3B8 理工系大学院プログラムの日米比較

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Introduction:

Japan has expressed anxiety for many years about the paucity of doctorates in science and engineering it has been producing with respect to the United States. This paper summarizes actual differences in the structures of graduate programs between the countries. Various graduate programs in science and engineering of 14 U.S. universities were compared with those of 10 Japanese universities. In addition, results from surveys and in-depth interviews carried out by the author were also incorporated. The main differences were as follows:

Administration:

The Japanese graduate system is much more centralized than the American one. The form of what comprises a graduate program varies extremely little from university to university in Japan. Funding is also extremely centralized and constricted, which presents difficulties for professors in assuring funding for potential graduate students.

Whereas most of the top graduate schools in Japan are connected to the ex-Imperial colleges, the top graduate schools in the U.S. are a mixture of public and private universities. The public universities are often more inflexible in their admission requirements, but that is about the only difference, with the public universities emulating the private universities as far as possible. In Japan, up to now it has been the reverse.

Difference in Program Structure:

Japanese M.S. programs require 30 units of classes, a thesis, and take two years. Japanese Ph.D. programs start beyond the M.S., are mainly research, require another thesis, and take three years.

By comparison, U.S. graduate programs are extremely varied. Master's programs usually take 1-2 years, may or may not require a thesis, a "final project" , or an internship at some corporation. Double master's programs are also not uncommon. It is standard for M.S. programs to require one major specialization, one or more minor specializations, laboratory courses, and "other courses", some of which may be required to be from a different department. (See Figs. 1,1, 1.2, 2.1,2.2, 3.1, 3.2) Ph.D. programs can take anywhere from 4 to 10 years, require some sort of qualification exam, a preliminary exam, a thesis, and a thesis defense. The Ph.D. program may or may not include the actual getting of an M.S. degree, but in addition to the above course requirements, more courses in one's speciality and more research is required, as well as often at least one year of teaching.

Japanese graduate programs depend heavily on seminars and lectures, with the rest of the time ideally being taken up by research. Little homework is required, most of it in the form of reports. By contrast, US graduate programs depend heavily on highly-structured courses, with problem sets requiring sizeable amounts of time, mid-term and final exams.

Whereas the difficulties in advancement through a Japanese graduate school stem more from financial problems and lack of equipment and / or

time, U.S. graduate schools are quite competitive, with a series of exams the graduate student must pass before being admitted to candidacy. These exams are not trivial; one-third to one-half of the students to not pass.

Certain courses are found in Japanese graduate departments which are not found in US graduate departments: courses dealing with secondary equipment and data. In the US, it is taken for granted that the student will learn this on his own if necessary. Other courses that are more often found in Japanese graduate departments than in US ones are application courses tailored to the student's speciality (Matrix Algebra for Engineers, for example.) The US is more likely to offer these as joint courses or simply tell the student to take a particular course in another department.

Financial Aid:

Most US graduate students in science and engineering are funded through a combination of Teaching Assistantships, Research Assistantships, and outright fellowships. The forms of individual graduate funding differ according to school and department. Investigating 177 U.S. universities, most departments of 109 of them waived tuition in all cases when providing funding, 39 of them required tuition to be paid in all cases, and the rest were mixed. The levels of actual financial payment ranged from a miniscule $2000 per term to $15,000/ term in the case of some of the fellowships.

Japan falls way behind the U.S. in terms of financial aid. Graduate students are still considered, for the most part, to be responsible for their own financial support. A certain amount of money is provided by companies to individual researchers, but the employment obligations thus incurred are found to be onerous by many. Two major sources of official funding exist for graduate students in Japan: Fellowships from the Japanese Society for the Promotion of Science and so-called "scholarships" from the Japanese Scholarship Foundation. The latter would more appropriately be called interest-free student loans which must be repaid unless the student continues on to employment in academia. In 1994 26.2% and 59.0% of the total M.S.. and Ph.D. students were covered by these scholarships, with the amount provided being roughly half (assuming purchasing power parity) of what US graduate students receive as T.A.s and R.A.s. This value is reduced yet again since Japanese universities do not grant tuition waivers. At present, taking the entrance exam has a fee of around 30,000 yen, the entrance fee is around 300,000 yen, and tuition per year is around 450,000 yen. A comparison of the average effective stipends of graduate students in the US and Japan, corrected for the presence of tuition waivers, etc., is given in Figure 4 (using 1992 data)

Departments and Interdisciplinary Programs:

Japanese graduate departments are narrow in the range of courses covered by comparison to U.S. graduate departments, and almost totally lack interdisciplinary courses. U.S. research university departments can have up to a third of their courses as joint courses with other departments. U.S. mid-level universities do not have interdisciplinary courses, basically because of their emphasis on practice as opposed to theory.

Differences in Reception after Graduation:

Whereas in the United States M.S. and Ph.D. recipients have a definite value in the employment market of industry above and beyond that of someone who has stopped at a bachelor's, in Japan the main area of employment for graduate students is still considered to be academia. Companies may find use for M.S. recipients, but the reputation of a doctorate

is of an over-specialized intellectual who cannot adapt to a company environment. [4] In the U.S.., M.S. and Ph.D. recipients hold positions higher in salary and responsibility than people of similar age with only B.S. degrees. In the case of doctorates, this is particularly so. In Japan, little or no distinction is made between the job responsibilities of a BS graduate and someone with a higher degree. Figure 5 shows yearly salaries for B.S., M.S., and Ph.D. recipients in the U.S. and Japan presently employed in non-executive positions in industry, according to year of B.S. graduation. Figure && shows yearly salaries for B.S., M.S., and Ph.D. recipients in the U.S. and Japan presently employed in governmental positions, according to year of B.S. graduation [5]. Comparing salaries, it is in fact financially disadvantageous in Japan to continue for a higher degree, while in the U.S. it is advantageous, especially for a Ph.D. in industry.

Conclusions:

In regards to possible actions Japan can take to increase the number of graduate degree recipients, the simplest and most obvious is to increase the financial support of graduate students and to improve the level of facilities and equipment in Japanese graduate departments. This simply requires money.

However, it is questionable as to how effective this will be until Japan has some form of market demand for people with higher degrees. It is a circular problem: Japanese companies will not place a premium on the possession of a higher degree unless the people holding such are demonstratively superior in research capabilities. However, until the possession of a higher degree becomes obviously highly valued, people with skills and ambition might as well work their way up through the company ladder, rather than go to graduate school.

This paper is a very condensed version of a report the author has written for NISTEP.

Bibliography:

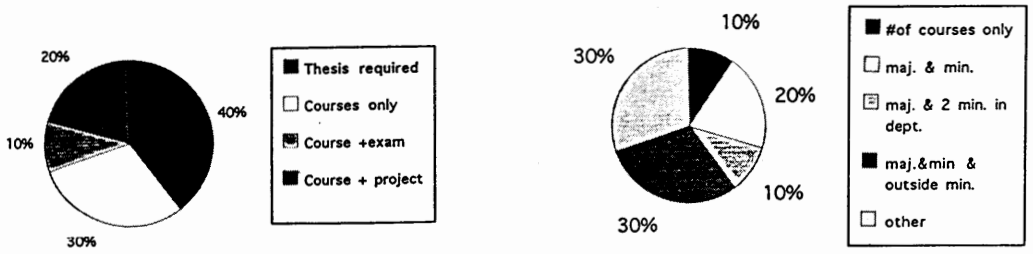
[1] American Society for Engineering Education, Directory of Graduate Studies and Research--1992 ASEE, Washington

[2] Pamphlets from MESC on the Japanese Scholarship Foundation and the Japanese Society for the Promotion of Science.

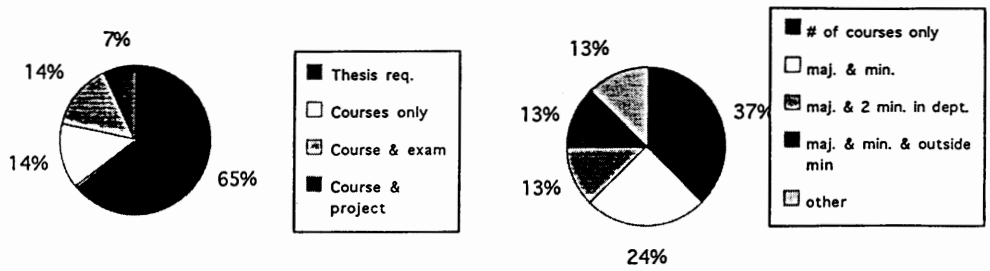
[3] Ibid, ASEE, Ibid, MESC

[4] "Increasing the Number of Course Ph.D.s in Science and Engineering Taught-Course Doctorates in Japan", C. Nishigata and Y. Hirano, NISTEP report #24

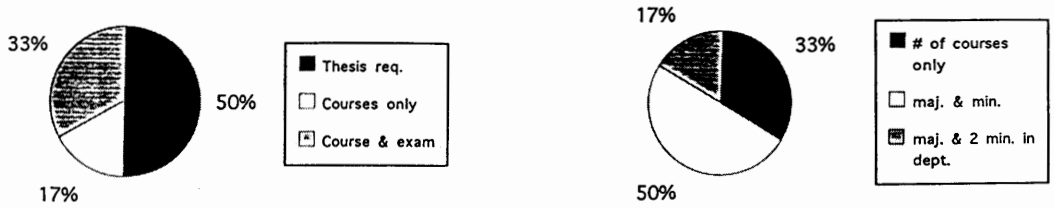
[5] "Survey on the Handling of Graduates in Science, Engineering, and Agriculture", Institute for Future Technology, 1993, and "Salaries of Scientists, Engineers, and Technicians-1993" Commission on Professionals in Science and Technology, Washington, D.C.



Figures. 1.1, 1.2
M.S. Program structure (general and in detail of courses) in U.S. Industrial Engineering and Operations Research Departments (10 cases)



Figures 2.1,2.2
M.S. Program structure (general and in detail of courses) in U.S. Computer Science and Electrical Engineering Departments (15 cases)



Figures 3.1, 3.2
M.S. Program structure (general and in course detail) in U.S. Mechanical Engineering Departments (6 cases)

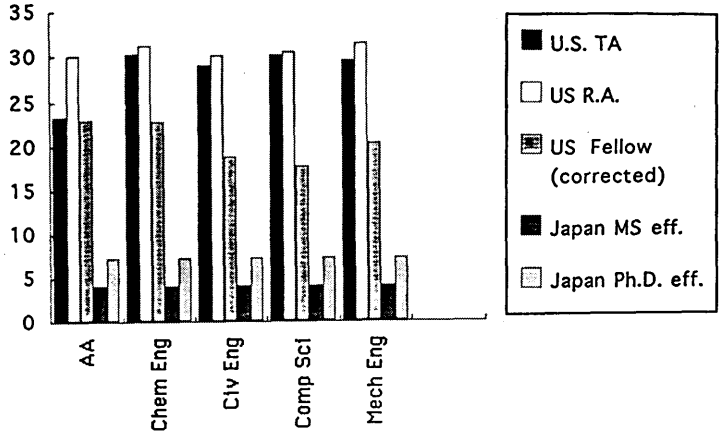


Figure 4
Average Effective Stipends of Graduate Students in the U.S. and Japan (10,000 yen/ month units)

Comparison of Japanese and US salaries in Industry of BS, MS, and PhD Recipients by Year of BS Graduation. (Yearly Salaries in 10,000 yen units)

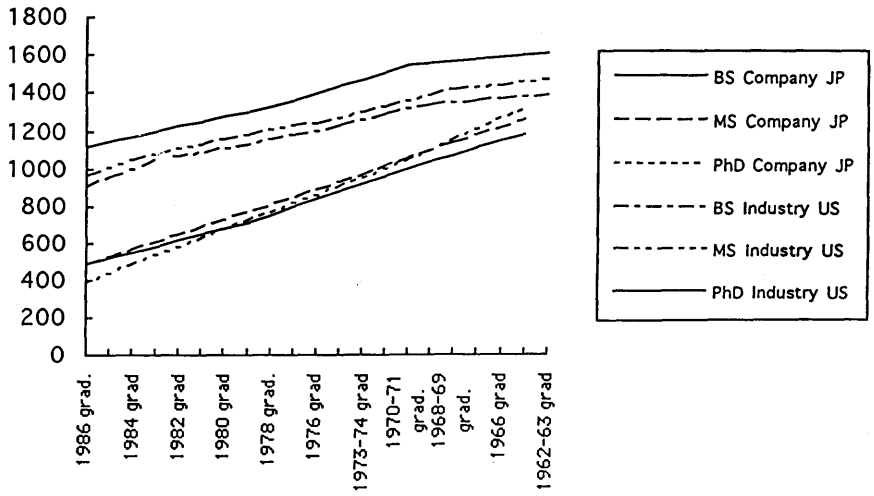


Figure 5

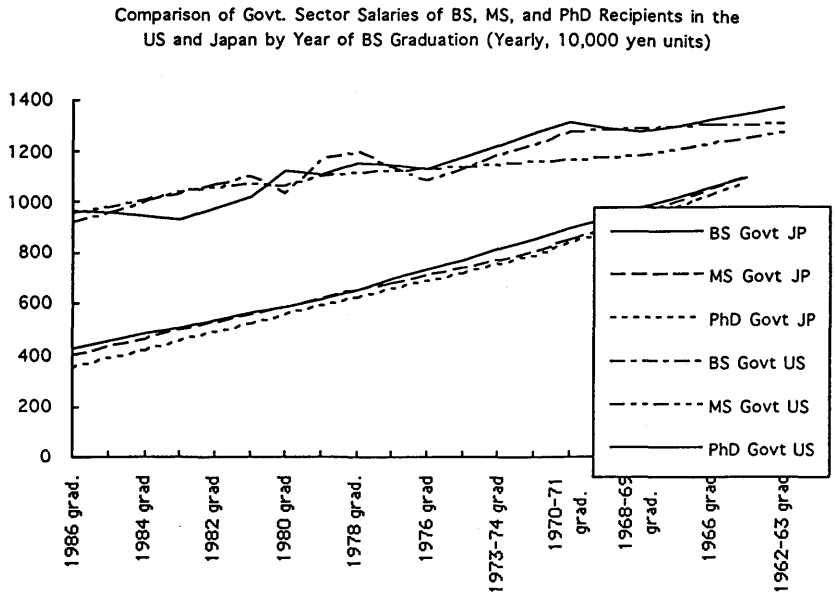

Comparison of Govt. Sector Salaries of BS, MS, and PhD Recipients in the US and Japan by Year of BS Graduation (Yearly, 10,000 yen units)
1400
1200
1000
800
600
400
200
0
1986 grad.
1984 grad
1982 grad
1980 grad
1978 grad.
1976 grad
1973-74 grad
1970-71 grad.
1968-69 grad.
1966 grad
1962-63 grad
BS Govt JP
MS Govt JP
PhD Govt JP
BS Govt US
MS Govt US
PhD Govt US

Figure 6