EE-402A

Topics in International Technology Management

# Innovation Systems In the U.S. and Asia

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# Outline

- About this series
  - Important notes to for-credit students
- Innovation and corporate competitiveness
- Innovation as a process
  - University-industry-government roles in an innovation system
- Comparison of the innovation systems of the U.S., Japan, and China



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# About this series

- Produced by the US-Asia Technology Management Center, School of Engineering, Stanford University
  - <http://asia.stanford.edu> for details about this series, past series
- This is our 15th annual series: different theme every year
- Thanks to Squire, Sanders & Dempsey, LLP, for a gift in support of this series
  - Our 5th year of support from SSD !!



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## Everyone is welcome!

- Mixed audience: students, industry

## Stanford students - to receive credit:

Register for the seminars (EE-402a)

(1) Email written comments on nine sessions (see Syllabus for details), AND

(2) Attend in person eight sessions at the auditorium

- Auditorium attendance waived for official SCPD students

- See Syllabus for details



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**For today:**

- Please fill out & submit survey
  - This is your attendance record for today 9/27
- Get syllabus, find course webpage via http://asia.stanford.edu

Send any questions and email summaries to:

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# Why innovation?
# Because things change

| | | |
|---|---|---|
| Film camera | Digital camera | Combo i-Phone / camera / game player . . . (?) |
| Phonograph record | CD | Download from Internet |
| One team builds entire automobile | Assembly line | Supply chain (different companies for parts, systems, assembly, sales) |

*Past* → *Present* →



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# Some types of innovation

- Develop new product (or service) for existing market
- Develop new market or application for existing product (or technology)
- New combination or package of technologies, products, services
- Change business process (e.g. outsourcing)
- Develop new business model
  - What to sell versus what to give away for free (cellphones)
  - Subscription or leasing, instead of sale (software, webhosting services)
- Completely new idea ("breakthrough" -- rare)



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# Various types of innovation

| | |
|---|---|
| New Product | Nintendo “Wii” (new feature added to existing product category) |
| New Market for existing product | (Hypothetical: use Wii to improve athletic training programs) |
| New Combination | Apple i-Phone |
| New Business Process | Company outsources employee medical services to specialist firm |
| New Business Model | Flat rate for cellular phone service |
| Completely New … | Personal computer ? |



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# Innovation as a process

- "The process leading from the discovery or invention of a new idea or technology to its practical implementation (often via commercialization)"
  - Early stage (basic research): typically without a practical implementation (product) in mind
  - Late stage (development): driven by technology and cost demands of a real-world application
- Usually, different people are involved at the different stages: together, they make up an innovation system



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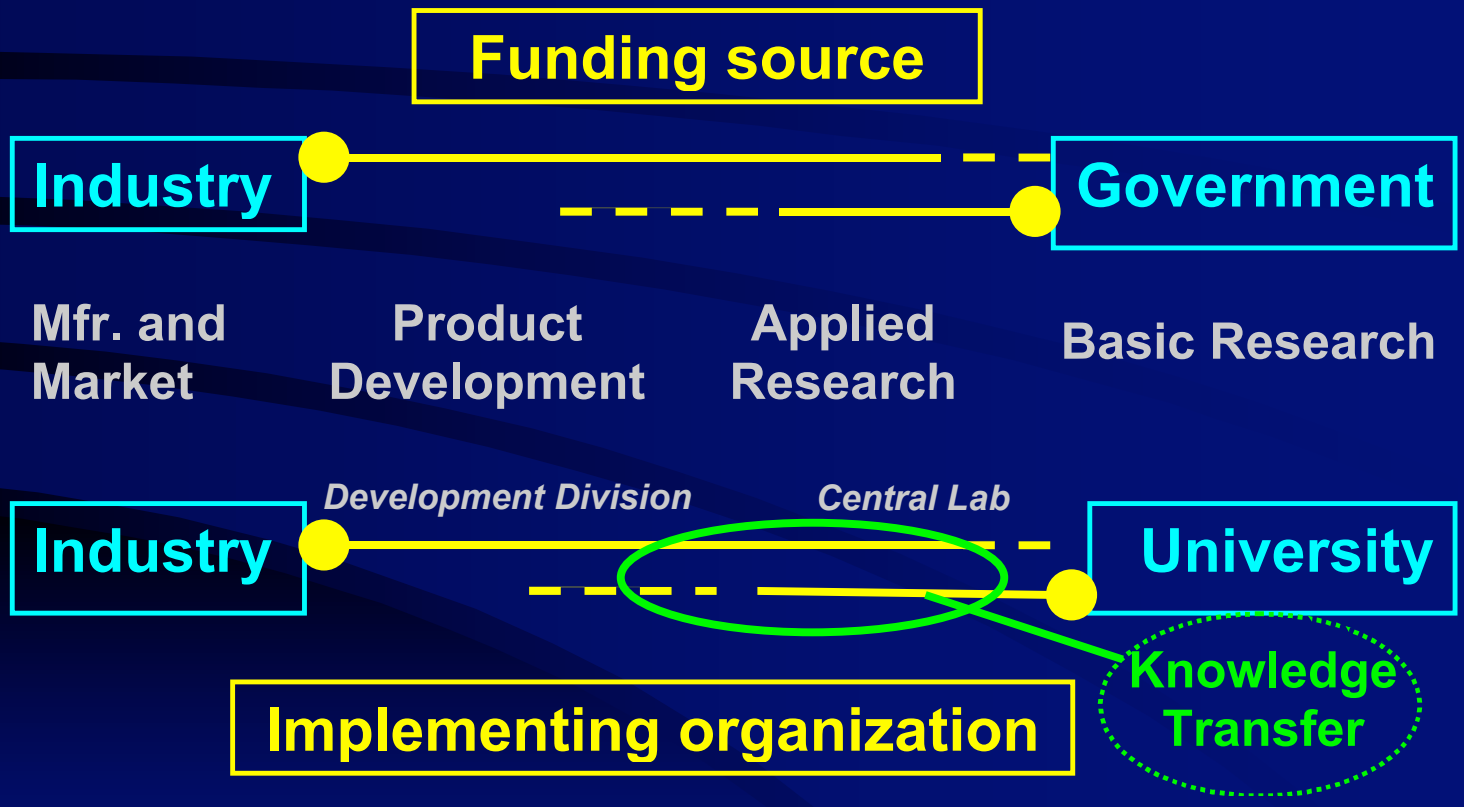
# University, industry, government roles in an innovation system



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# (Explanation of previous slide)

- Natural division of labor
  - Basic research:  government funds, university conducts
  - Product development:  industry funds, industry conducts
- Transition of roles at "Applied Research"
  - Both industry and government fund applied research
  - Both industry and university conduct applied research
- Knowledge transfer
  - Internal to industry:  central lab to product division
  - From university to industry



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# "Innovation system"

- The institutions
  - At national level, primarily: universities (and other research institutes), industry, government
- The mechanisms
  - Funding
  - Transfer
    - Rights licensing, new company creation, …
- The underlying policies
  - Provide overall direction, may provide constraints



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# Factors in comparing national innovation systems - 1

- How government money flows to R&D in university, industry, and government labs
  - Does the flow promote cooperative relationships?
- Employment patterns of R&D workers
  - E.g., high mobility (change companies often), or not
- Patterns of university-to-industry knowledge transfer (mechanisms and policies)
  - Rights ownership and licensing
  - Ownership of start-up companies and their assets



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# Factors in comparing national innovation systems - 2

- Infrastructure issues
  - Degree of macro-economic development; speed of growth
    - Advanced economies typically rely on innovation for competitiveness more than do developing economies
  - Sector-internal characteristics
    - E.g., Is there much M&A inside the industry sector?
  - Other national policy objectives
    - E.g. to spread out capital more than just to a few big companies or business groups)
  - Legal framework for IP and enforcement



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# Stanford mini-case: Professors must obtain own research funds

- Direct cost to a Stanford EE professor of a 50% time graduate student RA: about $50 - 60,000 / academic year
- Cost of a 50% time RA plus university overhead ( ~ 58%): about $85,000 / academic year
- Number of Ph.D. students in a typical EE professor's research group: about ten
- Percentage of EE Ph.D. students with "own" fellowships or other funding: around 10%
- On average, professor must get funding from outside for about nine Ph.D. RAs: turn funds over to Stanford, which hires the RA



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# Sources of Funds: Stanford School of Engineering

**2005-06 Sources of Operating Funds**

**$214.6 M (including $119.2 M for research)**

- **University funds** 21.0%
- **Endowment income** 11.0%
- **"Sponsored" research (contracts)** 45.0%
  - **About 3/4 sponsored by U.S. government**
- **Other (gifts, centers, licensing, etc.)** 23.0%

# Companies fund research via "unrestricted" channels at SU

- Contract Research ("Sponsored Projects")
  - Largest source of funds, but most is from governments or private foundations (not from companies)
- The "other" channel: unrestricted funding
  - More economical for the sponsor (not charged full 58% overhead)
  - But, channel provides much less control to the sponsor
  - Creates a different type of relationship between company and professor than does a research contract
  - Professors often use these funds as matching funds in their government grant proposals



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# How "matching funds" work

- Let's say, … university professor applies in competition for $1 million grant from U.S. government
- Formally promises (in budget proposal to government) to do $1.5 million worth of work
  - Leverages / stretches the government money
  - Shows that someone else values the research
- Professor must obtain $500,000 of "matching funds"
  - Not permitted to use other U.S. government grants as matching funds
  - Most likely source of matching funds: industry support



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# Stanford mini-case: Some sources of "unrestricted" funding

- Expendable gifts to support research by specific professors
- Membership fees to "industry affiliate programs"
  - Include channels to provide support for research by specific professors (and even specific Ph.D. students)
- Fees (via gifts or affiliate programs) for accepting visiting researchers from companies to be in residence at Stanford
- Licensing royalties (only about 1% of School of Engineering budget)

# Comparing the U.S. and Japan systems - 1

| | U.S. | Japan |
|---|---|---|
| Government money | Competition-based | Still mostly allocated |
| | Each agency funds both university & industry research | Separate systems: companies < METI, universities < MEXT |
| | Direct subsidy of industry R&D politically difficult | R&D policy: for industry / economic development (not much for defense) |
| | Matching funds: industry - university partnerships | Matching funds within industry for government projects |



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# Comparing the U.S. and Japan systems - 2

| | U.S. | Japan |
|---|---|---|
| Employment patterns | High mobility: industry "buys" Ph.D. graduates | Lifetime employment: hire young & assign to research in company lab |
| Patterns of transfer from university | Highly developed licensing and also "spillover" relationships | New laws and patterns since 1998; still "bugs" in working out implementation |
| | Many examples of successful new company spin-out | No superstar examples of successful spin-out (yet) |



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# Comparing the U.S. and Japanese systems - 3

| | U.S. | Japan |
|---|---|---|
| Infrastructure | Companies strong at M&A to acquire knowledge, tech | Highly developed company-internal knowledge transfer |
| | Need innovation for high value-added business (to sustain high cost of living) | |
| | Legal system well-established in general, consistent enforcement | |



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# The result: comparing university-industry cooperation in U.S. and Japan

## U.S.

- Most common pattern: university-based research with real-time industry participation
- Motivations for research cooperation:
  - Two-way, long-term knowledge exchange
  - Recruiting
- Industry expects to pay to participate
  - But not pay full cost

## Japan

- Most common:
  - Research outsourcing
  - Rare: company visitor in university research group
- Motivations:
  - Company's specific commercial objectives
- Close, lasting personal relationships between professors & graduates
  - May marginalize revenue to university



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# China - 1

| | |
|---|---|
| Infrastructure: transitional economy | Some funding for S&T development still comes from World Bank, UNESCO |
| | Lack of large domestic companies with resources or needs to fund research in universities (but university research funding is coming from foreign firms) |
| | Industry cooperation with university focuses on recruiting, long-term relationships for later use |
| | Reorganization of university sector, still many Soviet-style research institutes |



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# Background: Higher Education in China - 1

- Western-style shifted to Soviet style from 1949
  - Universities specialized in single disciplines / fields
  - Advanced research done more in government research institutes
  - Research topics defined (only) by government
- Shut-down of universities during cultural revolution (1964 - 1976)
  - Nationwide college entrance exams resumed: 1978
  - Chinese government sends grad students, visiting scholars to U.S.: from late 1970's
  - (Re)appearance of university graduate schools



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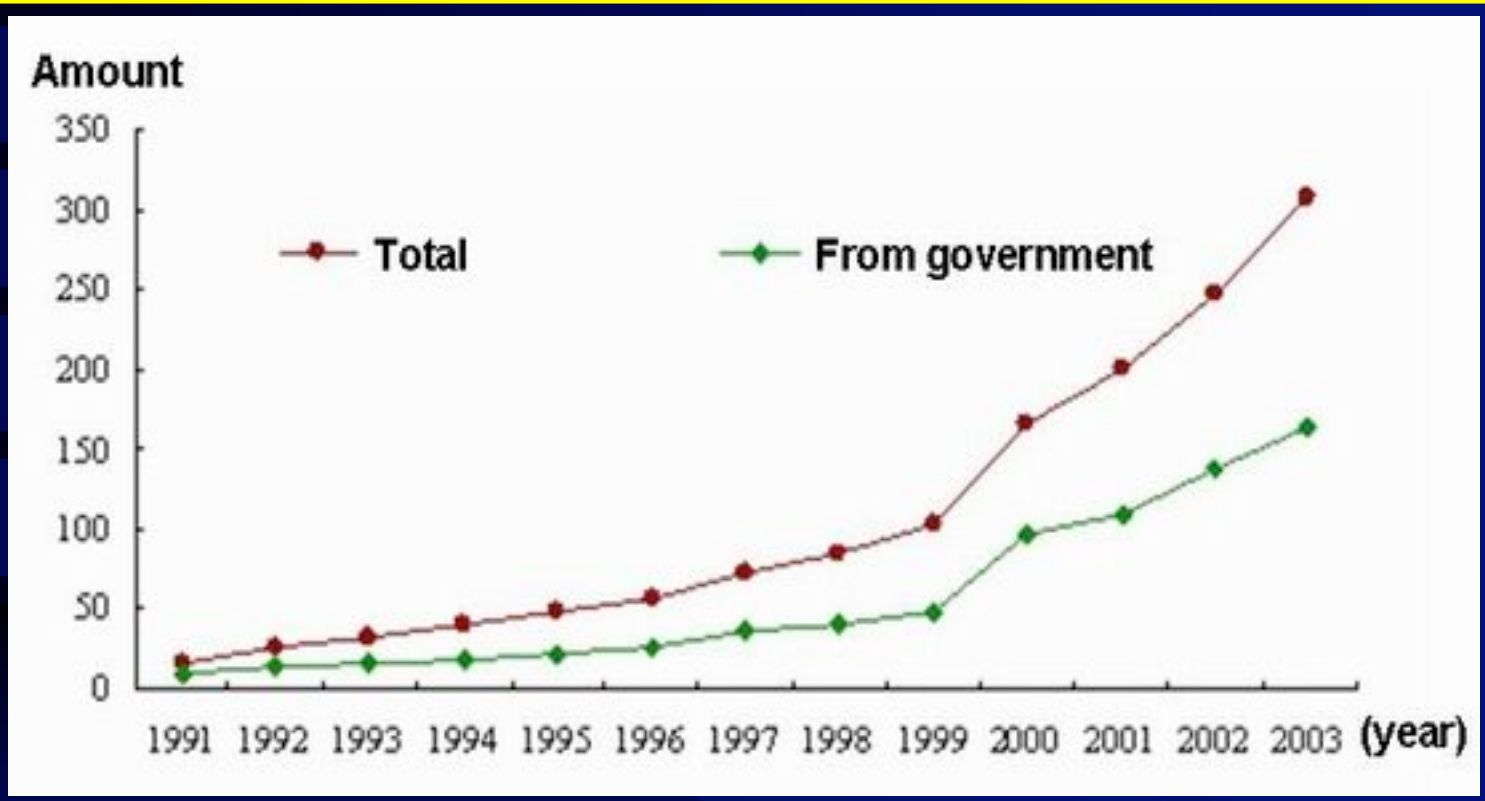
# Higher education in China - 2

- Chinese government policy statement (1998): build some Chinese universities into world-class institutions
  - Major shift back toward Western-style, comprehensive universities
  - Mergers: between 1996 - 2000, 383 universities into 212
  - Hiring of returnee-professors (from universities abroad)
  - Government gives major increases of S&T funding to universities
    - Relative share of government R&D budget shifts away from national institutes
  - Focus also on innovation

# S&T funding in Chinese universities, 1991 - 2003




- Unit: 100 M RMB; cited in Chen and Kenney, 2005



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# Total R&D spending in China (from all sources of funds)

- 2003: total R&D spending was RMB 154 billion
  - Increase of 20% over 2002
- Universities accounted for 10.5% of total R&D spending
- Government research institutes: 25.9%
  - But research institute share of R&D spending had been 42.8% in 1996
- Company R&D: 62.4% of total spending
  - Had been 43.3% in 1996

China Nat'l Bureau of Statistics, cited by Chen and Kenney 2005



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# Background: High-Tech Business in China

- Tend to compete more on cost than on the most advanced technologies
  - R&D mostly for product development, localization, some re-engineering (e.g. to cut manufacturing cost)
- Hiring from U.S. (including returnees): for management roles, not for company research
- Foreign R&D labs in China: active programs with Chinese universities, hire recent graduates
- Little direct interaction between Chinese companies and U.S. universities



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# China innovation system: Distinctive features - 2

| | |
|---|---|
| Government money | Apparently still not trying to obtain leverage from matching funds; not concerned with promoting cooperation |
| Employment | High mobility, but industry is probably still much less important market for Ph.D.s than in U.S. |
| Patterns of transfer | Robust spin-out of start-up companies, which the university may own !! |
| | No famous start-up companies from universities (yet), but Lenovo came from CAS Institute of Computing Technology |



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# Highlighting some differences

| | U.S. | China | Japan |
|---|---|---|---|
| Government funding | Promotes univ-industry symbiosis | Separate systems for funding university and industry | |
| Industry wants < top universities | Real time partnerships | Research outsourcing | |
| National labs | Special purpose | Historically dominant | Leverage industry R&D |
| University start-ups | Robust | | Still weak |
| Innovation goal | Sustained competitiveness, but specifics vary according to the national economy | | |



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# Looking ahead to the rest of the series

- Several sessions on industry case studies
- Will look at a government policy or two
  - E.g. Japan: "Innovation 25"
- Regional industry conditions
  - Next week: Prof. Lin Xu on "The Diversity of Start-Ups in China"

# Some sources used


Chen, Kun and Martin Kenney. 2005. "Universities/Research Institutes and Regional Innovation Systems: The Cases of Beijing and Shenzhen." Presented at "Universities as Drivers of the Urban Economies in Asia" sponsored by the World Bank and Social Research Council (May 24-25, 2005).

Rosenberg, Nathan, and Richard Nelson. 1996. "The Roles of Universities in the Advance of Industrial Technology." In Rosenbloom and Spencer, eds., Engines of Innovation, Boston: Harvard Busines School Press, pp. 87-110.

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