Fostering Engineers with Creative Power: Activities and Achievements of Manufacturing and Engineering Design Center

Toshiharu Kazama¹, Naohiko Hanajima², Kazumichi Shimizu², Kohki Satoh²

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

Abstract
In 2006 Muroran Institute of Technology established Manufacturing and Engineering Design Center (known as cremo) and has been running for five years. The center has three groups that have been actively concentrating on monozukuri: the education support group, the fundamental manufacturing research group, and the regional cooperation group. The center assists students in becoming highly skilled and innovative engineers. The center supports fundamental researches on monozukuri. In addition, the center strengthens regional cooperation and collaboration. In this report, the activities and achievements of the center are summarized briefly.

Keywords: Engineers education, Students, Local residents, Manufacturing, Engineering design

1. Introduction
Muroran 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.) [1–2] on January 26, 2006. The center has been running for five years, advancing its goal of supporting monozukuri.

The center has dealt with the five-year-project supported by a subsidy of the Ministry of Education, Culture, Sports, Science and Technology. In this report, examined from the perspective of the keyword monozukuri, the center activities are introduced. The center achievements are summarized—particularly addressing practical education and its support and emphasis for 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 performed mainly by the Education Support Group in the center. For machine processing, the technicians support students to provide technical advice and to manufacture parts.

As activities of supporting monozukuri education, making operation and maintenance of the machines including ITC equipment (rapid prototyping, a three-dimensional (3D) digitizer, an electric circuit simulator, a circuit board layout software, and 3D CAD), parts, the atelier, and rent-a-tool, informing events and schedule by the center calendar, listing the available machinery and equipment by the list, uploading the application documents. As activities of publicity, maintenance of a home-page on the web, and posting the center promotional posters on campus.

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; then the proposals are examined and selected. The accepted proposals were four, respectively, in every year during the 2006–2010 academic years. The total of the projects was 20: two in civil engineering, five in mechanical engineering, two in information engineering, one in material engineering, two in chemistry, and four in social science. The projects were performed widely in the university departments and subsidies were used effectively.

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.

Furthermore, to the students, the center conversely proposed two projects: one was the 'eco-run project' starting in 2007 (Fig. 1); another was the 'robo-con project' started in 2008 (Fig. 2). Regarding the 'eco-run project', a kit-car was built in 2007; our original eco-car was manufactured, the students participated in the 'eco-run contest' and they ran completely in the circuit in 2008. Two teams participated in the contest, one of which was ranked fourth in 2009. The team of the commercial vehicle category was awarded second prize. Regarding the 'robo-con project', the special prize of the robo-con produce contest was awarded in 2008. The team participated consecutively in domestic contests in 2009 and 2010 academic years.
- **Student staff: The 'cremo crew'**

Some students (around fifteen) are employed as part-time assistant technicians, designated as the 'cremo crew'. 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 circuits, and rapid-prototyping; the latter is in charge of the 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. The events were held 21 times in 2007, 10 times in 2008, and 11 times in 2009.

The crew also supports opening of the center on weekday evenings at 17:00–20:00 and on Saturdays at 13:00–17:00. The center opened 133 evenings and 26 holidays in 2007, 118 evenings and 31 holidays in 2008, and 129 evenings and 32 holidays in 2009 academic years.

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, whose contents respectively constitute the textbooks of mini-workshops, how to use machines, and the textbooks of technical workshops. The books are distributed to students and are available in the center. The booklets went into their second printing once and were revised once. The total numbers of copies of recipes, hints, and techniques were, respectively, 1900, 700, and 700 (Fig. 3).

- **Support of classes of practical education and technical skills**

The center supports practical education classes. The classes were 9 in 2007, 12 in 2008, 14 in 2009, and 12 in 2010 academic years.

To enhance the motivation of students for monozukuri, lectures on monozukuri are held a few times a year. The lecturers were professors and engineers invited from other universities and companies. All lectures were given in Japanese to audiences including students and university staff. The lectures were sometimes given in conjunction with related classes in the coursework.

The center continually shakes down the safety environment. The center provides users with a safety manual, has safety cameras, requests accident reports and disaster reports, and displays examples of accidents. No fatal accident has occurred in the center since it was established.

The center runs licensing systems of the machine users for students and staff and provides the safety training program almost every week. The center requests that users undergo the program before use of machines and issues the license card to people who have completed the program. The issued cards are 154 in 2007, 179 in 2008, 217 in 2009, and about 200 in 2010.

The center technical staff gives technical workshops. Members of the staff also teach how to use the machines and assist the students in making parts by themselves on a daily basis. The numbers of manufacturing requests were 31 in 2006, 64 in 2007, 70 in 20008, and 78 in 2009.

3. **Activities of Fundamental Research**

Fundamental Manufacturing Research Group performs investigation of fundamental manufacturing technologies such as precision machining, non-conventional manufacturing process, and IT-driven manufacturing systems.

In 2006, research and development of nano/micrometer-size manufacturing technology using a microwave plasma processing device were established as the prime theme. Both of the experiment and simulation were performed. Chemical vapor deposition (CVD) characteristics were examined to construct low-temperature plasma processing technology for microelectromechanical systems (MEMS). Regarding experiments, a line-based microwave plasma reactor enabling generation of plasma in a wide area under atmospheric pressure was built. Regarding simulation, computer simulation of the microwave mode was performed.

In 2007, research was pursued to examine application to semiconductor processing specifically. The optimum geometry of a waveguide of the microwave line-based plasma generator was reviewed by simulation of the finite
difference time domain (FDTD) method. The surface wave plasma device with high density was developed. The silicon nitride film was deposited under 300°C, which was a higher protective film with water vapor transmission rate of 0.083 g/m²/day, and the leaked electric current became less than $1.0 \times 10^{-9}$ A, which can be applied to a micro-display.

In 2008, the research subjects on metal processing technology and casting technology were added to research on microwave plasma technology. The research themes were the following: Coupling analysis of FDTD and plasma for microwave surface plasma processing device; Fabrication process of sub-micron electrode on SiO₂ board and application of surface acoustic wave (SAW) devices; Research on machining of thin walled parts; and Mechanical properties of spherical graphite cast iron made using frozen molding processing.

In 2009, the research subjects were arranged and rebuilt as four research projects: Plasma processing research project; Thin wall machining research project; Frozen molding process research project; and Pipeline mechanism research project.

In 2010, fundamental research groups relating to monozukuri were organized and exploratory studies were set forward. Five research projects were supported: Pavement repair using microwaves, Plasma processing research project, Machining of low-stiffness parts, Cutting process using water-jet machines, and Mechanisms of a pipeline.

4. 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—related to the keyword monozukuri.

The center holds open colleges for regional residents, which provide people the basics and fun of monozukuri. In the 2007 academic year ‘making an original mutton barbecue pan’ and ‘introductory to digital monozukuri using three-dimensional CAD and rapid prototyping machine’. In the 2008 academic year ‘making an original wind bell’, ‘introductory to digital monozukuri using three-dimensional CAD and rapid prototyping machine’, and Academia–Industry Cooperative Personnel Training Project. In 2008 and 2009 academic years were the ‘Academia–Industry Cooperative Personnel Training Partnership Project. From 2008, we began the ‘Ship Recycle Project’.

- 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 especially for schoolchildren. The numbers of attendees were 3360 people in Muroran, 1470 in Sapporo, 225 in Noboribetsu, 218 in Takinoue, 216 in Matsumae, 108 in Tomakomai, 85 in Takikawa, 59 in Okoppe, 58 in Date, and so on (Fig. 4). The center also offers practical classes for school pupils on campus, in addition to special lectures such as the ‘Science Partnership Project (SPP) in regional schools in Hokkaido (Fig. 5).

- 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’. The name suggests an image of a coffee break and the event opens two or three times a year. 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, a hands-on seminar for international visiting students, and an open college 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 one-year anniversary in 2007, and the memorial symposium in 2010. 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 barbeque held by local residents. The colleges for regional young workers were also provided through a government-financed aid project to support learning skills and to foster monozukuri workers in the short-term workshop.

5. Achievements and Outcomes

The center, the students, and the staff have been recognized every year with awards as listed below.

In 2008 academic year:
- Seventh Monozukuri Collaboration Center Chairman’s Award (the Materials Process Technology Center)
- Special Awards, Robo-con Produce Contest
- Rangaku-Awards of Muroran Institute of Technology (2 awards, Muroran Institute of Technology)
In 2009 academic year:
- Hakuho Award (Hakuho Foundation)
- Japan 300 High-Service Awards (Service Productivity & Innovation for Growth)
- Monozukuri Collaboration Grand Award (The Materials Process Technology Center)
- Rangaku-Awards of Muroran Institute of Technology (2 awards, Muroran Institute of Technology)
- Sixth Cutting Process Dream Contest Academic Category Challenge Award (Mori Seiki Co., Ltd., awarded to a work manufactured in the center)
In 2010 academic year:
- Achievement Award (Japanese Society for Engineering Education)
- Second Prize of Stock Car Class, 30th National Convention, Honda Cup Eco Mileage Challenge 2010 (Honda Motor Co., Ltd.)

The numbers of users are summarized here. The numbers of students attending classes were: 2,010 in 2006, 2,641 in 2007, 3,473 in 2008, and 3,786 in 2009 academic years. The numbers of self-users were: 938 in 2006, 1,810 in 2007, 2,264 in 2008, and 2,359 in 2009 academic years. The numbers of attendees from regional residents are about 1,500 people each year.

The prime publications at the present are: annual reports of the center of 2006, 2007, 2008, and 2009 academic years; the center pamphlets of 2006, 2007, 2008, and 2009 academic years; the English center leaflet, the monozukuri booklets consisting of three books of the first and second editions, and the monozukuri safety manuals of the first and second editions.

6. Remarks
Since 2006, the center has assisted students in becoming highly skilled and innovative engineers. It has strengthened regional cooperation and collaboration in terms of monozukuri. Regarding its relation to education and research, the center cultivates technical knowledge and creativity of students, supports education in manufacturing technology through project/problem based learning (PBL), and facilitates curriculum development and program improvement. 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/.

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References

Biography
Dr. Toshiharu Kazama is a Professor of the College of Design and Manufacturing Technology, Graduate School of Engineering, Muroran Institute of Technology. He is charged with the Mechanical Systems Engineering Course. He was a former Director of Manufacturing and Engineering Design Center to March 2011.

Dr. Naohiko Hanajima is an Associate Professor of the College of Design and Manufacturing Technology, Graduate School of Engineering, Muroran Institute of Technology. He is charged with the Mechanical Systems Engineering Course. He was a former Chief of the Education Support Group, Manufacturing and Engineering Design Center to March 2010.

Dr. Kazumichi Shimizu is a Professor of the College of Design and Manufacturing Technology, Graduate School of Engineering, Muroran Institute of Technology. He is charged with the Manufacturing and Engineering Design Center. He has been the Chief of the Regional Cooperation Group since 2007 and has been a Director of Manufacturing and Engineering Design Center since 2011.

Dr. Kohki Satoh is a Professor of the College of Design and Manufacturing Technology, Graduate School of Engineering, Muroran Institute of Technology. He is charged with the Electric and Electronic Engineering Course. He has been a Chief of the Fundamental Manufacturing Research Group, Manufacturing and Engineering Design Center since 2007.