Invited Paper

Optics education for and in industry in Japan

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ABSTRACT

Based on the results of enquête to the industry in the year of 1990~1991, recent statistical data on "Optics Educations in and for Industry in Japan" will be reported. The contents of enquête are divided into the following three questions: (1) Optical education system and the way of performance in the industries, (2) Requirements to the university education from industries, (3) Possible way of joint research projects between industries and universities.

1. INTRODUCTION

Not only the traditional optical companies like Nikon or Cannon, but also electrical, mechanical and other industries, such as NEC or Toshiba so on, contributed to the enquête as shown in Fig.1. The capital scales of industries are also widely distributed.(Fig.2)

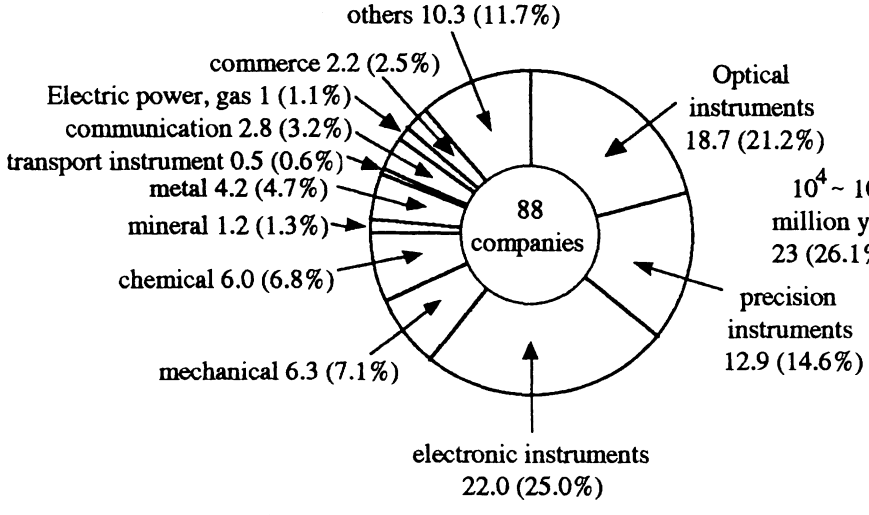

Fig.1 Type of industries of answered companies

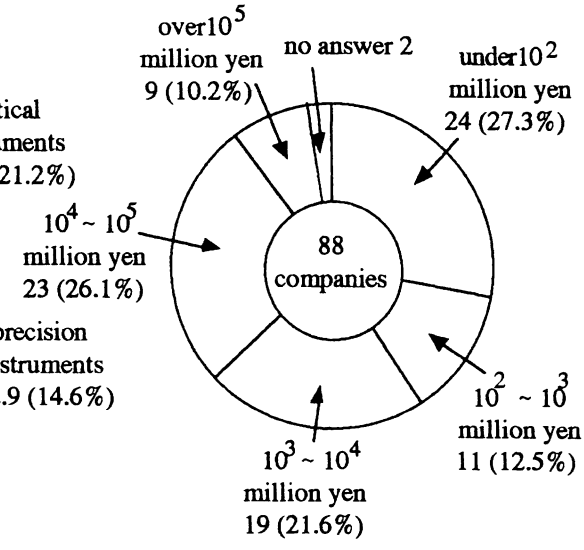

Fig.2 Capital of answered companies

The data shown here should, therefore, be read as that of more averaged and integrated. Because the optical new technologies are extremely expanding, developing and permeating to many fields of industries, the key words are selected as follows:

(1) Fundamental optics (physical, geometrical, quantum optics, etc.)
(2) Light emission (laser, SOR, LED, LD, illumination, etc.)
(3) Image formation (lens design, holography, etc.)
(4) Opto-electronics (Laser, LD, OEIC, CD, etc.)
(5) Opto-mechatronics (precision mechanics, robotics, etc.)
(6) Optical sensing (fiber sensor, remote sensing, etc.)
(7) Optical informations and communications (optical computer, communications, display, etc.)
(8) Spectroscopic applications (spectroscopic instruments, etc.)
(9) Micro-optics (micro-lens, selfoc, OEIC, fiber, etc.)

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(10) Optical materials (optical glass, photographic material, nonlinear crystal, etc.)
(11) Physiological optics (vision, colour, etc.)
(12) Bio-optics (Bio-technology, medical instruments, etc.)
(13) Environmental optics (space optics, safety, ocean, etc.)
(14) Optical work (laser precision work, etc.)
(15) Optical instruments (camera, copier, laser printer, optical measuring instrument, etc.)

2. OPTICS EDUCATIONS IN INDUSTRY

About 56% of the 88 industries responded that they perform steady educational programmes on optical technologies (Fig.3) and 28% are planning to establish such courses for young engineers, in which the technical fields are shown in Fig.4.

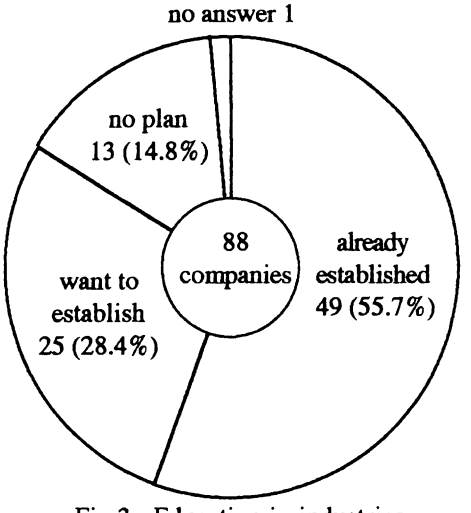

Fig.3 Education in industries

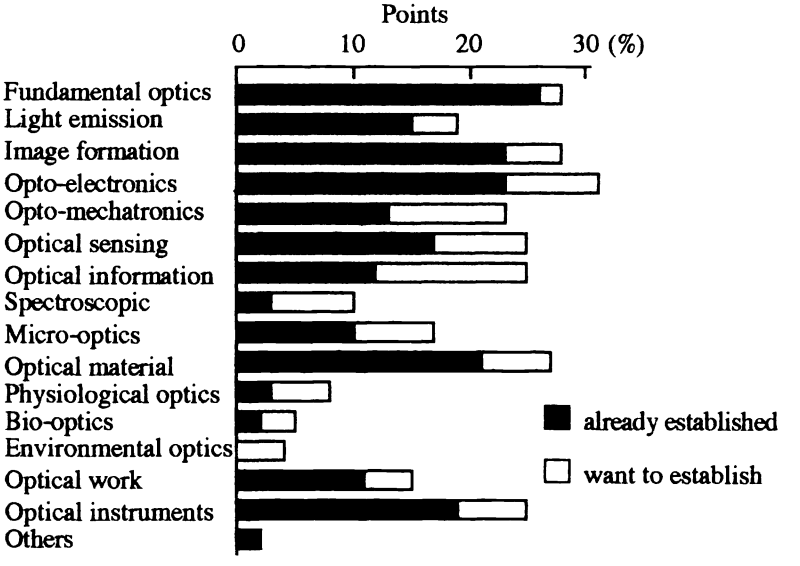

Fig.4 Educational programmes of optics in industries

The educations in industries are generally aimed to strengthen the professional knowledge, problem solving and creative skills and then to build up the person contributed to that company. (Fig.5,6)

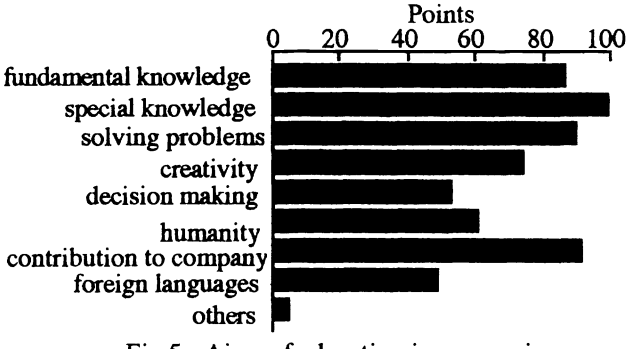

Fig.5 Aims of education in companies

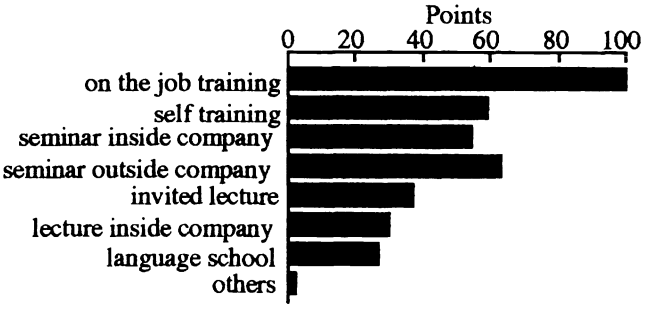

Fig.6 Methods of education in companies

These programmes are usually performed by the practical trainings in the technical works, mainly in R&D departments of the industry and by attending at the special seminars arranged by several institutions, such as OITDA* , JOEM**, etc., or participating with the meetings of academic societies, i.e. OSJ*** or SPIE, etc. Many fields of industries have attention to the necessity of education programme on the field of optical technology. (Fig.7)

The activity of such organizations like OITDA or JOEM, etc. had historical and social factors created a greater and a different role for development of Japanese industries than their counter parts in the West.

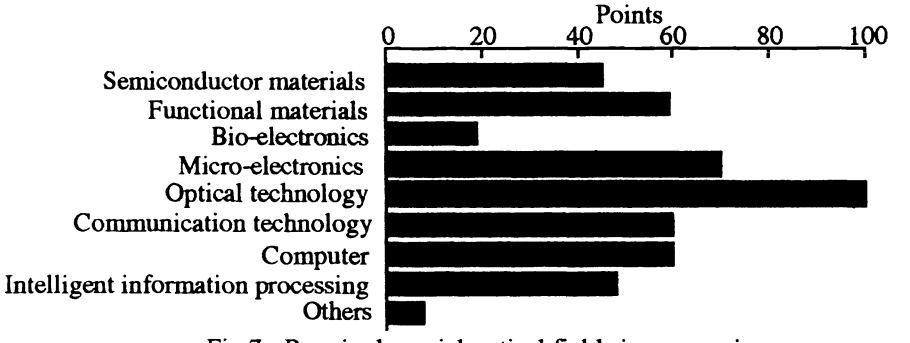

Fig.7 Required special optical fields in companies

3. REQUIREMENTS OF EDUCATIONAL PROGRAMME TO THE UNIVERSITY

About 60 schools among 515 universities and technical colleges (applicants to the universities are about 900,000 every year) in Japan have optics educational and research programmes. The optical science and technology curriculum is, in general, below the average relative to the other fields of science in universities. (University is more conservative in Japan!) Curriculum on fundamental optics is mainly established traditionally in the Department of Applied Physics, and optical research activities are growing in departments of electronics, information and material science, etc.

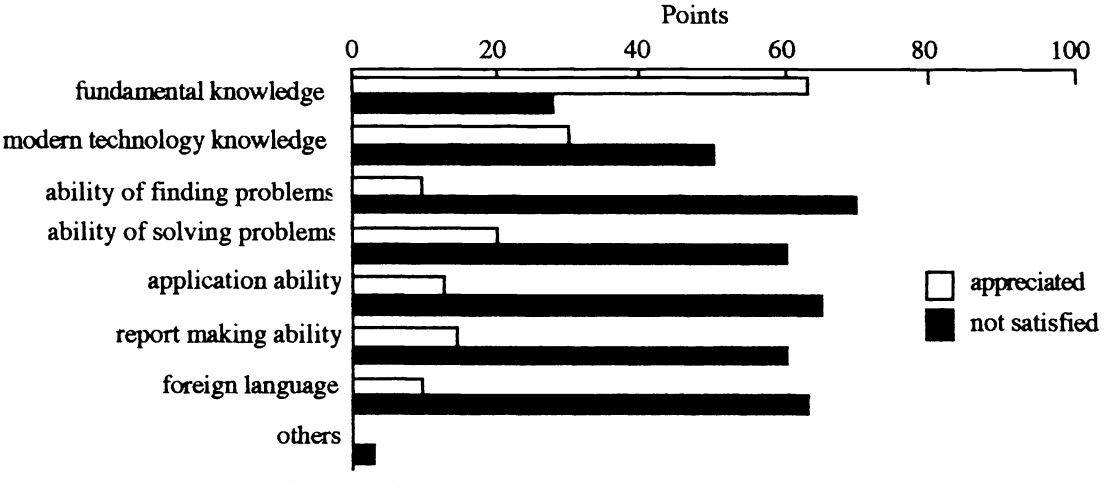

Fig.8 Evaluation of university eduction from industry

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* OITDA: Optoelectronic Industry and Technology Development Association, established in 1980, sponsored by 257 companies (mainly electrical industry). Office: Mori Build. 9,10F, 1-19-5, Toranomon, Minato-ku, Tokyo 169, JAPAN.

** JOEM: Japan Optoelectro-Mechanics Association, established in 1987, originally in 1981, sponsored by 115 companies (mainly optical precision industries). Office: Kikai-shinko-kaikan, 3-5-22, Shiba-kouen, Minato-ku, Tokyo 105, JAPAN.

*** OSJ: Optical Society of Japan (subgroup of J.S.A.P. - Japan Society of Applied Physics), supported by 1797 members and co-sponsored companies of 207. At 1971, OSJ has separated from JSAP and activated with publishing original optical monthly journals. Office: Kunimatsu Build. 4F, 1-2-6, Kudan-kita, Chiyoda-ku, Tokyo 102, JAPAN.

Most of industries require the universities to educate the students not only the fundamental knowledge but also new optical technologies. The rate of satisfaction to the graduate students are shown in Fig.8. Only the fundamental knowledge is appraisable , but very strict evaluation to the other important abilities has been appointed, for example, skills to develop the new technologies. To the question "what fields of optical technologies are requested to the university curriculum for industry?", the results are shown in Fig.9.

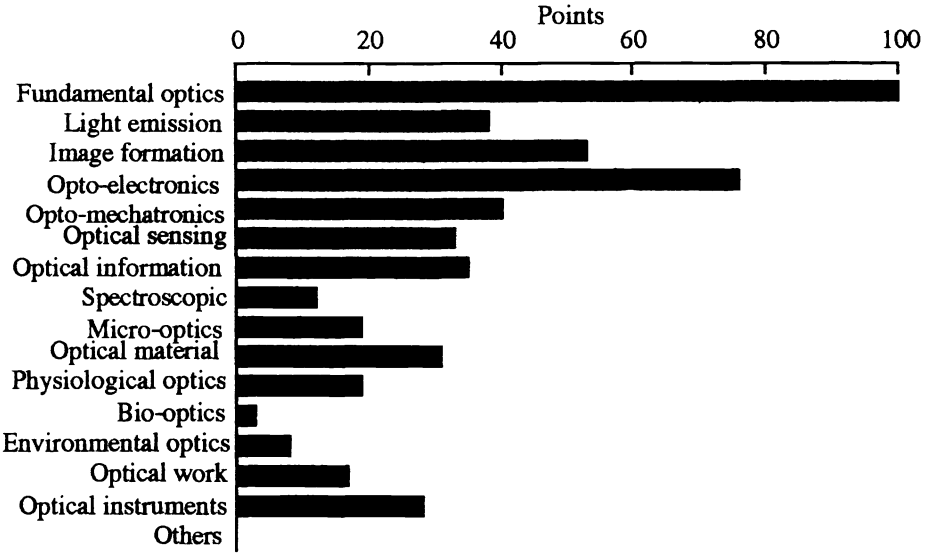

Fig.9 Required special optical fields in university education

4. POSSIBILITIES OF JOINT RESEARCH PROJECTS BETWEEN UNIVERSITIES AND INDUSTRY

The Japanese universities have been developed historically rather isolated and independent from the industries. From 1960's, cooperating with the development of technology, the number of technical colleges, engineering departments in universities, as well as the number of technical students increased very rapidly. The transition of last 30 years concerning high education in Japan is shown in Table 1.

Table 1 Total Number of Universities, colleges and students

year	Number of Universities and Colleges	Number of Applicant ($\times 10^3$)	Number of Passed Students ($\times 10^3$)	Rate of Applicants to the same generation (%)
1949	180	-	-	-
1960	245	198	163	21.2
1965	317	395	250	25.9
1970	382	539	333	25.7
1975	420	640	424	34.5
1980	466	637	412	32.3
1985	499	842	477	34.0
1990	509	886	492	34.4
1991	515	925	-	34.7

Among them, private schools managed mainly by student tuition are 377. Well educated human resources in Japan have supported the development of technology and industry. It is to say that Japanese universities have contributed in more economically - oriented Japanese R&D system in such a way.

On the other side, the potentiality of basic researches in the university, especially of the creative science, are fallen down relative to the raise of industry. Fig.10 shows the total research money invested in Japan.

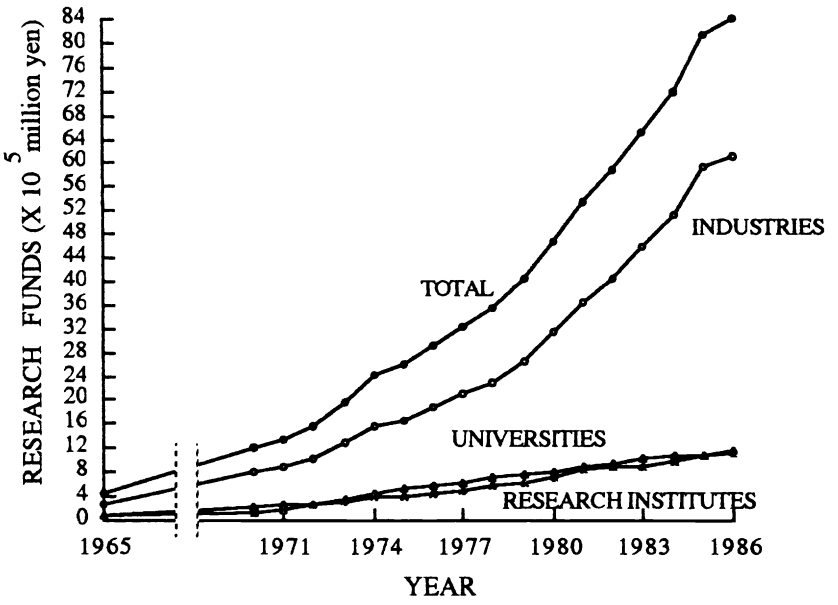

Fig.10 Transition of research funds in Japan

It has been reported that the roles of the Japanese university are as the provider of new concepts, the preserver of past research and technology, and as the librarian of knowledge. This argument may considerably be certificated by the fact shown in Fig.10.

The national policy of education should be changed to stir up the basic research in some active and research-oriented universities. Many of industry people are aware of this problems and the Engineering Academy of Japan has also proposed an increased cooperation with universities. It is pointed out there that, though improvement of research environment of universities shall be one of basic responsibilities of the nation to the world, a university-industry cooperation in Japan should be promoted immediately so that we do not lose timing, keeping the following factors in mind: 1) creation, upon recognizing intrinsic functions of universities and industries, of a framework and/or mechanism which complements all parties involves and provides mutual benefit, 2) needs for the industry-government-academia basic research cooperation system in addition to governmental support included national research laboratories. These now seems to be a consensus that Japan's basic research, not only optical science but all, must improve, and increased, not much interfered cooperation with industry may represent one way in which Japanese universities could up-grade their basic research and could contribute to the world.

5. ACKNOWLEDGEMENT

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