Practical Education for Engineering Students and Regional Citizens in Manufacturing and Engineering Design Center (cremo) at Muroran Institute of Technology

Toshiharu Kazama¹, Naohiko Hanajima², Kazumichi Shimizu²

1. Muroran Institute of Technology, 27-1, Mizumoto-cho, Muroran, Hokkaido, 050-8585, Japan kazama@m[m[m.m.m.m.uroran-it.ac.jp
2. Muroran Institute of Technology

Abstract
To foster engineers with creative power and to highlight the importance of technology, the Manufacturing and Engineering Design Center (known as 'cremo') at the Muroran Institute of Technology was established in 2006 and has remained active ever since. The center has two support groups and one research group, which all concentrate on monozukuri. The Education Support Group provides educational support for practical training classes on and off campus, technical support for pursuing student projects and making experimental apparatuses, technical manuals describing how to use and how to make things, and PDCA-conscious engineering design education related to monozukuri. The Regional Cooperation Group coordinates activities in cooperation with elementary, junior high, and high schools, bureaus, and industries in and around Muroran City, which include hands-on classes for pupils and children, workshop for visiting international students, and open seminars for local residents.

Keywords: Engineers education, Students, Practical education, Manufacturing, Engineering design

1. Introduction
Murooran Institute of Technology strongly values its social obligation to train students to be top-notch engineers with creative power, to nurture research and development, to foster technical innovation, and to contribute engineering and technology to regional companies and residents. To do so, the Institute has established a Manufacturing and Engineering Design Center (MEDeC; known as 'cremo'; The Japanese name is 'Monozukuri-Kiban' Center.) [1] on January 26, 2006: it is designed to support monozukuri (or monozukuri).

What is 'monozukuri' (see Appendix)? The Japanese word 'mono' means a thing or a product; the word 'zukuri' is a process of making. However, a mere translation does not convey the accurate connotation of monozukuri. The concept is much more intense. It signifies having the spirit to produce excellent products and the ability to improve a production system and process constantly, and further including integration of skill and ideas, technology and science, hardware and software, contents and design, as well as human development [2-3].

The center has three project groups: the Education Support Group, which provides educational support for practical training classes on and off campus and plan-do-check (study)-action (PDCA/PDSA)-conscious engineering design education related to monozukuri; the Fundamental Manufacturing Research Group which performs investigation of fundamental manufacturing technologies such as precision machining, non-conventional manufacturing process, and information and communication technology (ICT)-driven manufacturing systems, and the Regional Cooperation Group which coordinates the following activities in cooperation with local schools, administrative agencies and bureaus relating especially to education related to technology, regional centers of industrial technologies, and industries in and around Muroran City: internship programs, collaboration on engineering skill upgrading, and an educational awareness program.

The center has a fully integrated a collection of machine tools and hand tools for manufacturing, an atelier, a tataru (Japanese traditional ironworks) space, instruments for measurement, audio/visual equipment for presentations, and related equipment designed for teaching state-of-the-practice manufacturing methods. Furthermore, the center includes a seminar room, an IT-based workshop, a metal processing workshop, a welding workshop, a casting and forging workshop, in addition to a glasswork section and a plasma-nano surface processing section.

In this report, examined from the perspective of the keyword monozukuri, the center activities are introduced, particularly addressing practical education and its support and emphasis for the students and local residents.

2. Practical Education and Its Support for Students
Practical education to students and support to students in terms of monozukuri are mainly performed by the Education Support Group in the center. For machine processing, the technicians support students to give technical advice and to manufacture parts.

- Support to classes of practical education
The center supports practical education classes. During the 2007 academic year, the center supported five subjects
in the 1st term and four subjects in the 2nd term (Plate 1). In 2008, seven subjects in the 1st term and five subjects in the 2nd term. To enhance the motivation of students for monozukuri, lectures on monozukuri are held a few times a year (e.g., five times in 2007 academic year). Lectures are sometimes distributed, linking to the related classes in the coursework.

- Support of practical education projects and student initiative projects

A teacher who wants to start a practical class might be anxious about costs for preparing teaching materials. The center therefore provides a subsidy to support such trials for practical education under the so-called 'monozukuri education support project'. The subsidy is offered to the public in the institute, and then the proposals are examined and selected. The accepted proposals were four respectively in 2006, 2007, and 2008 academic years (Plate 2).

In addition, the center encourages students to be active in relation to monozukuri from the point of financial support as well as technical support. The initiative project for students is called the 'monozukuri project'. The center accepted four proposals in 2006, one in 2007, and two in 2008 (Plate 3). Furthermore, to the students, the center conversely proposed projects: the 'kit-car project' in 2007 and the 'eco-run project' and 'robo-con project' in the 2008 academic year (Plate 4).

- Student staff: the 'cremo crew'

Some students (around fifteen) are employed as part-time assistant technicians, designated as the 'cremo crew' (Plate 5). The 'cremo crew' takes charge of assisting the technical business in the center and assisting activities of the center. The 'cremo crew' members are divided into three groups and three charges. The former is the group of machine processing, electric circuit, and rapid-prototyping; the latter is the charge of dealing with a homepage, a notice board, and a parts corner. These members are mixed because the students are self-educated and learn through mutual interaction. The crew supports hands-on events and mini-workshops (Plate 6). The crew also supports opening of the center on weekday evenings at 17:00–20:00 and on Saturdays at 13:00–17:00.

Lists of machines, equipment, and instruments as well as guides, instructions, and forms are uploaded on the center homepage. Rent-a-tool and rent-a-space are also provided to students. The 'cremo crew' and the center staff wrote notes and manuals of monozukuri. The manuscripts are edited as three bound books: recipes, hints, and techniques. The books are distributed to students and available in the center (Plate 7).
3. Activities of Regional Cooperation

One mission of engineering universities is cooperation with regional schools and local residents through science and technology. The center and the regional cooperation group drive cooperation activities—practical classes, symposia, seminars, events, engineers' exchange, and technical transmission from generation to generation—relating to the keyword monozukuri.

- Workshops and lectures for children and pupils

To increase the number of children who are interested in science and technology, it is necessary to have a good opportunity to contact and learn monozukuri with surprise and joy. The center and the group therefore provide mini-workshops for children (Plate 8) and practical classes for school pupils on-campus, in addition to special lectures such as the 'Science Partnership Project (SPP)' in regional schools in Hokkaido (Plate 9).

The center and the group sometimes invite school classes. Alternatively, the staff members visit the schools. The contents are, for example, hands-on thread processing, drilling and tin casting. In such cases, we induce the teacher leading the class to participate in the workshop and exercise because we expect to enhance their interest and knowledge related to monozukuri with the children and pupils.

- Techno-café

Muroran City is famous in Hokkaido for iron and steel industries as well as monozukuri. The general public, however, is not so familiar with technology and engineering. To become a household concept, the center and the group hold an off-campus event designated as 'Techno-café' (Plate 10). The name suggests an image of a coffee break and the event opens two or three times a year (Table 1). The event plays host to lectures, sometimes with hands-on materials, relating to contents from engineering and technology to art and literature in terms of monozukuri.

- Symposia, hands-on seminars, and open college

The center and the group hold a symposium (Plate 11), a hands-on seminar for international visiting students (Plate 12), and an open college (Plate 13) relating to monozukuri. The symposium was opened for our students, university staff, and regional citizens at the opening ceremony of the center in 2006. The seminar was performed as a hands-on seminar when the students of our sister university visited our campus. The open college provided a workshop related to casting and making a pan for a mutton barbecue held by local residents.

<table>
<thead>
<tr>
<th>No.</th>
<th>Thema</th>
<th>Place</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>'Mystery of Natto (soybeans)'</td>
<td>Muroran</td>
<td>2006.12.19</td>
</tr>
<tr>
<td>2nd</td>
<td>'Secret of Boruta'</td>
<td>Muroran</td>
<td>2007.7.27</td>
</tr>
<tr>
<td>3rd</td>
<td>'Art and Engineering'</td>
<td>Muroran</td>
<td>2007.10.6</td>
</tr>
<tr>
<td>4th</td>
<td>'Mystery of Japanese Swords'</td>
<td>Sapporo</td>
<td>2007.12.16</td>
</tr>
<tr>
<td>5th</td>
<td>'Monozukuri in Jomon Period'</td>
<td>Muroran</td>
<td>2008.11.1</td>
</tr>
<tr>
<td>6th</td>
<td>'Mini-Workshop in Spring Break'</td>
<td>Sapporo</td>
<td>2009.3.15</td>
</tr>
</tbody>
</table>

Table 1 List of Techno-café
4. Remarks
Since 2008, the center has assisted students in becoming highly skilled and innovative engineers, and has strengthened regional cooperation and collaboration in terms of monozukuri. Regarding its relation to education and research, the center cultivates the technical knowledge and creativity of students, supports education in manufacturing technology through project/problem-based learning (PBL), and facilitates curriculum development and program improvement. The activities spread over widely various monozukuri and the number of annual participants increased to over 4,000 in 2006, 5,000 in 2007, and 7,000 in 2008 academic years. Information related to the center’s functionality, activities, the latest events, and announcements is available from the website: http://www.muroran-it.ac.jp/cremo/.

5. Acknowledgments
The authors thank Dr. Kohki Satoh of Muroran Institute of Technology for managing the Fundamental Manufacturing Research Group, and Mr. Toshiyuki Konishi, Mr. Ataru Muramoto, Mr. Hideaki Yamamori, and the technical staff of Muroran Institute of Technology for their technical support. This project is supported by an education reform support project (Kyouiku Kaikaku Keihi) of the Ministry of Education, Culture, Sports, Science and Technology.

Appendix: What is MONODZUKURI? [2]
MONODZUKURI literally means "goods production." However, MONODZUKURI is not simply about manufacturing products. It is the art and the joy of making things as perfectly and efficiently as possible while respecting nature in terms of both the materials used and the environment. This concept is at the core of our notion of value creation, and should be positively applied to industries beyond manufacturing to enhance the competitiveness of Japanese industry as a whole.

(1) MONODZUKURI as the Integration of Skill, Technology and Science
MONODZUKURI represents the combination of three factors: Skill, Technology and Science.
   a. Skill: The process of improvement; for example, improving the quality of a product, e.g. a tape recorder.
   b. Technology: The process of combining skills to enhance the functionality of a product, for example, the transformation of a tape recorder to a Walkman.
   c. Science: The facilitation of scientific innovation to produce technological breakthroughs, for example, changing the technology paradigm of the Walkman from magnetic-based recording technology to optical (CD) recording technology. An emphasis on the balanced integration of these three factors is vital to taking the required step forward to reach the next stage of enabling drastic industrial innovation.

(2) Scope of MONODZUKURI
MONODZUKURI is not limited to the making of hardware, it also extends to the making of software, which includes the use and creation of intangibles such as ideas, design, contents, and so on. In this case, the idea of MONO ("thing" or "product") therefore represents the idea of a comprehensive theme that mediates, supplies, and amplifies functions, both physical and conceptual.

(3) MONODZUKURI Represents Human Development
MONODZUKURI is closely linked with human development. However, our country’s human resources are at risk due to the mass retirement of baby boomers and the increasing number of inactive youths not participating in the workforce. Transferring technological knowledge to youth and inspiring children with the joy of working through various MONODZUKURI experiences play an essential role for the development of the next generation.

References

Biography
Dr. Toshiharu Kazama is a Professor of the College of Design and Manufacturing Technology, Graduate School of Engineering, Muroran Institute of Technology and is charged with the Mechanical Systems Engineering Course. He has been a Director of Manufacturing and Engineering Design Center since 2007.
Dr. Naohiko Hanajima is an Associate Professor of College of Design and Manufacturing Technology, Graduate School of Engineering, Muroran Institute of Technology and is charged with the Mechanical Systems Engineering Course. He has been a Chief of the Education Support Group, Manufacturing and Engineering Design Center since 2007.
Dr. Kazumichi Shimizu is an Associate Professor of College of Design and Manufacturing Technology, Graduate School of Engineering, Muroran Institute of Technology and is charged with the Manufacturing and Engineering Design Center. He has been the Chief of the Regional Cooperation Group, Manufacturing and Engineering Design Center since 2007.

27