Museum of Industrial Technology and Engineering Education at Nippon Institute of Technology

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Abstract: The Museum of Industrial Technology of Nippon Institute of Technology was formally opened in 1988. Its main exhibits are a variety of machine tools that were actually used in Japan from the beginning of the Meiji era (1868-1912) until recent years, their total number amounting to about three hundred. They are classified and displayed in chronological order according to the year of production so that visitors to the museum can easily understand the transition of the machines. Moreover, about half of them are restored to working condition. Therefore, the museum can function as a machine shop and, in case of necessity, can provide students with occasions of 'actual production practice,' namely, the engineering education. Eight staff members attached to the museum take the responsibility for its administration and management. However, students also have opportunities to participate in its activities to develop their practical skills and thinking through such experiences in the engineering education. The engineering education includes many kinds of activities such as restoration and reproduction of exhibited machine tools, preparation of explanatory VTR tapes for exhibited machines, production of various exhibits necessary for occasions of special exhibitions, and so forth. In this article, the following will be given as practical examples of students' activities: (1) restoration of a hand-operated driving equipment, (2) reproduction of an automatically indexing gear cutting machine and a profile copy reduction shaping machine, and so on. In addition, the response of students to the work of 'actual production practice' and also the thinking of the authors, who are promoters of the above educational work, on the engineering education will be presented together with some reconsideration.

Keywords: museum, education, practice, restoration, reproduction

1. Introduction — outline of the museum

Since its founding in 1907, our educational foundation, originally named 'Tokyo Engineering School,' has devoted itself to offering technical education directly linked with practical work. It now offers consistent education from junior high school to postgraduate doctoral courses.

In 1967, it established Nippon Institute of Technology (NIT) for the purpose of accepting students who have scholastic abilities and capabilities equivalent to those of graduates of technical high schools.

In the above context of our idea of education, it was suggested that NIT should have a machine museum and

utilize it as an educational aid. This suggestion developed into a concrete plan to establish the Museum of Industrial Technology of Nippon Institute of Technology. And the museum building was completed on the campus of NIT in November 1986 as a project in commemoration of the 80th anniversary of the Tokyo Engineering School, the origin of NIT. The museum was temporarily opened in September 1987 and, after the completion of the inside arrangements, formally opened in November 1988. It would be noteworthy that the museum is open not only to those who are related to NIT but also to general public without charging an admission fee.

The main exhibits of the museum are a variety of machine tools that were actually used in Japan from the beginning of the Meiji era (1868-1912) until recent years, their total number amounting to about three hundred. They are classified and displayed in chronological order according to the year of production so that visitors to the museum can easily understand the transition of the machines. Moreover, about half of them have been restored to working condition. Therefore, the museum can function as a machine shop and, in case of necessity, can provide students with occasions of 'actual production practice,' namely, the engineering education.

2. Outline of the engineering education at NIT by utilizing the museum

It has been taught that the following should be always kept in mind during the education of engineering students.

Students should be educated so that they may ① have the ability of denying themselves, ② recognize the preciousness of labor, ③ understand how theories and basic ways of thinking are applied to machine tools, and ④ acquire the ability to know at least themselves before they graduate from a university.

In order to realize the foregoing, NIT gives students chances to solve various problems for themselves, offers them chances for trial and error together with facilities and persons necessary to them, and, therefore, teachers are merely required to give the students pieces of advice on their trial and error. Furthermore, it is hoped that, if possible, the teachers support students to become a 'person of totality,' namely, a person who, without remaining in his specialty, wrestles frontally with all sorts of problems including those of political and economical nature. This is necessary because today's researchers and developers are not allowed to stay in their respective specialties any longer. They might be violently jostled right after they go out into the world, where companies and nations readily compete with each other for a scientific or technological output, invention and discovery, where 'high-tech friction' always exists both politically and economically, and where various advantages, disadvantages, and speculations are getting entangled.

The main purpose of the museum-centered engineering education is to educate students for research and development on the basis of the preceding four educational principles ① - ④ by offering the museum to students as the place of trial and error, and the exhibited workable machine tools as the facility for students' actual production practice. And the staff members of the museum, including the authors, are ready to help them in their activities. Therefore, the authors are to some extent self-confident that they offer technological education on the basis of scientific knowledge by letting students use real machine tools, which should be the starting point of the 'actual production practice.' The authors are also planning, as part of future projects, the reeducation of full-fledged members of society and the training of foreign engineers.

At present, eight staff members attached to the museum take the responsibility for its administration and management. For about ten years, however, students of NIT have been allowed to have opportunities to participate in its activities under the supervision of the staffs so that they can develop practical skills and thinking through such experiences in the engineering education. Most students who participate in the above activities are seniors studying for graduation research. However, about ten juniors also engage in disassembly and repair of all sorts of old machines collected into the museum as part of practical exercise for about ten days during summer vacation.

The museum offers the following subjects for graduation researches: (1) production of machines which are restorable and suitable for exhibition but are difficult to obtain, (2) production of spare parts for the restored machines and their tune-up, (3) preparation of explanatory boards and videotapes of exhibits for nonprofessional visitors, (4) participation in preparatory work for special exhibitions, and so forth.

3. Examples of the educational experiences at the Museum of NIT

3. 1 Restoration of a hand-operated driving equipment

In the Meiji era, Ikegai Ironwork Co. (the present Ikegai, Inc.) made a hand-operated driving equipment to operate a lathe. There remained, however, merely a sketch of the equipment as shown in Fig. 1. Consequently, restoration of the equipment was planned as part of the educational experiences and, based on the sketch, a reproduction shown in Photo 1, has been completed. The flywheel is about 2m in diameter and weighs about 300kg. In the course of restoration, plans were drawn through conjecture from the sketch, machine parts, except those needed casting, were prepared inside the museum by using exhibited machine tools, and were assembled in an arrangement suitable for working a cone pulley lathe having a bed length of about 1,800mm.

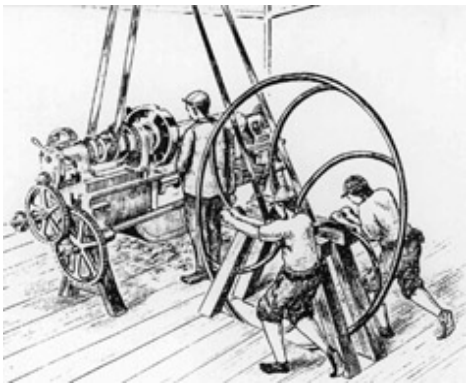

Fig. 1. Sketch of a hand-operated driving equipment copied from the Fifty Years History of Ikegai Ironwork Co.

Photo 1. The restored hand-operated driving equipment.

After the restoration was completed, students were asked to measure the power generated by the driving equipment. For this purpose, they produced a prony brake with reference to literature by utilizing a pair of scales and lumber which were available in the museum. A pair of students for graduation research accomplished this series of work within a year. Through the measurements, it has been found that a power of about 250W is generated when the main shaft of the lathe rotates at about 70 r.p.m.

3. 2 Reproduction of an automatically indexing gear cutting machine and a profile copy reduction shaping machine, and experiments by using them

Reproduction of an automatically indexing gear cutting machine was conducted. The machine was a product of Gould & Eberhart Inc. of the United States in 1901 and was imported to Japan by Ikegami Ironwork Co. In Photo 2 is shown the reproduced machine.

The machine adopts the 'form milling method,' namely, it is equipped with a gear formed cutter, which has the same profile as that of the groove of a gear, and directly copies the exact cutter profile on the gear material as shown in Fig. 2. Though the vertical movement of the cutter (or, the depth of the cutting) is manually operated, the indexing and horizontal movements are automatically controlled. It should be mentioned here that this was the first machine tool that automatically manufactured gears in Japan.

In parallel with the reproduction of the above gear cutting machine, reproduction of a profile copy reduction shaping machine shown in Photo 3, which was a product of Ikegai Ironwork Co. in 1925, was also conducted.

This machine cuts material into the involute edge of a forming tool by reduction shaping a profile copy, the forming tool being used to make the gear formed cutter mentioned above. At that time all gear formed cutters had to be imported, and it is said that the machine was developed for the purpose of realizing their domestic production. It is also said that some visitors from Europe, who were concerned with machine tools, admired the function of the machine even at the initial stage of its development. The originals of those two types of machines have been borrowed from their owners to be exhibited in the museum. The reproduction of those two machines was started in April 1994 and was completed in February 1998. Each year, a pair of students for graduation research engaged in the reproduction of the respective machines, so the total number of students engaged in the reproduction was sixteen.

Photo 2. Reproduction of an automatically indexing gear cutting machine.

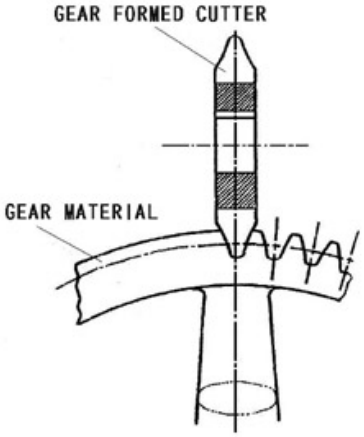

Fig. 2. Manufacturing of a gear with a gear formed cutter.

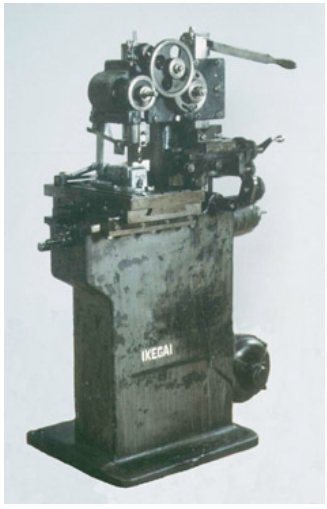

Photo 3. Profile copy reduction shaping machine under reproduction.

Photo 4. Snapshot of a planing machine on the monitor of the explanatory VTR tape.

The reproduction work was sequentially composed of understanding the structures and movements of the machines, drawing plans through sketching them, preparing their parts, finishing the parts, and assembling them. The reproduced machines are shown in Photos 2 and 3. Though the contents of the reproduction work are briefly described above in two and a half lines, the actual work was by no means that simple.

After the reproduction was over, two seniors started to adjust and run the two machines in April 1998, and put them in working condition. Then they produced a forming tool by using the reproduced profile copy reduction shaping machine for the purpose of producing a gear formed cutter of specific module, actually produced the gear formed cutter with the forming tool, fixed it to the reproduced automatically indexing gear cutting machine, and made it run finally. The ultimate goal of their graduate research was the automatic manufacturing of spur gears of specific module, namely those having a fixed number of teeth and simple in shape. Through this type of research, students experienced the 'form milling method' which is seldom seen today.

3. 3 Preparation of explanatory VTR tapes for exhibits

In the museum, explanatory VTR tapes and panels are prepared for visitors who are not familiar with machine tools. The preparation of those explanatory devices is also one of subjects of graduation research. Usually two seniors work on those subjects, one on tapes and the other on panels for a year.

Photo 4 is a snapshot of a planing machine on a monitor of the explanatory VTR tape. So far VTR tapes for six types of machines such as a lathe, a milling machine, a planing machine, and so on, have been prepared. The running time of each tape has been decided to be about 5 minutes from investigations of various similar examples. Both scenario-writing and videotaping are carried out by students themselves. Their products have been improved by comments through questionnaires on occasions of special exhibitions, and the final products are actually shown in the museum.

4. Conclusions

Students' responses to the 'actual production practice' are generally satisfactory. For example, they realize that the production of various machine parts is possible without using proper machine tools and that they can measure the power of the driving equipment for a lathe with their hand-made prony brake. However, at the same time they become to know that their success is brought by the aid of the staff members of the museum. For instance, their drawings are too inadequate to produce machine parts and the aid of the staff members is definitely necessary. In fact, after the 'actual production practice,' they become respectful to the staff members.

In promoting the above engineering education, the following should be reconsidered.

Reproduction of an exhibited machine takes about three or four years. Those students who happen to meet the time of completion of the reproduced machine can experience the interest and usefulness of the 'actual production practice,' but those who engage in the reproduction process merely in the initial or mid stage tend to experience only troubles and bitterness of the practice. The latter case is mainly brought by the fact that the reproduction practice is not always planned by students' own will. In such a case, they are not much interested in the reproduction and, therefore, are not willing to study necessary knowledge of the machine.

Accordingly, it is considered essential that students select the machine to be reproduced so that they may be interested in the machine itself, and that the reproduction period is short (two years at longest) enough for them to take part in the practice during the whole period. Needless to say, economical support should be given to them as well as the service of human and material environment.