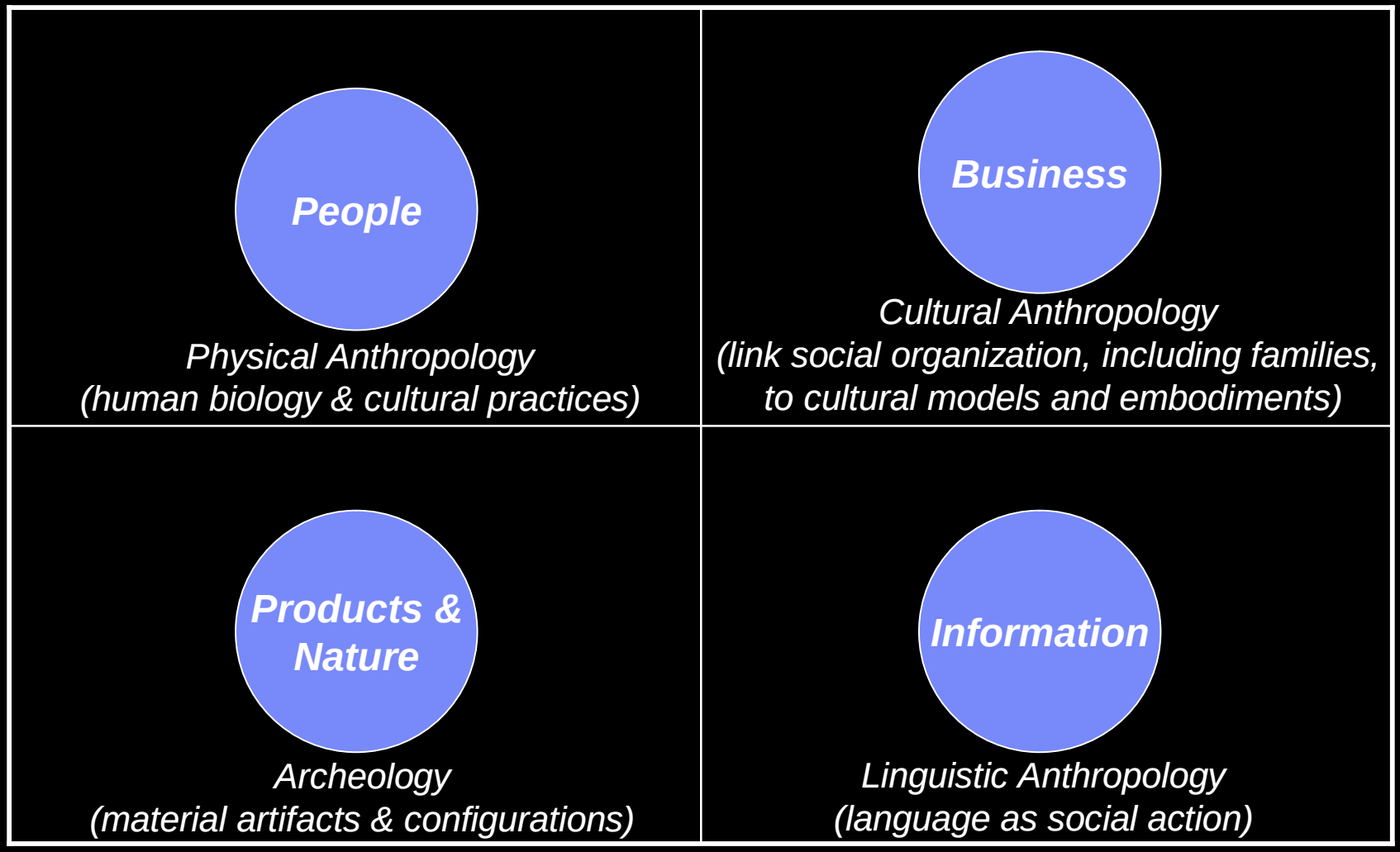
Complexity 1: So many types of service jobs/industries



Complexity 2: So many academic disciplines…



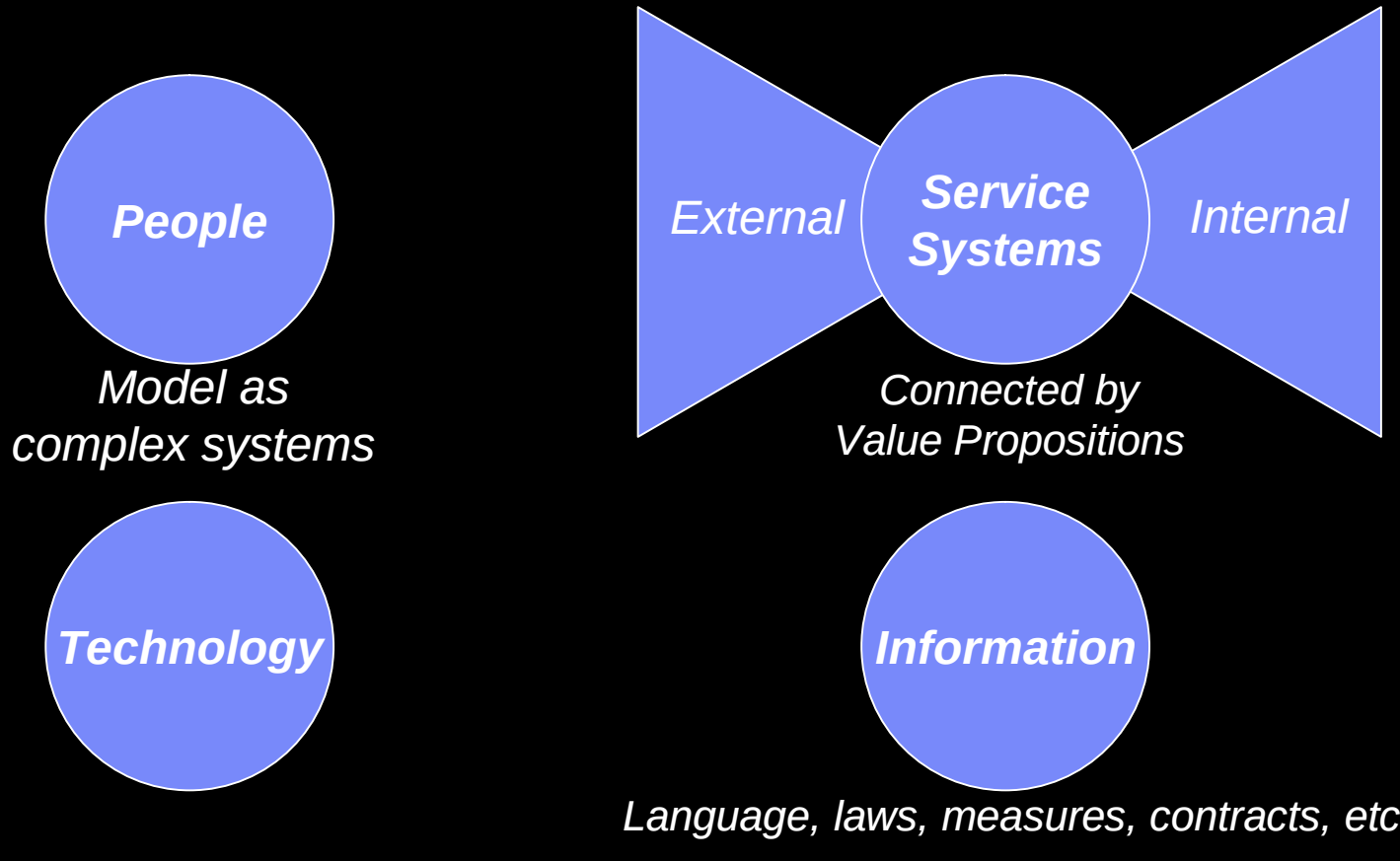
Complexity 2b: For example, anthropology is, well…



Complexity 3: So many definitions of service…

Service = value coproduction = the application of competence for mutual benefit

Service System: A value co-creation configuration of people, technology, value propositions connecting internal and external service systems, and shared information (language, laws, measures, contracts, etc.)



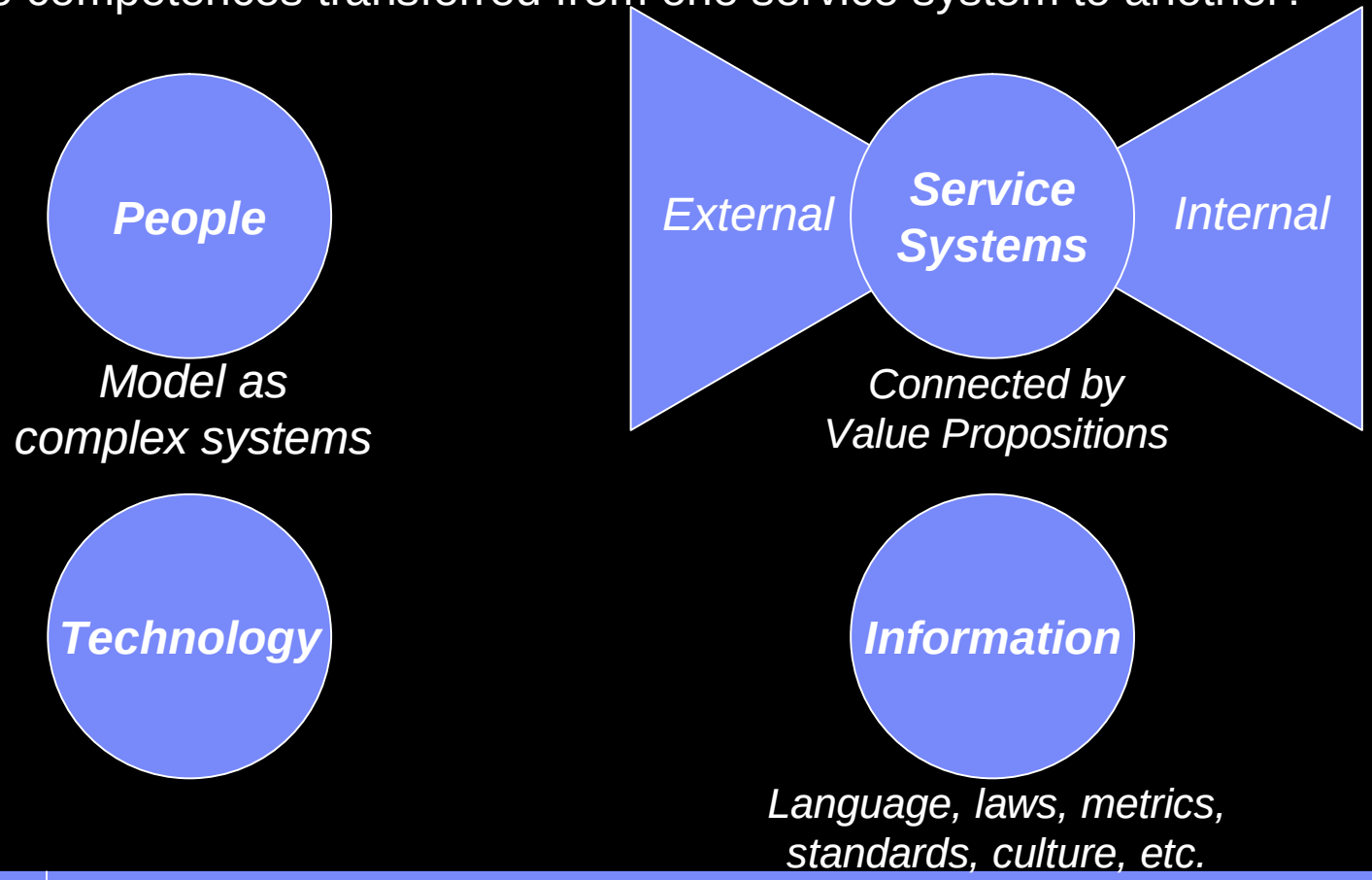
Complexity 4: No unique, fundamental problems…

What are the origins, types, and evolutionary patterns of service systems?

How are service systems similar to/different from other types of complex systems?

Are service systems the most complex type of complex system? How to invest?

How are competences transferred from one service system to another?

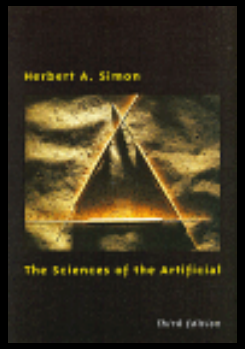


Service scientists are both broad and deep – T-shaped.

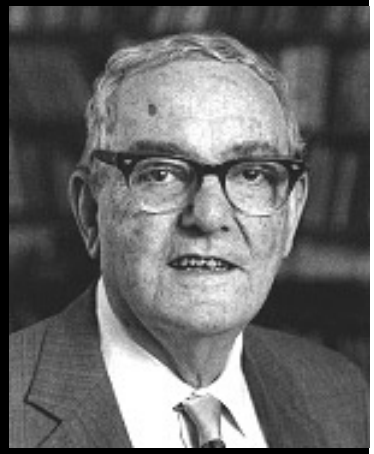
"Need I-shaped, T-shaped, π-shaped people… " – Stuart Feldman (Oct. 6, 2006)

Slide by Jean Paul Jacob

Herbert A. Simon – Gets my vote as the first service scientist



The Sciences of the Artificial
by Herbert A. Simon



- http://en.wikipedia.org/wiki/Herbert_Simon
- "Herbert Simon (1916-2001), in the course of a long and distinguished career in the social and behavioral sciences, made lasting contributions to many disciplines, including economics, psychology, computer science, and artificial intelligence. In 1978 he was awarded the Nobel Prize in economics for his research into the decision-making process within economic organizations. His well-known book *The Sciences of the Artificial* addresses the implications of the decision-making and problem-solving processes for the social sciences. "

Models of a Man :
Essays in Memory of Herbert A. Simon
by Mie Augier (Editor), James G. March (Editor)

Service systems or “value co-creation systems” as complex systems
An intellectually deep, integrative area of great economic significance

As called out in this National Academy of Engineering, 2003 report:

- “The studies suggest that services industries represent a significant source of opportunity for university-industry interaction. 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. In most manufacturing industries, service functions (such as logistics, distribution, and customer service) are now leading areas of competitive advantage. Innovation and increased productivity in the services infrastructure (e.g., finance, transportation, communication, health care) have an enormous impact on productivity and performance in all other segments of the economy. Nevertheless, 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.”

- From "The Impact of Academic Research on Industrial Performance“ (ttp://newton.nap.edu/catalog/10805.html)

Thanks for your questions and comments!

Contact
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Paul Maglio (maglio@us.ibm.com)
Wendy Murphy (wendym@us.ibm.com)

OR/MS Today - June 2006

Service Science

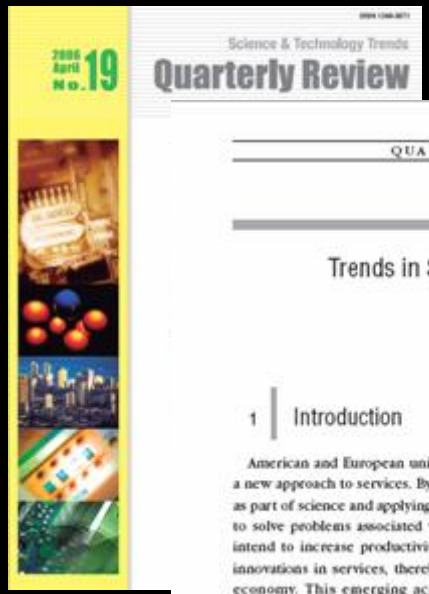
Serving the Services

The emerging science of service management opens opportunities for operations research and management science.

By Brenda Dietrich and Terry Harrison

The services industry continues to be a rapidly growing segment of many developed economies, including the U.S. economy [1, 2]. Although a significant portion of the services industry is focused on providing services to individuals (medical, insurance, legal, financial), the business services sector, in which one company provides service to another company, is also a rapidly growing segment [3, 4]. Examples include traditional consulting, design, technical support (typically for products), call center operations, IT implementation and IT outsourcing. New business models, based on improving efficiency through automation, aggregation of risk, economies of scale or reduction of capital assets, lead companies to outsource and in some cases off-shore business processes that do not provide differentiation in the marketplace. Transportation and warehousing, procurement, manufacturing, benefits management and back-office processes such as accounting are all now being provided as services. Business services are complex, and are typically purchased and managed by separate organizations within an enterprise.

Over the past several decades mathematical models of traditional manufacturing and logistics systems have been developed and used for strategic planning. More recently similar models have been used to support operational decision-making. Significant gains in efficiency within the manufacturing and logistics industries have been attributed to the use of such models, together with a supporting information technology infrastructure [see 5, 6, 7, 8 for examples]. Manufacturing Resource Planning (MRP), which automated the calculations of material requirements within manufacturing, evolved in to Enterprise Resource Planning (ERP), which monitors all manufacturing enterprise processes, and formed the information base for advanced planning and e-commerce.



3

Trends in Services Sciences in Japan and Abroad

KAZUYOSHI HIDAKA
Affiliated Fellow

1 Introduction

American and European universities are taking a new approach to services. By regarding services as part of science and applying scientific methods to solve problems associated with services, they intend to increase productivity and bring about innovations in services, thereby invigorating the economy. This emerging academic discipline is called "Services Sciences, Management and Engineering," or simply "Services Sciences." The services here refer to the interactive process of creating economic values between the service provider and the user, and include not only the service industry as a tertiary industry but also the service business in the manufacturing sector. This article explains how services sciences have developed (Chapter 2), what services sciences are (Chapter 3), services sciences in European and American universities (Chapter 4), and the current status of this field of research in Japan (Chapter 5), followed by a conclusion (Chapter 6).

2 Background

2-1 U.S. investment in service research as a national strategy

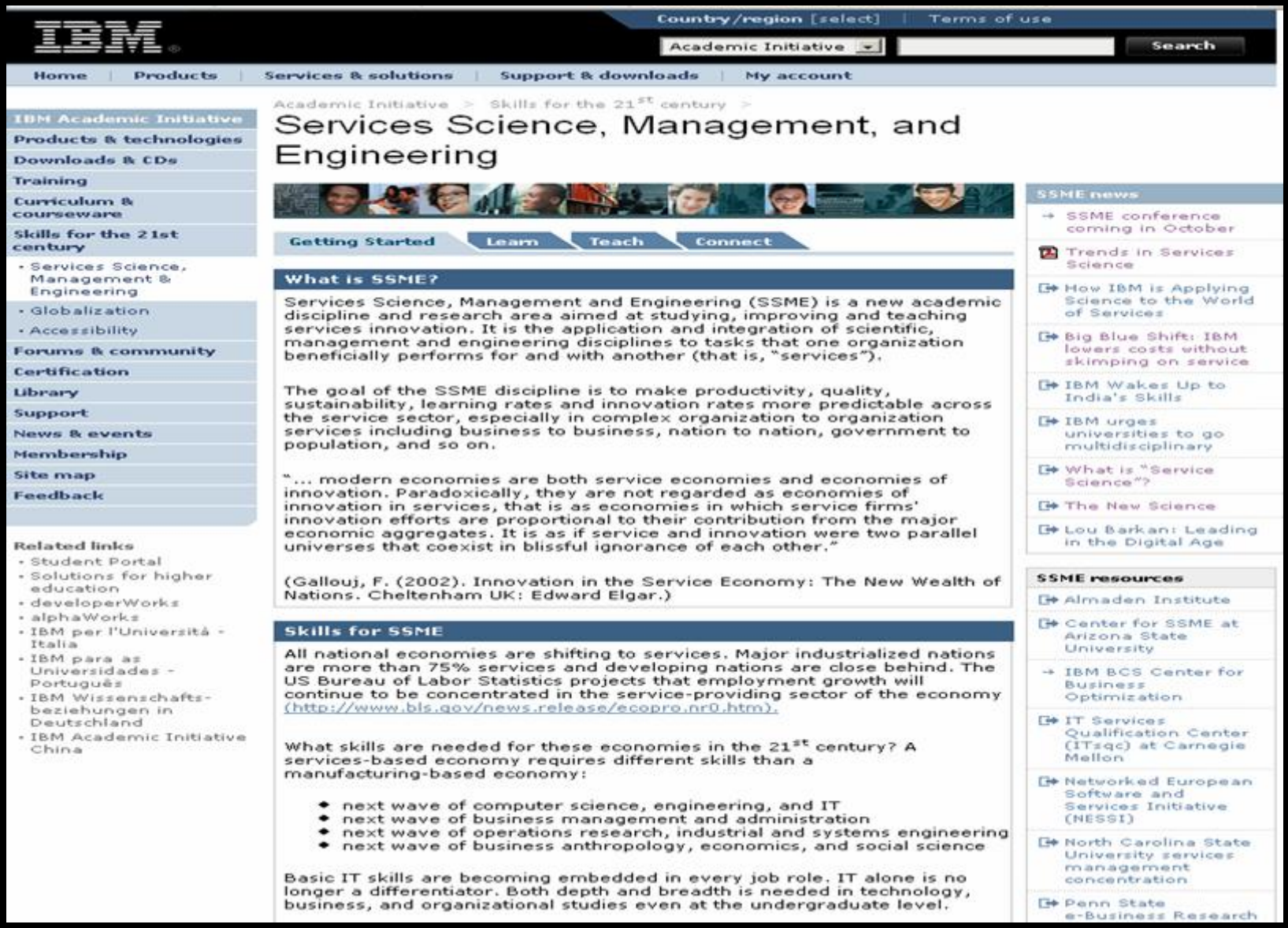
The U.S. Council on Competitiveness published a report (commonly known as the "Palmisano Report"[21]) in December 2004 that emphasizes the importance of national innovation strategy from the three perspectives of human resources, investment and infrastructure. Based on an analysis of the current position of the U.S., the report cites, as the reasons that the country needs innovation, threats from other countries as a result of globalization, a slowdown in research in science and technology, and delays in smooth technology transfer to the manufacturing sector. It also points out the service sector's lack of research investment in innovative business process design, organization and management, despite services' major contribution to the economy. To put it simply, a factor behind this report is a perception that research investment in services should be addressed as part of U.S. national strategy. The report triggered a move toward integrating many recent approaches to services in academia into the term "services sciences."

2-2 Development of the service economy

What kind of role are services given in the global economy? Nowadays, services are increasingly important to the economy. This is evident from two facts: the service industry has grown significantly, and even companies that fall outside of the service industry are more and more reliant on "service-based business."

(1) Development of the service industry

Trends in the working population by industry demonstrate that the workforce in the service industry has increased sharply worldwide. Figure 1 shows the change in the working population in the world's top 10 countries by workforce size over the past two centuries[22]. In developed countries, mainly in Europe and North America, the working population in the secondary (manufacturing) industry increased sharply over the periods of the First Industrial Revolution, which was ushered in by the improvement of spinning machines in England in the late 18th century, and the Second Industrial Revolution, which took place as a result of the increased use of oil and electricity in the late 19th century. However, by the middle of the 20th century,



http://www.ibm.com/university/ssme

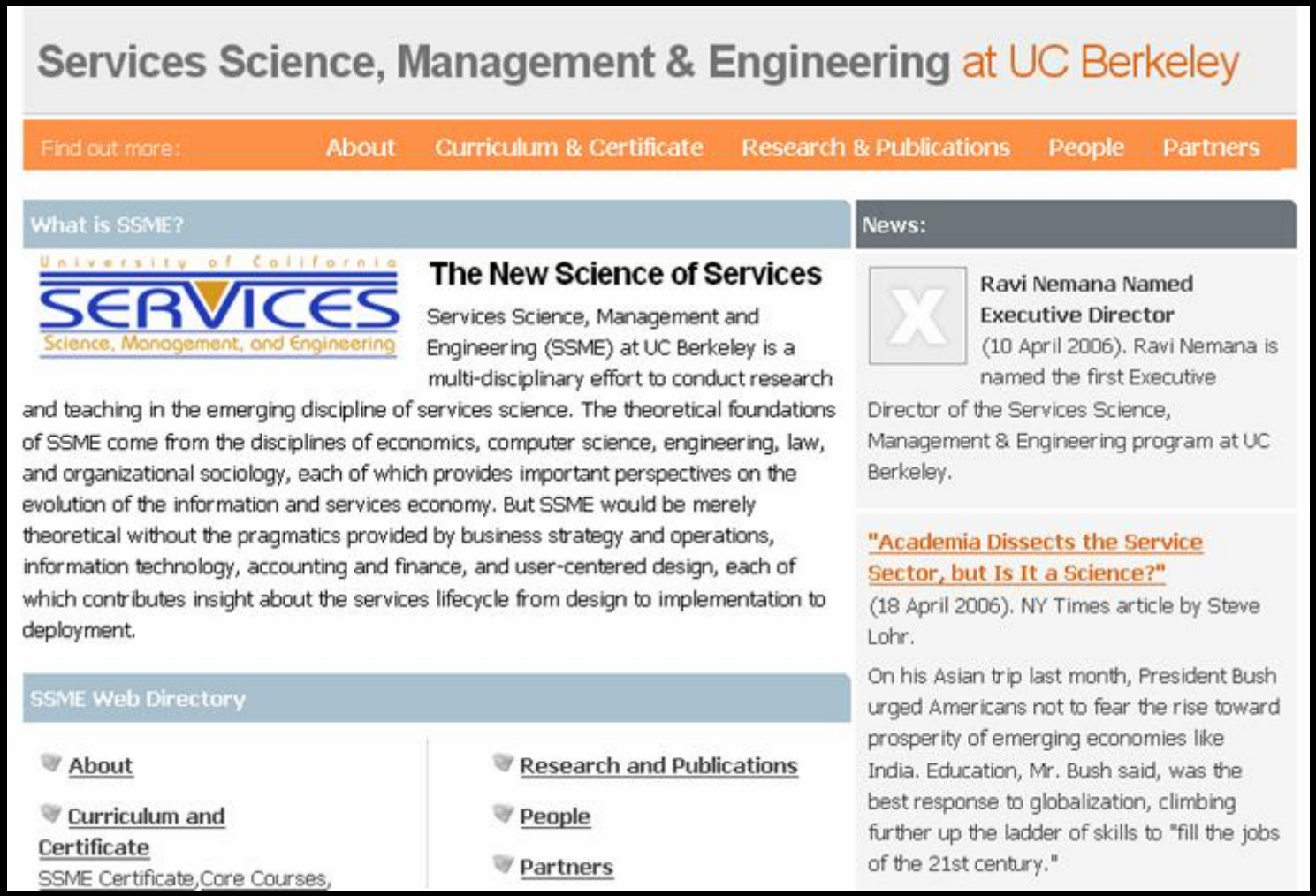
Textbooks

- Berry (1999)
- Chase, Jacobs, Aquilano
- Davis
- Fisk, Grove, & John (2000)
- Fitzsimmons & Fitzsimmons (2001)
- Grönroos (2000)
- Hoffman & Bateson (2002)
- Lovelock & Wright (2001)
- Sampson (2000)
- Teboul (2006)
- Zeithaml & Bitner (2003)

Service Management:
Operations, Strategy, and Information Technologies
by James Fitzsimmons and Mona Fitzsimmons

Journal and Conference

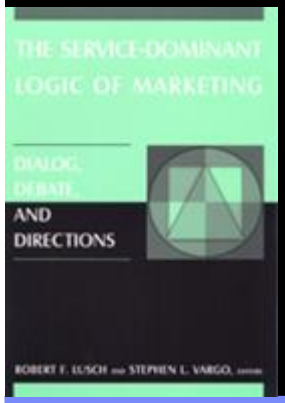
Berkeley SSME Certificate Program



http://ssme.berkeley.edu/

On what foundational logic, could we build a science of service?

- Defines service as the application of competencies for the benefit of another entity and sees mutual service provision, rather than the exchange of goods, as the foundational logic
- This new paradigm is service-oriented, customer-oriented, relationship-focused, and knowledge-based



The Service-Dominant Logic of Marketing: Dialog, Debate, and Directions
by Robert F. Lusch and Stephen L. Vargo

To Nations: Innovation sustains skilled employment/export growth

1800-	**England**	**Industrial Revolution**
1850-	**Germany**	**Chemicals Revolution**
1900-	**USA**	**Electrical & Information Revolution**
1950-	**Japan**	**Quality Innovation: Product Revolution**
1990-	**Finland**	**Mobile Communication Revolution**
2000-	**India**	**Cost Innovation: Services Revolution**
2000-	**China**	**Cost Innovation: Product Revolution**
?	**?**	**Service Systems Revolution**

Sustainable growth depends on innovation via regional government, industry, academic collaboration.

Service

- **Service is value coproduction**
  - Value change is the motive for interaction
  - Coproduction is the method, not doing it alone (self service)
  - Motive & Method: Have someone else do something (or allow or enable something) so you don't have to do it yourself, and be deprived of the benefit of the other – what is the value add of the other? what is the cost of the other? what are the alternatives?
- **Value is complex**
  - Context dependent judgment (update mental models of world)
  - Made by a person or group of people
  - Sometimes formalized into an explicit measurable quantity

Service System

- A service system has the capability to interact with another service system to produce and consume services (coproduce value)
- Some example service systems:
  - Person (smallest)
  - Business (1 person to 1 million people)
  - Nation (1 million to billions of people)

Service System

- A type of complex system that can evolve & learn
  - Can nucleate around a person (an entrepreneur, prime mover)
  - Can grow more intelligent (adapt to/transform environment)
  - Can disappear (become maladapted to environment)

- A value coproduction configuration of
  - People (division of labor, multitasking)
  - Technology
  - Value propositions connecting internal and external service systems
  - Shared information (language, laws, measures, etc.)

So, service is…

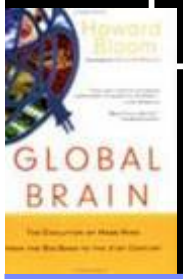
Invest for improved mutual performance in which client and provider coproduce value

- High talent (Person Power)
  - Knowledge-intensive business services (business performance transformation services) (e.g., chef's, concert musicians)
- High tech (Technology Power)
  - Environment designed to allow average performer to provide a superior performance, including self service and eventually a utility (average cook with great cook book and kitchen; average musician with a synthesizer)
- Highly organized & motivated (Value Proposition Power)
  - Businesses, markets, government services, institutions
  - Networks of partner both internal and external coordinating performance
- Highly coordinated (Shared Information Power)
  - Language, laws, measures (including KPI, prices), explicit models, etc.

Building tools & organizations – accelerating growth of capabilities

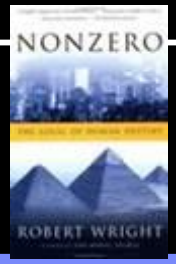
Billion Years Ago	Natural Processes
12	Big Bang (EMST)
11.5	Milky Way (Atoms)
8	Sun (Energy)
4.5	Earth (Molecules)
3.5	Bacteria (Cell)
2.5	Sponge (Body)
0.7	Clams (Nerves)
0.5	Trilobites (Brains)
0.2	Bees (Swarms)
0.065	Mass Extinctions
0.002	Humans Tools & Clans Coevolution

Generations Ago	Human Processes
100,000	Speech
750	Agriculture
500	Writing
400	Libraries
40	Universities
24	Printing
16	Accurate Clocks
5	Telephone
4	Radio
3	Television
2	Computer
1	Internet/e-Mail
0	GPS, CD, WD



Global Brain: The Evolution of Mass Mind from the Big Bang to the 21st Century

by Howard Bloom



Nonzero : The Logic of Human Destiny

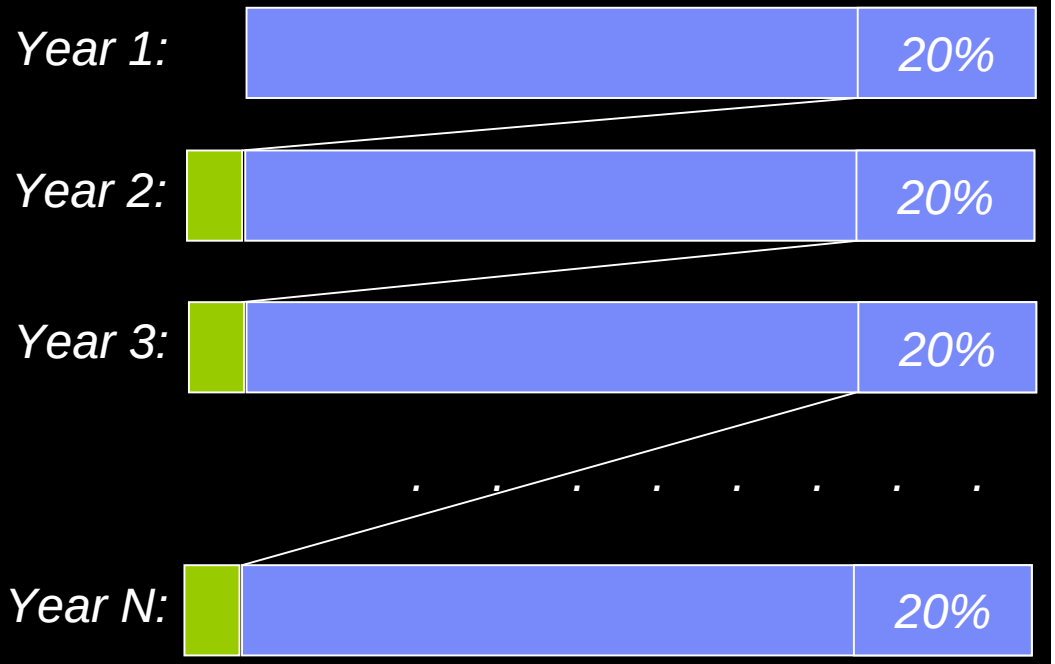
by Robert Wright

What would service scientists actually do?

- Service scientist own the body of knowledge around service system problem solving
- Service scientists identify a service system that needs improvement
- Service scientists identify the stakeholders their concerns and perceived opportunities
- Service scientists envision augmentations (additional new service systems) or reconfigurations (of old service systems components) that best address all problems and opportunities
  - Identify year-over-year improvement trajectories
  - Identify incentives to change (ROI, leadership, laws)

Example: Are there "scale laws" of service innovation – year-over-year compounding effects?

- Problems
  - Input: Student quality
  - Process: Faculty motivation
  - Output: Industry fit
- Augmentations
  - A: -20% eLearning certification
  - B. +10% Faculty interest tuning
  - C. +10% On-the-job skills tuning



After a decade the course may look quite different
Service systems are learning systems: productivity, quality, etc.

How will we know when we have succeeded?

- A textbook that is used in service science and complex systems courses around the world
  - Data from variety of service systems (e.g., call center), models, analytics, action research plans and case studies of service systems
- Payoff in business and societal results from systematic service innovations
  - Productivity, quality, compliance, innovation, and learning curves
  - Better measurement systems, models of business-clients-competitors, and theory of value proposition evolution between service systems, theory of investment, entrepreneurship, and institution formation
- Perhaps even a Moore's like law or investment road map for predictable service system capability growth
  - We've even had a few people starting to propose some!

If time permits…

- Call centers as exemplar service systems
  - Balance productivity and quality
  - Balance compliance and innovation
- Service innovation, beyond cost cutting (e.g., global sourcing, automation)
  - How to grow when markets don't
  - Blue ocean strategies

Spohrer-Engelbart Cycle of Service System Evolution
(Augmentation Systems: Bootstrapping Capability Infrastructure via Coevolution of Human System and Tool System)

- Population Growth (Atomic Service Systems, Self Service, Multitasking)
  - Assume growing population of service systems in an environment
  - Each service system is multitasking two services based on two underlying capabilities or competences
- Organization Growth (Outsource Service, Higher-Level Multitasking)
  - Advantage of pairs forming to trade, or forming an organization
  - Coase's Law and Kaldor-Hicks Efficiency enabled within organization
  - Thus, a growing populations of multitasking service systems gives rise to increasingly specialized service systems, professions, markets and organizations
- Technology Growth (Improvement, Free Time, Rise of New Goals, Multitasking)
  - Over time learning curves and efficiency leads to better competencies
  - Learning curves improve specialization and technologies used, until it is cost effective to form new service systems that provide the technology
  - Free time leads to new goals, competences, and more multi-tasking
  - As technology capability improves some service systems shift back to self service – multitasking more and using high capability technology
- Infrastructure Growth (Fairness, New Environment, New Multitasking Goals)
  - If the service and technology become universally needed, the technology may be embedded into the environment as part of a government action to establish a new utility or national infrastructure (institution formation) to ensure fairness of access
  - Improved environment fosters population growth

One last service system surprise… R&D service sector…

- Baumol and Oulton – Progessive and symptotically stagnant sectors of economies
- Circa 1960: Imagine an economy with two sectors (manufacturing and services). Technology for labor substitutions increase productivity at a steady pace in the "progressive" sector, and the "stagnant" or "asymptotically stagnant" sector absorbs the labor from the other.
- Circa 2002: Now imagine that the asymptotically stagnant sector is R&D (primus inter parus). Oulton (Bank of England) suggests that R&D which produces information is not a final result, but is actually input to the progressive sector. So as long as R&D productivity gains are slightly positive, the economy as a whole does not stagnate!

  Let, y_i = the output of sector I, Li = the primary input quantity used by sector I, where $L_1 + L_2 = L$ (constant), Pi = the price of the sector's output, G_i = the growth rate of the productivity of the primary input used directly by sector I (with $0 < G_1 < G_2$, so that sector 1 is the relatively stagnant sector, w primary input price

  $Y_1 = F_1(L_1, t)$, $Y_2 = F_2(y_1, L_2, t)$

- Surprise: Data from Fano: In US, between 1921 and 1938 industrial research personnel rose by 300%. Laboratories rose from fewer than 300 in 1920 to over 1600 in 1931, and more than 2,200 in 1938.

  R&D grew most rapidly in US during the time centered around the great depression!

What is Visible to the World (2004 – 2006)

- Thought Leadership and Press
  - Over 90 press articles (e.g., NY Times, Wall Street Journal)
  - Over 10,000 non-IBM web site mentions and growing by over 500 a month
- Workshops and Funding
  - SSME summit at Palisades with more than 250 participants from 22 countries
  - 8 National Workshops (China, Japan, India, US, Norway, Germany, Israel, Ireland)
  - Germany – $87M Innovation with Service
  - Japan – $30M Service Productivity
  - China – Five Year Plan in Modern Services
  - Pending – EU NESSI; US legislation; NSF Complex Systems
- Skill Needs and Course Development
  - 38 courses, programs, degrees in 11 countries (e.g., Berkeley, NCSU)
- Science and Publications
  - 15 academic articles (e.g., CACM special issue, POMS)
  - 16 conferences, workshops, panels (e.g., INFORMS, Frontiers)
  - Special Interest Groups already forming in INFORMS, AIS, HFES; IEEE and ACM also targeted

New skills are needed

- **All national economies are shifting to services – service systems are an important type of complex system**
  - major industrialized nations are >75% services, developing nations are close behind – growth increasingly depends on service innovation at multiple scales - person, family, city, firm, nation
  - credit cards are a simple example of service innovation, requiring integrated business, technology, and social-organizational change to be successful
  - drivers: outsourcing, globalization, internet, self-service - Wipro, IBM, EDS, eBay, Amazon, Google
- **New workforce skills are needed - to better study, manage, and engineer service systems**
  - study benefits from a combination of business, organization, technology skills – soft skills enhance hard skills – more organizational transparency and data sharing by industry would help greatly
  - new profession (like service scientist) needed, and new tool (service system ecology simulator)
- **Educational system is slowly shifting toward services**
  - service management, operations, marketing, and engineering courses and programs exist - study of complex systems seeks to integrate
  - Research universities should increase number of grant proposals focused on service systems
  - new multidiscipline (like SSME) needed, to integrate and break down silos – industry must hire them
- **National systems are slowly shifting policy towards service innovation**
  - bootstrapping investment in research and education through targeted programs
  - focusing attention on intellectual property protection for service innovation
  - new innovation policy and metrics needed (government role in creating historical data sets)

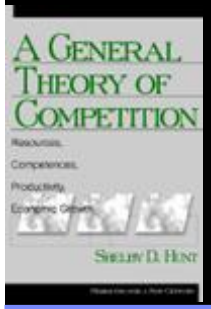
Some Types of Service Systems

- People
- Families
- Businesses
- Cities
- Nations
- Hospitals
- Universities
- Call Centers
- Data Centers
- Professional Associations
- Disciplinary Associations
- Government Agencies
- PACs
- NGOs
- Non-Profits
- Foundations
- On-line Communities, MMORPGs, Virtual Worlds

On what theory of economics, could we build a science of service?

- Firms: Viewed as historically situated combiners of heterogeneous and imperfectly mobile resources under conditions of imperfect and costly to obtain information, towards the primary objective of superior financial performance.

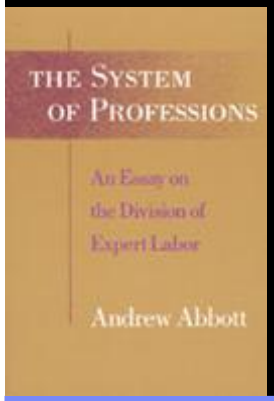
- Resources: Viewed as tangible and intangible entities available to the firm that enable it to produce efficiently and/or effectively a market offering that has value for some market segment(s).



A General Theory of Competition : Resources, Competences, Productivity, Economic Growth (Marketing for a New Century)
by Shelby D. (Dean) Hunt

How do new professions arise?

- In *The System of Professions* Andrew Abbott explores central questions about the role of professions in modern life: Why should there be occupational groups controlling expert knowledge? Where and why did groups such as law and medicine achieve their power? Will professionalism spread throughout the occupational world? While most inquiries in this field study one profession at a time, Abbott here considers the system of professions as a whole. Through comparative and historical study of the professions in nineteenth- and twentieth-century England, France, and America, Abbott builds a general theory of how and why professionals evolve.



The System of Professions:
An Essay on the Division of Expert Labor
by Andrew Abbott

How do new professions and new disciplines coevolve with government institutions?

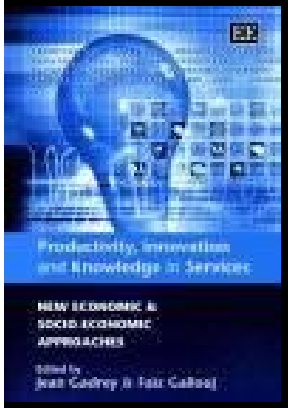
- Emergence of German dye industry, German mid-19th Century
- Emergence of chemistry as an academic discipline
- Emergence of patent protection in the new area of chemical processes and formula
- Emergence of new relationships connecting firms, academic institutions, government agencies, and clients
- Demonstrates needed coevolution of firms, technology, and national institutions
- Took England and US over 70 years to catch up!!!

Knowledge and Competitive Advantage :
The Coevolution of Firms, Technology, and National Institutions
by Johann Peter Murmann

How does the service economy and the innovation economy relate?

- "… modern economies are both service economies and economies of innovation. Paradoxically, they are not regarded as economies of innovation in services, that is as economies in which service firms' innovation efforts are proportional to their contribution from the major economic aggregates. It is as if service and innovation were two parallel universes that coexist in blissful ignorance of each other."

- Gallouj, F. (2002). Innovation in the Service Economy: The New Wealth of Nations. Cheltenham UK: Edward Elgar.



Productivity, Innovation and Knowledge in Services
by Jean Gadrey and Faiz Gallouj

The New York Times

Business

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Academia Dissects the Service Sector, but Is It a Science?

By STEVE LOHR
Published: April 18, 2006

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On his Asian trip last month, President Bush urged Americans not to fear the rise toward prosperity of emerging economies like India. Education, Mr. Bush said, was the best response to globalization, climbing further up the ladder of skills to "fill the jobs of the 21st century."

But a ladder to where? That is, where are educated young Americans likely to find good jobs that will not be shipped off to India or China?

Enlarge This Image

Noah Berger for The New York Times

Kurt Koester, a Berkeley student, is complementing his engineering studies with a course in services science.

The answer, according to a growing number of universities, corporations and government agencies, is in what is being called "services science." The hybrid field seeks to use technology, management, mathematics and engineering expertise to improve the performance of service businesses like transportation, retailing and health care — as well as service functions like marketing, design and customer service that are also crucial in manufacturing industries.

A couple of dozen universities — including the University of California, Berkeley; Arizona State; Stanford; North Carolina State; Rensselaer Polytechnic Institute; and Georgia Tech — are experimenting with courses or research programs in the field.

The push for services science is partly a game of catch-up — a belated recognition that services now employ more than 75 percent of American workers and that education, research and policy should reflect the shift. "Services is a drastically understudied field," said Matthew Realff, director of a new program at the National Science Foundation to finance university research in the field. "We need a revolution in services."

Stay tuned!

The Journey Continues

http://www.nytimes.com/2006/04/18/business/18services.html

Michigan Tech Service Systems Engineering Undergraduate Major (http://www.sse.mtu.edu/)

- 128 semesters credits:
- 22 University defined General Education
- 15 Mathematics
  - Calculus with Technology I&II,
  - Elementary Linear Algebra,
  - Elementary Differential Equations,
  - Engineering Statistics
- 11 Science
  - General Chemistry,
  - Physics I,
  - Intro to Psychology
- 26 Engineering Core
  - Computer Science I,
  - Engineering Analysis and Problem Solving,
  - Modeling & Design,
  - Statics & Strength of Materials,
  - Circuits and Instrumentation,
  - Thermodynamics & Fluid Mechanics,
  - Multidisciplinary Senior Project
- 15 Business/Economics
  - Accounting I,
  - Fnance, (this should touch on Financial Engineering)
  - IS/IT Management
  - Strategic Leadership,
  - Economic Decision Analysis
- 29 Service Systems Engineering
  - World of Service Systems Engineering ()
  - Service System Design
  - Web Based Services
  - Human Interaction in Service Systems
  - Operations of Service Systems ()
  - Optimization and Adaptive Decision Making
  - Project Planning and Management
  - Managing Risk
  - Simulation
  - Quality Engineering
- 09 Electives

Michigan Tech Service Systems Engineering Undergraduate Major (http://www.sse.mtu.edu/)

- 128 semesters credits:
- 22 University defined General Education
- 15 Mathematics
  - Calculus with Technology I&II,
  - Elementary Linear Algebra,
  - Elementary Differential Equations,
  - Engineering Statistics
- 11 Science
  - General Chemistry,
  - Physics I,
  - Intro to Psychology
  - (seems like they should also add Environmental Science, as well as Biology I or Bioinformatics)
- 26 Engineering Core
  - Computer Science I,
  - Engineering Analysis and Problem Solving,
  - Modeling & Design,
  - Statics & Strength of Materials,
  - Circuits and Instrumentation,
  - Thermodynamics & Fluid Mechanics,
  - Multidisciplinary Senior Project
- 15 Business/Economics
  - Accounting I, (this should touch on Activity Based Costing as well)
  - Finance, (this should touch on Financial Engineering)
  - IS/IT Management
  - Strategic Leadership,
  - Economic Decision Analysis
  - (they should add Organizational Learning Theory, Service Marketing, Qualitative Methods, Pricing Strategy/Value Propositions)
- 29 Service Systems Engineering
  - World of Service Systems Engineering (Service Economy, Front Stage/Back Stage - much of Teboul, plus some of Service Engineering)
  - Service System Design
  - Web Based Services
  - Human Interaction in Service Systems
  - Operations of Service Systems (This should include Service Management material from Fitzsimmons)
  - Optimization and Adaptive Decision Making
  - Project Planning and Management
  - Managing Risk
  - Simulation
  - Quality Engineering
- 09 Electives

Can there really be a science of service?

"Wherever there are phenomena, there can be a science to describe and explain those phenomena. Thus, the simplest (and correct) answer to "What is botany?" is, "Botany is the study of plants." And zoology is the study of animals, astronomy the study of stars, and so on. Phenomena breed sciences."

- Newell, A., Perlis, A. & Simon, H. A. (1967). Computer Science, *Science, 157*, 1373-1374.

Possible Objections… to Computer Science

- Only natural phenomena breed sciences
- The term “computer” is not well defined
- Computer Science is the study of algorithms, not computers
- Computers are instruments, not phenomena
- Computer Science is a branch of another science
- Computers belong to engineering, not science

- Newell, Perlis, & Simon (1967)

Possible Objections… to Service Science

- Only natural phenomena breed sciences
- The term “service” is not well defined
- Service Science is the study of work, not services
- Services are performances, not phenomena
- Service Science is a branch of another science
- Services belong to engineering (or management), not science

- with apologies to Newell, Perlis, & Simon (1967)

What makes SSME hard is that it is multidisciplinary…

- Services depend critically on people, technology, organizations, and **co-creation** of value
- People **work together** and with technology and with organizations to provide value for clients
- **Shared information** helps coordinate activities – language, laws, measures, models, etc.
- So a **service system** is a complex **socio-techno-economic** system
- Growth requires innovation that combines **people, technology, organizations, value, shared information, clients**
- A service system is a value coproduction configuration of people, technology, internal and external service systems connected by value propositions, and shared information
- Services systems are both designed (Artificial) and shaped by evolutionary forces (Natural)