

# Universities and Services Sciences, Management, and Engineering

*Presented by:*

**Stuart Feldman**

*Vice President*

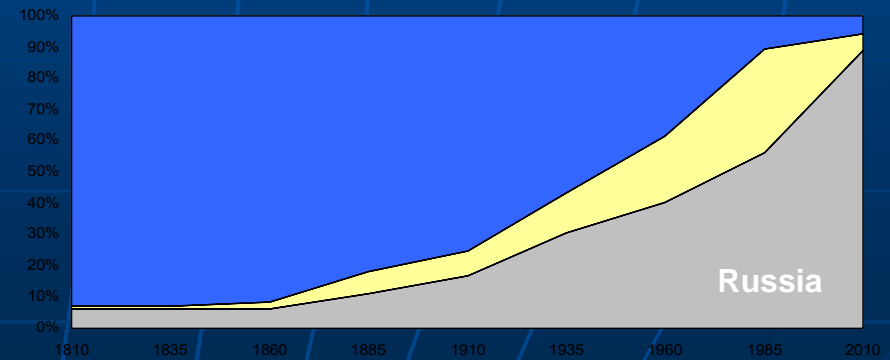
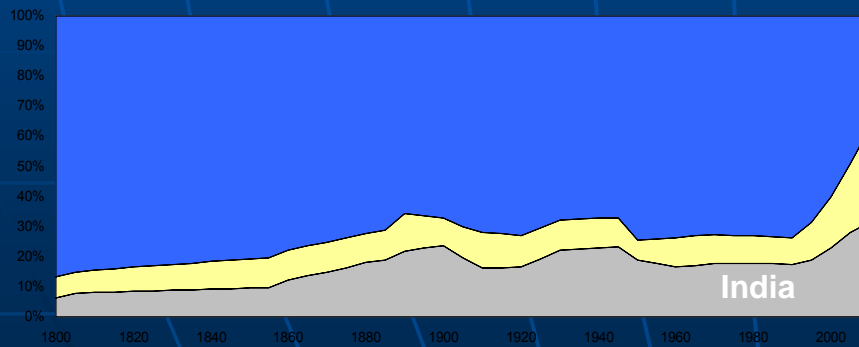
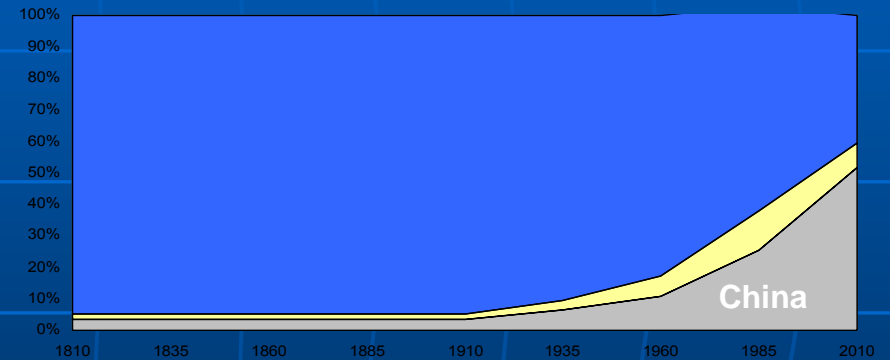
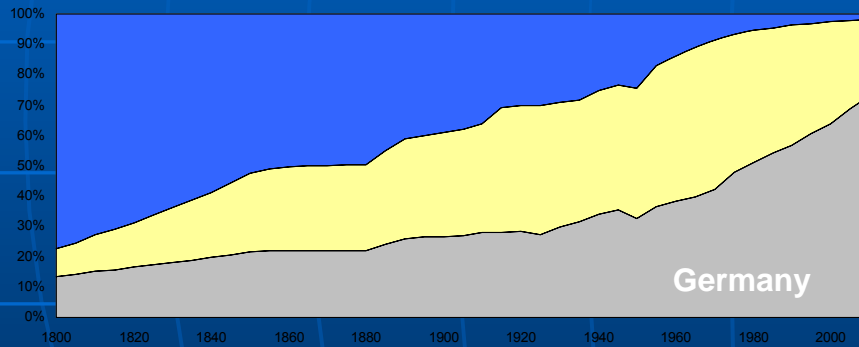
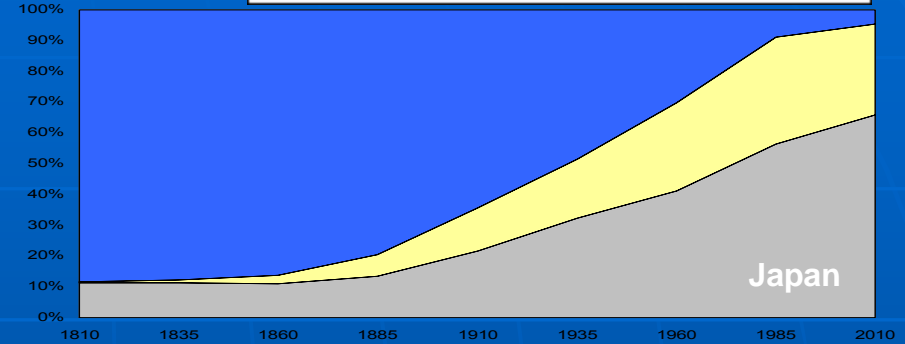
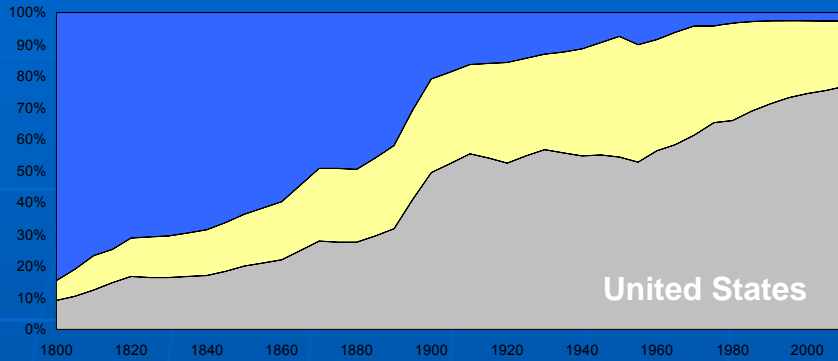
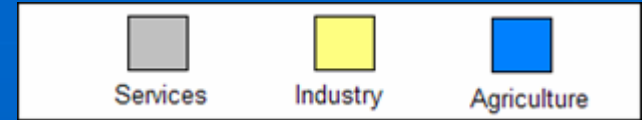
*Computer Science Research*

*Council of Graduate Schools  
Washington, DC  
8 December 2006*

# Key Messages

- Importance of services
  - Services have long been the dominant part of developed economies and are increasingly important in developing economies.
  - Information-based services are now the most rapidly growing and significant piece of the economy.
- Aspects of services
  - Computational and automated approaches are increasingly important
  - Computational services and Business processes are closely related
  - Humans continue both as performers and recipients
- SSME: Applications of computer science and engineering discipline
  - New ways to apply advanced techniques to model, analyze, monitor, and improve services.
  - Opportunities now exist to apply scientific approaches and engineering methods to create and manage services.
  - Importance of Government and to Industry
- SSME - Education
  - Numerous universities around the world are teaching service courses, planning courses, or building new degree and certificate programs consonant with SSME.
- SSME - Research
  - Huge opportunities for exciting, valuable research on short and long time scales.
  - Need to understand basics
    - (social sciences, autonomous service models, lifecycle analysis, etc. etc.)

# The Rise of the Service Economy



# Projected US Service Employment Growth, 2004 - 2014

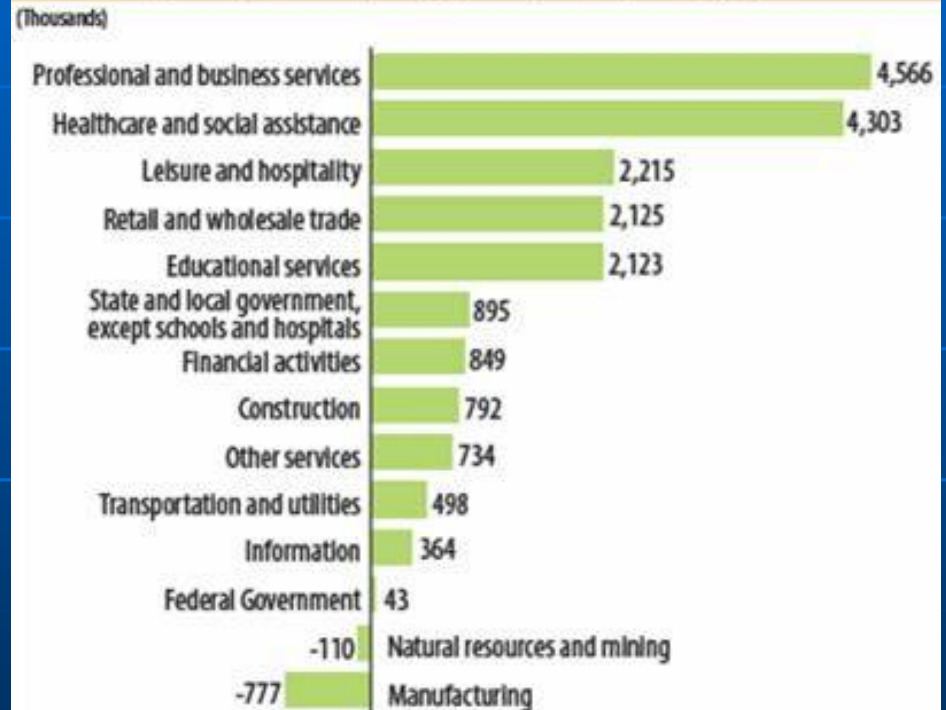
Numeric wage-and-salary employment by industry type, 2004 and projected 2014



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.

## Employment change

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



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.

# Aspects of Services

Intention

Business & Social

Measures,  
Goals,  
Incentives

Management

Management & Control

SLAs, Non-Func'l Attributes  
(Security, Performance,...)

Behavior

Implementation & Execution

Functional definition  
Semantics

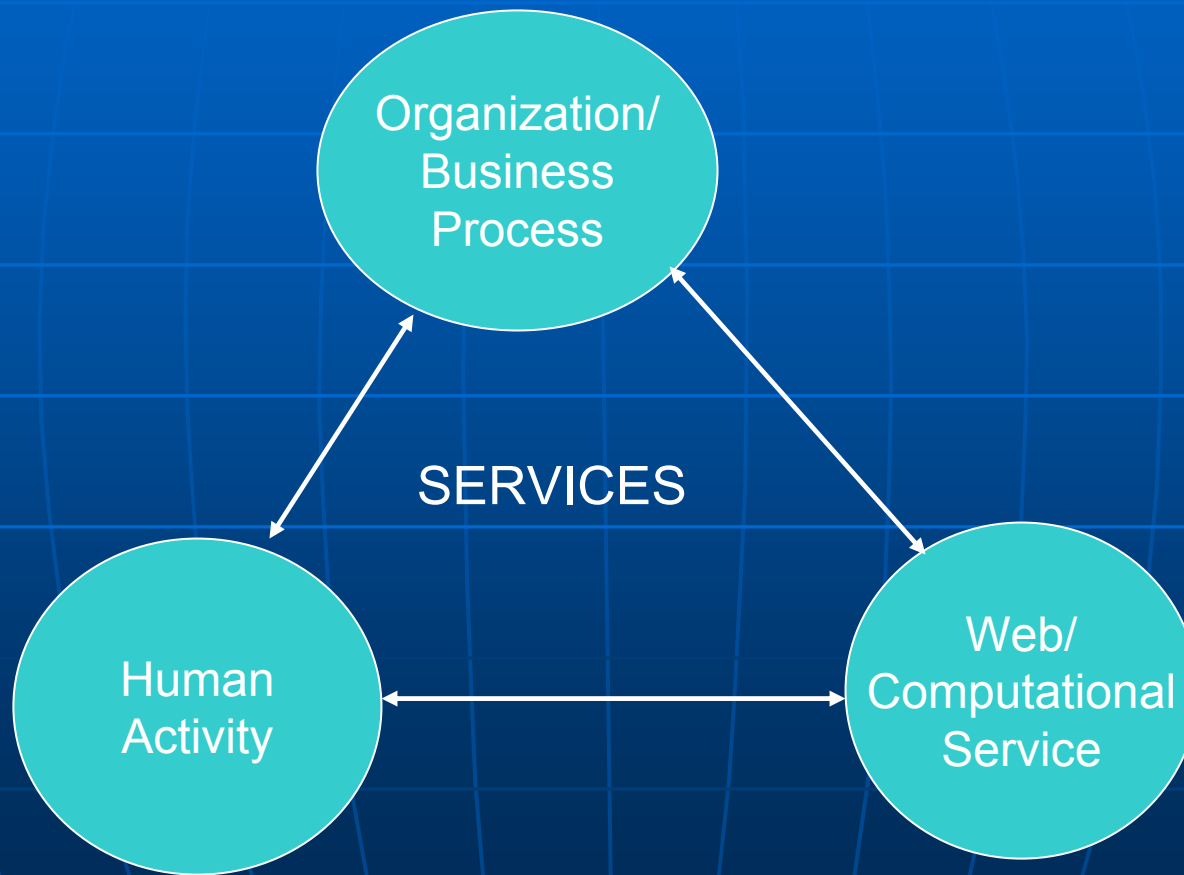
# Services Sciences & SSME

- Services Sciences
  - Many types of scientific approaches needed to understand services
  - Services Sciences cross the disciplines
  - Highly technical knowledge useful and essential
    - But includes knowledge in the difficult but “soft” sciences too
- SSME = Services Science, Management & Engineering
  - All aspects are important
  - Much important work is about how to manage better, how to engineer for success and effectiveness, especially for complex engineered systems.
  - Expect rapid changes in technical base
    - Tooling
    - Capabilities
    - Experience
  - Implications for careers, economies

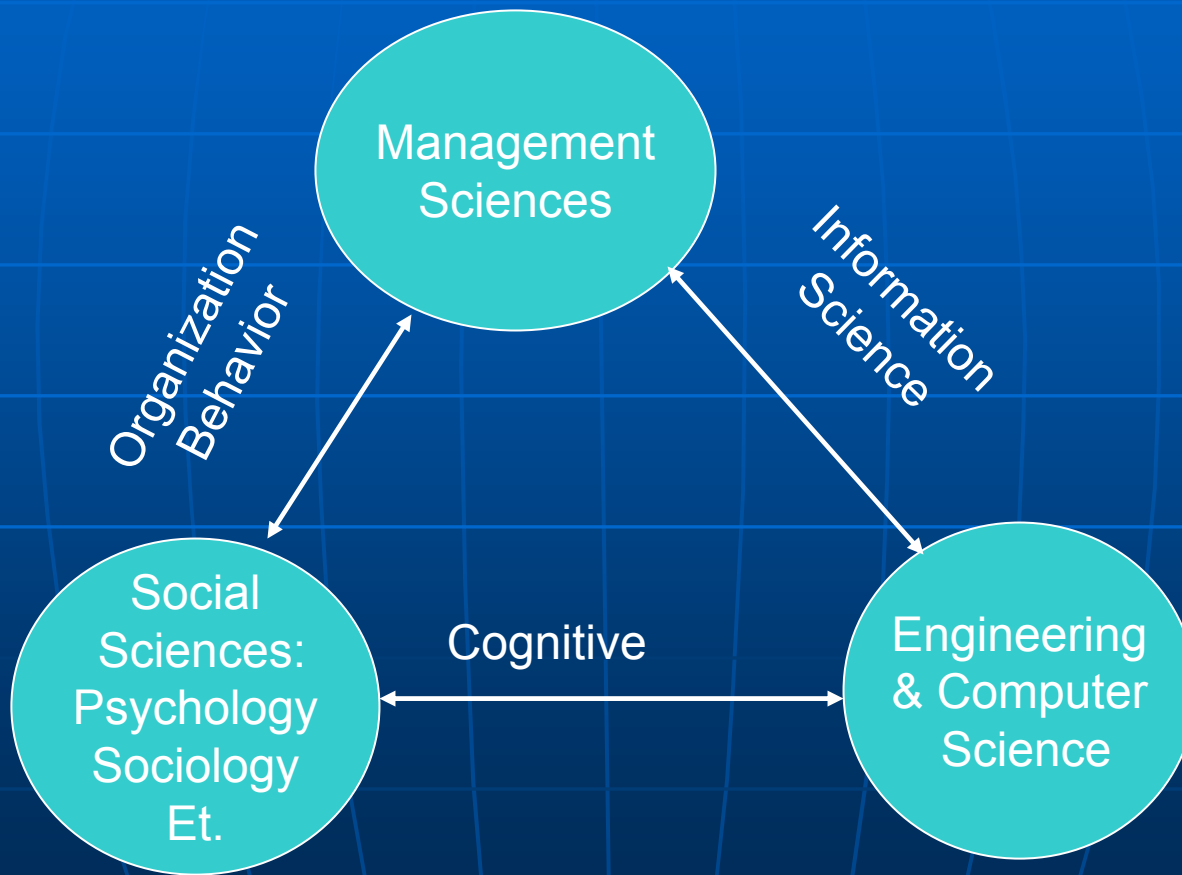
# Cross-Disciplinary Studies

- Services are fundamentally cross-disciplinary
  - Human aspects fundamental
    - Actors (participants, performers, tacit knowledge holders)
    - Purpose providers and incentive targets
    - High level requirements, design, understanding
  - But also IT issues
    - Efficiency (Moore's Law, embedding in software)
    - Growth, innovation
  - Experience as well as classroom learning may be valuable
- Implications for education
  - T-shaped people,  $\Pi$ -shaped people

# Topic Relationships



# Research Fields



# Research and University Issues

- Time scales for change
  - Following William Clark, it took German bureaucrats >50 years to create basis of modern research university
  - Computer science took ~25 years to reach reasonable acceptance in universities
- Need to break through to understanding of importance and excitement
- Need for one or more new disciplines
  - Respect, boundaries
  - Support, expectations
  - Students
  - importance

# Intellectual Clusters

- Most of work discussed and courses offered come from
  - Operations Research and Mathematics
    - Optimization, logistics, supply chain
  - Management Science
    - Organization behavior, process management, etc.
  - Industrial Engineering and system Engineering
    - Complex systems engineering, process management, etc.
  - IT (Computer Science etc.)
    - Knowledge management, distributed computing, web services, simulation, software engineering, ...
  - Physics
    - Complexity, modeling

# Curriculum

- Master's degree is the main entry point for experimenting
  - Soft spot in for experimentation, relatively easy to establish new programs, certificates, specializations
  - Refocusing of existing degrees (MBA)
  - What should be done at the Bachelor's level?
  - When will PhD programs thrive, how to start?

# SSME Courses - 1

- **Some schools teaching SSME-related courses (22 schools in 11 countries)**
  - Arizona State University CSL includes engineering and psychology in business degrees
  - Carnegie Mellon (CMU) offers Masters in Information Systems Management and Masters of Science in Information Technology asserted to encompass SSME
  - Katholieke University Leuven (Belgium) offers ICT/S Management of Information and Communications Systems
  - Portland State University teaches Technology Management, which they assert contains “engineering, science and management”
  - Rensselaer Polytechnic offers a Masters that has been redesigned over the past 2 years to be multi-disciplinary; also have an MBA with service content
  - Rochester Institute of Technology offers a Masters in Service Management that continually evolves and is updated for any type of business
  - State University of Management, Moscow (Russia) offers eMarketing MBA, uses courseware from Almaden’s web page; has SUR for Center of SSME Education and Research Programs project.
  - Texas A&M combined 4 departments to create an undergrad degree for engineering design
  - Tsinghua (China) offers IT service courses for graduate students
  - Cornell Undergraduate IT curriculum; OR & CS cross
  - Harbin Institute of Technology (China) “Introduction to SSME” fall 2006

# SSME Courses - 2

- **Some schools teaching SSME-related courses (22 schools in 11 countries)**
  - EPFL Federal Institute of Technology Lausanne (Switzerland) offers a course on enterprise and service oriented architecture
  - JAIST: (Japan) Management of Technology (MOT) course at the Japan Advanced Institute of Science and Technology, Professor Akio Kameoka teaches a class on Service Sciences for students with job experience.
  - University of Tsukuba: (Japan) MBA Program and Public Policy (MPP) started a short-term class named "Science of Services: Theory and Practice" in the fall Quarter of 2006.
  - Business school of IDC in Herzlyia (Israel) offers SSME taught by Haifa lab
  - Business school of Tel Aviv (Israel) offers SSME taught by Haifa lab.
  - Technical University of Brno, Czech Republic (Czech Rep) A new course was offered there in the spring 2006 semester focusing on IT services (management, outsourcing ...).
  - University of Manchester, (UK) IBMers teaching IT Architecture and Patterns for Reuse, 4 existing masters programs (UK – 6)
  - Western Michigan U Informed Services in Technology, Management and Engineering Curricula
  - Delft University of Technology (Netherlands) - Management of innovation in an open world, Marc Zegveld; strategic management & technology
  - Sogang University, (Korea) SSME course at its Graduate School of Business Administration.

# Existing SSME-related Programs

- **7 Schools that are currently offering SSME degrees or programs**
  - Helsinki Polytechnic Institute (Finland) offers a Master's program for Service Management (Ing of IBM co-teaches)
  - ITESM (Mexico) offers a postgrad program on services management
  - University of Manchester (UK) offers 4 service related masters degrees since 2004
  - University of Pavia (Italy) offers Engineering of Digital Services (new) undergrad
  - Virginia Polytechnic offers under grad service marketing degree focus on quality
  - University of California Silicon Valley Center Course and Program on Knowledge Services, Data Mining, Business Analytics
  - U of Maryland RH Smith MBA encompasses SSME

# Existing SSME-related Programs

- **3 schools that are currently offering certificates in SSME**
  - ITESM (Mexico) offers a professional certificate on services management for business and engineering students
  - Warwick University (UK) – graduate skills certificate – interdisciplinary and IT skills
  - UC Santa Cruz Knowledge Services and Enterprise Management (KSEM) is a new interdisciplinary graduate certificate program from UCSC Extension in cooperation with the Baskin School of Engineering
- **6 schools that are currently offering concentrations in SSME**
  - CMU offers an undergrad concentration in service management (6 courses)
  - NCSU offers a concentration for 2 degrees, Masters in Business and Masters in Computer Networking
  - UC Berkeley offers a certificate in SSME
  - UC Merced offers a minor in service science
  - Virginia Tech – master's degree concentration among 3 departments
  - EPFL Federal Institute of Technology Lausanne (Switzerland – 10) offers a specialization specifically called service science

# Schools Currently Creating SSME Courses - 1

- **16 schools that are currently creating SSME courses**
  - **North Carolina State University (NCSU) is creating 5 new courses for SSME in its concentration**
  - Tsinghua (China) is planning "Introduction to Services Science for 2007 and has SUR with 34-38
  - UC Berkeley developing curricula, joint among Haas School of Business, Engineering school and Information school
  - UC Santa Cruz – Kevin Ross developing a Service Engineering course with Almaden
  - Peking (China) research & curriculum building for SSME (SUR)
  - Harbin Institute of Technology (China) research & curriculum building for SSME (SUR)
  - Zhongshan (China) research & curriculum building for SSME (SUR)
  - Huazhong University of Science and Technology (China) research & curriculum building for SSME (SUR)

# Schools Currently Creating SSME Courses - 2

- **16 schools that are currently creating SSME courses**
  - Huazhong University of Science and Technology (China) research & curriculum building for SSME (SUR)
  - Central China Normal University (China) research & curriculum building for SSME (SUR)
  - Grant proposal for Curricula Development in Engineering Business Management and Services Science (EBMSS) has been selected, and accepted for sponsorship by the EC Tempus programme. The proposal for developing a graduate studies Master of Science Module, has been put together by the teaching staff from a consortium of three European universities from Greece (Greece), Serbia (Serbia), and Germany (Germany).
  - Northern Illinois University  
<http://www.cob.niu.edu/faculty/m10nlr1/ssme/> starting up SSME
  - Virginia Tech, proposal to add 3 modules on SSME - Managing customer relationships, process analysis and Design, Service Innovation
  - Illinois Institute of Technology – planning how to update offerings for service science
  - University of MD Baltimore County, engineering degree concentration includes Effective Management & Communication; Leadership & Team Development; Project management & Fundamentals; and Cases in Corporate Finance and Electives: Topics in Applied Ethics; Engineering Management Project; Managerial Economics; and Engineering Law & Ethics.
- **19 other schools intend to create SSME-related programs**

# Research Support

## ■ Government

- Funding agencies react to their clients and their demonstrated needs and wishes
- Funding agencies also take some initiative
- Working already with EU, NSF, etc
- We heard about some programs and directions that can start the process
- All changes at the margin – need to push for massive reallocations reflecting the 75% of economy tht seVICES represent

## ■ Industry

- Pump-priming
- Specific projects
- Not a practical replacement for government funding base

# Service Oriented Computing

- Theoretical and research topic
  - $WS \ll SOA \ll SOC$
- SOA is a dominant trend today in enterprise computing
- Practical use at this time mostly:
  - Focused on integration (EAI)
  - Particular relevant to legacy
  - Web Services provide guidelines for interfaces (not always for implementation)

# Human Activities

- Two divergent views
  - People perform actions that cannot (yet) be automated
    - Advanced Analog-to-digital converters
    - Judgment, legal responsibility
  - People are the reason for the automation
    - The purpose, the motivating force of the activity
- These are reflected in two different approaches to introducing humans into workflows
  - Undefined but constrained boxes in a Petri Net
  - As purposeful but somewhat unpredictable actors who require and deserve support

# Aspects of Services

Intention

Business & Social

Measures,  
Goals,  
Incentives

$$S = G \times N \times F \times R$$

$$s: I \xrightarrow{\Omega} O$$

$$s(t) \quad \bar{s}$$

Management

Management & Control

SLAs, Non-Func'l Attributes  
(Security, Performance,...)

Behavior

Implementation & Execution

Functional definition  
Semantics

# Business Processes ~ Computational Services

- Processes have well defined interfaces and behaviors
  - Even though they are (usually) performed by people
  - Contractual and customary expectations of cost, quality, reliability
  - Can be internal or external to an organization
- Services have well defined computational interfaces, inputs, and outputs
  - Service Level Agreements can define performance, quality, cost/penalty
  - Can be built out of other services
- Convergent modeling
  - We use UML for both
- Partially automated translation
  - Natural mapping between defined process and IT realization, supported by tools
  - Optimization, Simulation