



Circumstances of Survey Education Conducted in Japanese Universities

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Abstract Contents of the survey education conducted in civil engineering departments of universities in Tokyo were investigated by using their syllabus, to grasp the current state of survey education in Japan. As a result, in the order of the number of departments that teach the particular items, “Theory of error”, “Traversing”, “Leveling”, “Plate table surveying”, “Global positioning System (GPS) surveying”, “Photogrammetry”, “Geographic Information Systems (GIS)” and “Remote sensing”. It was found that land-based surveying techniques, such as “Traversing”, “Leveling” and “Plate table surveying”, were treated preferentially over aerial-data based surveying, such as “GPS surveying”, “Photogrammetry” and “Remote sensing”. Furthermore, to grasp the items taught as university course content reflect the techniques actually used in work situations, the content of 6 textbooks used for lectures at the universities was investigated by comparing with the General Standard of Operation Specifications for Public Surveys (*General Standard*). The *General Standard* is used as the model standard when surveying companies work actually. As a result, not many textbooks cover such operationally demanded techniques. As other problems; given that the latest technique may be a major technique in the future, it is necessary to teach the latest survey techniques. The latest techniques, which have not been described as survey items in the *General Standard*, were also investigated, such as “Mobile Mapping System (MMS)”, “3-D laser scanners” and “Photogrammetry with satellite imagery”. So as to improve these problems, the authors developed a new textbook for teaching surveying based on an investigation of courses offered in the survey departments of universities. In the developed textbook, the survey techniques described in the *General Standard* and the latest techniques are included.

Keywords survey education, university, operational technique, textbook

INTRODUCTION

The population of the world reached 7 billion in 2012. The populations of Africa and Asia are increasing particularly rapidly. It is predicted that in 2050 the population of Africa and Asia will be 2.2 and 1.2 times that in 2012 respectively (United Nation, 2012). World irrigated area has been also increasing year by year (Earth Policy Institute, 2009). To produce enough food for this increasing population, it is important to conduct land improvement and irrigated land expansion, including the development of agricultural land and the construction of channels for irrigation and drainage of such land. In conducting land improvement projects, surveying techniques to know the coordinates, elevation, gradient, area and topographic features of the agricultural land and the skill to create maps of the surveyed land are indispensable.

From the 1950s through the 1980s, the major surveying techniques used in agricultural land development were angle measurement by using a transit and plate table surveying, which is a simple way of conducting onsite surveying. By 2000, most surveyors were using equipment that was up to date for that time. The Global Navigation Satellite System (GNSS) and the use of total stations (TS) became mainstream. The use of equipment that was up to date for that time changed the surveying techniques from analog-based ones to digital-based ones. At the same time, the precision of observations and the accuracy of results have improved.

In Japan, surveying techniques are taught at engineering and agricultural universities. The qualification of assistant surveyor is granted upon graduation from many such universities. However, the surveying techniques taught at such universities are those that were in the mainstream from the 1950s to the 1980s. Few universities teach the latest techniques that are used in actual working situations (Kunii et al., 2006).

In this study, the syllabus contents of some of the Japanese universities were investigated to clarify the relationship between the technical items taught in the lectures of the universities and the techniques used in actual working situations. The investigation aims at commenting on the surveying techniques that will be required in future university education.

METHODOLOGY

To know what items of surveying are taught at universities, the course content of universities was investigated based on their syllabi. As there are many universities that teach surveying in Japan, we extracted 13 departments of 11 universities in Tokyo that have engineering departments or courses. The surveying items taught in the lectures at these 13 departments were investigated. The items included traversing and leveling. For each technical item, the number of departments that teach the particular item was counted, and the percentage of departments teaching each technical item (the adoption rate) was calculated.

To grasp the items taught as university course content reflect the techniques actually used in work situations, the content of six textbooks used for lectures at the universities was investigated (Ohki, 1998; Ishii et al., 1999; Nakamura and Shimizu, 2000; Fukumoto et al., 2003; Asano and Iba, 2004; Hasegawa et al., 2004). The investigated items were the techniques described in the *General Standard of Operation Specifications for Public Surveys (General Standard)*, which is used as the model standard by surveying companies. The textbooks were investigated as to whether they have items such as “Connected traverse”, “Detail survey by TS”, “GNSS” and “Digital stereo plotter”.

The latest techniques, which have not been described as survey items in the *General Standard*, were also investigated, such as “Mobile Mapping System (MMS)”, “3-D laser scanners” and “Photogrammetry with satellite imagery”.

RESULTS AND DISCUSSION

Content of Survey Courses at Japanese Universities

Table 1 shows the technical items adopted in the surveying education at the 13 departments.

Departments that taught the “Theory of error” numbered 11, as did those that taught the “Traversing”. These are the largest numbers. The “Leveling” was taught by 10 departments, the “Plate table surveying” was taught by 9 departments, the “Global positioning System (GPS) surveying” by 9 departments, the “Photogrammetry” by 6 departments, the “Geographic Information Systems (GIS)” by 5 departments and “Remote sensing” by 4 departments. The most commonly taught items in the 13 departments were “Theory of error and “Traverse survey”. The next most commonly taught items were “Leveling”, “Plane table surveying”, “GPS surveying”, “Photogrammetry”, “GIS” and “Remote sensing”.

The reason that “Theory of error” was found to be so commonly taught is thought to be that the subject is important in the theory of surveying, which includes the processing of observed data and statistics.

The basics of surveying include knowledge of coordinates and topographic maps. There are two groups of techniques for obtaining data for coordinates and topographic maps. There are those conducted on the land, such as TS and leveling, and those conducted using aerial data obtained by satellites and airplanes. It was found that the university lectures emphasize the land-based techniques, such as traverse surveying, leveling and plane table surveying, over the aerial data-based techniques, such as GPS surveying, photogrammetry and remote sensing. It is thought that priority is placed on the land-based surveying because it is directly related to survey training at universities.

Table 1 Technical items adopted in the surveying education at the 13 departments

Technical item	Number of departments teaching the technical items	Adoption rate (%)
Theory of error	11	84.6
Traversing	11	84.6
Leveling	10	76.9
Plane table surveying	9	69.2
GPS surveying	9	69.2
Photogrammetry	6	46.2
Geographic Information Systems (GIS)	5	38.5
Remote sensing	4	30.8

Results of Investigation of the Textbooks Adopted for Surveying Lectures in the Universities

The *General Standard* has been revised in accordance with advances in survey techniques. For example, Global Navigation Satellite System (GNSS) was first described in the *General Standard* in 2011. GPS, which originated in the US, and Global Navigation Satellite System (GLONASS), which originated in Russia, are integrated in GNSS. The plotting instruments for photogrammetry in the 2013 *General Standard* were changed from analog to digital stereo instruments.

Table 2 shows the techniques described in the textbooks adopted for lectures at the universities and those described in the *General Standard*. The textbooks are denoted as Textbook A, B, C, D, E, F, in the order of the year of publication of the first edition. The investigated items of “Connected Traverse”, “Detail survey by TS”, “GNSS” and “Digital stereo plotter” are described in the *General Standard*.

All of the investigated items are included in the courses that are offered at the departments shown in Table 1. However, some of the textbooks do not have the investigated items. This must be because such items were not described in the *General Standard* when the first editions of the textbooks were published. It is must be meaningful that Textbooks C and D have explanations on digital stereo plotting instruments, which were not include in the standard items at the time of publication of the first editions of the textbooks, because it is possible for the latest techniques introduced in textbooks to become major surveying techniques in later years. The description of GNSS in Textbook F must be added in a later revision.

Based on the above, it is necessary to continuously revise textbooks to include the latest techniques and the techniques that meet the needs of the times.

Table 2 Description of survey techniques in 6 textbooks and the current techniques described in the *General Standard*

Textbooks adopted for lectures in the universities		A	B	C	D	E	F
Year of publication of textbooks A to F (First edition)		1998	1999	2000	2003	2004	2004
Description of survey techniques in the <i>General Standard</i>	Connected traverse	○	○	○	○	○	○
	Detail survey by TS*	×	○	○	○	○	○
	GNSS surveying	×	×	×	×	×	○
	Digital stereo plotter	×	×	○	○	×	○

*: Total Station ○: described in textbook ×: undescribed in textbook

Results of Investigation of Six Textbooks used for Surveying Lectures at the Universities

Table 3 shows the results of investigation of textbooks that are used for the lectures of the universities and the latest techniques that are not described in the *General Standard*. Textbook B introduces the latest techniques, such as MMS, even though it is not described in the *General Standard*. From a viewpoint of educating future engineers, it is necessary to adopt textbooks as introducing the latest technologies, because such information is useful in motivating students to learn advanced areas and to start their research.

Table 3 Description of survey techniques in 6 textbooks and the latest techniques that are not described in the *General Standard*

Textbooks adopted for lectures in the universities		A	B	C	D	E	F
Year of publication of textbooks A to F (First edition)		1998	1999	2000	2003	2004	2004
The latest techniques that are not described in the <i>General Standard</i>	Mobile Mapping System (MMS)	×	○	×	×	×	○
	3-D laser scanners	×	×	×	×	×	○
	Photogrammetry with satellite imagery	×	×	×	×	×	×

○: described in textbook ×: undescribed in textbook

**Fig. 1 Newly compiled surveying textbook published in April 2014**Title: *Newer surveying -Fundamentals and applications with newest technology-* (in Japanese)**Development of Materials for Teaching Surveying at Schools**

The authors developed a new surveying textbook to address the problems and tasks identified in the above discussion. The survey techniques described in the *General Standard* and the latest techniques that address the needs of the times were included in this textbook. The new textbook has an impressive 253 pages. The newly compiled textbook, which was highly evaluated by the editors of a publishing company, was published under the title of *Newer surveying -Fundamentals and applications with newest technology-*. (Okazawa et al., 2014) (Fig. 1). However, it is clear that this

new textbook will become obsolete, as survey techniques are continuously developing. While being the evaluation, it is important to continuously revise the textbook to address the changes of the times.

CONCLUSION

The study has clarified the following:

- (1) At engineering universities in Tokyo, 84.6% of departments taught theory of error, 84.6% taught transverse surveying, 76.9% taught leveling, 69.2% taught plane table surveying, 69.2% taught GPS surveying, 46.2% taught photogrammetry, 38.5% taught GIS and 30.8% taught remote sensing. It was found that land-based surveying techniques, such as traverse surveying, leveling and plane table surveying, were treated preferentially over aerial-data based surveying, such as GPS surveying, photogrammetry and remote sensing.
- (2) Textbooks C and D introduced the technique using a digital stereo plotting instrument even though the instrument was not a standard item at the time of first publication of the two textbooks. Given that the technique later became a major survey technique, it was found that introducing the latest techniques in textbooks is important.

The authors developed a new textbook for teaching surveying based on an investigation of courses offered in the survey departments of universities and the textbooks used at universities. The survey techniques described in the *General Standard* and the latest techniques, which address the needs of the times, have been included in the new textbook. It is thought that continuous revision to address the latest techniques and needs of the time is required, because surveying techniques rapidly develop with the time. It is important to consider the textbook in English, though the published textbook was in Japanese. Because the common language of study is English for students in developing countries.

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