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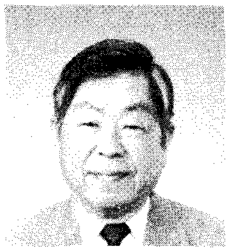
Recent Trends for 'Environmental Issues in Metal Forming' in Japan

- Special Lecture Presentation at the Spring Annual Meeting of KSTP -



Prof. H. Sekiguchi
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Thank you very much Prof. Dong-Yol Yang, the President of Korean Society for Technology of Plasticity (KSTP) and every attendant of this seminar, for your kind invitation to the commemorative Spring Annual Meeting of KSTP with 10^{th} anniversary. It is a great honor and pleasure for me to give a lecture here today.

First of all, I should like to express my congratulations to all the members of KSTP for the success of the spring annual meeting, on behalf of all colleagues of Japan Society for Technology of Plasticity (JSTP). As you know, there are only two scientific societies for technology of plasticity in the world; they are KSTP and JSTP. Here, I would like to tell you about an outline of JSTP very briefly for the closer friendship of two societies in future.

Our JSTP was founded in 1961 and we held a celebration ceremony of 40 years anniversary this May. Now, we have about 4,000 regular members, some student members, and honorary members (see Table 1). Supporting members are the companies in industries related to the technology of plasticity such as steel makers, nonferrous metal manufactures, home electric companies, car makers and so on, and they support the Society financially. The engineers of supporting companies, of course, have almost the same rights to the society like the regular personal members.

Table 1 Number of member of JSTP

	membership	students	Supporting members	Honorary members
1999	4126	150	390	48
2000	3983	139	379	49

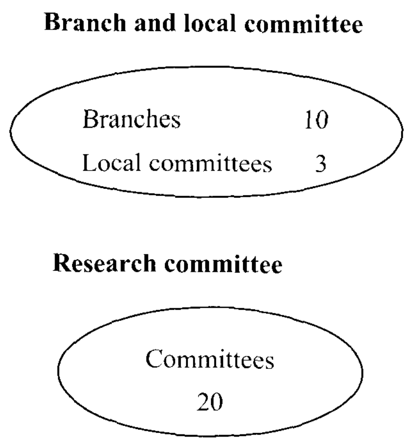

Fig. 1 Composition of committees of JSTP

Fig. 2 shows the constituents of JSTP. The members from universities and public institutes are about 17% and others are from industry.

Table 2 Conference in 2000

	General lectures	Special lectures	Theme session	Participants
Spring Conf.	240	2	2	700
Joint Conf.	240	1	2	666

Table 3 Activities of JSTP in 2000

	Number of meeting	Participants
Symposium	5 (No. 187-191)	532
Lecture	4 (No. 75-78)	180
Seminar	2 (No. 80, 81)	117
Forum	2 (No. 131, 132)	80

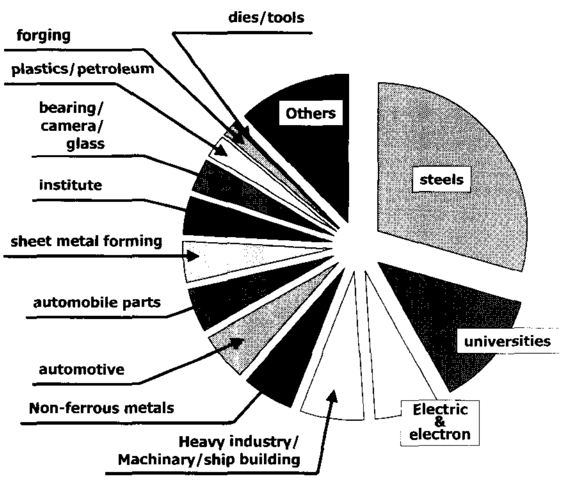

Fig. 2 Constituents of regular members

We have now 10 branches and 3 local committees for the convenience of the members. (Fig. 1) Each branch has its own activities and projects such as lectures, symposium and factory tours. As summarized in Table 2, we have two national conferences every year; one is the spring annual meeting, and other is the joint conference with the related scientific societies such as Japan Soc. of Mech. Engineers, Japan Soc. of Precision Engr., Japan Iron and Steel Assoc., Japan Institute of Metals, and others. Usually 5 or 6 parallel sessions are held for 3 days meeting with different topics such as rolling, forging, sheet metal forming and so on. Symposia, lectures, seminars and discussion meetings are often and regularly held concerning the late development and tendency of many industrial and academic topics, at Tokyo or at many districts (see Table 3). Journal of JSTP, Sosei to Kako (塑性と加工), is published monthly, and all the contents from the 1st issue in 1961 can be seen on CD-Rom.

Another important activities in JSTP are Research Committees. Now 20 research committees are established (see Table 4), and all the members of JSTP may take part in any committee as they like. In my case, I worked at a few committees such as roll forming, tube forming, wire drawing etc. Especially, I am much interested in the activities of Research Committee of Forging. This committee also plays the role of the national committee of ICFG (International Cold Forging Group). Now we have about 150 members, and one third of the members are from universities and others are engineers from industries. We can always exchange our mutual information and interests, and the philosophy of the committee is "Give-and-Take". That means our academic members can always learn practical problems to be solved in industry, and appropriate cooperative works can be conducted in cooperation between the academic side and the industrial side.

Table 4 JSTP research committees

	Parts	Number of members		Parts	Number of members
1	Roll-forming	45	11	Powder compaction process	40
2	Rolling process	73	12	Joining	100
3	Process tribology	68	13	Simulation	112
4	Tube-forming	75	14	Extrusion	45
5	Sheet metal forming	100	15	CAE	30
6	Theory of plasticity	31	16	Ultrasonic technology	40
7	Forging	154	17	Wire-drawing	107
8	High-energy-rate forming	31	18	Environmental issues	45
9	Plastics	38	19	Education	47
10	Semi-solid processing	43	20	New material	8

Well, my today's topic is Environmental Issues and Metal Forming. First, I will show you the outline of nowadays environmental problems for your reference, and then, our research activities in JSTP research committee on environmental issues. Moreover, I want to introduce ICEM (International Committee on Environment and Manufacturing) and its activities. After that, I would like to show you one of my research works on ecological problems.

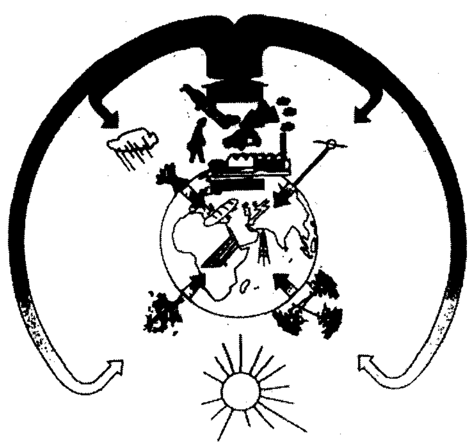

Fig. 3 Sustainable Development

As you know well, the first conference which addressed global environmental concerns (see Table 5) was held in the United Nations in 1972. A second one, the United Nations conference on environment and development was later held in Rio de Janeiro in 1992. At this conference, the international agreement on the concept of "Sustainable Development" was announced (see Fig. 3).

Table 5 Global environmental problems

1. Global warming
2. Ozone layer destruction
3. Acid rain
4. Desertification
5. Decrease in rain forests
6. Industrial wastes
7. Decrease in wild life
8. Pollution problems in developing countries
9. Ocean pollution

To realize the concept, many environmental measures must be taken into consideration, even in metal forming technologies. Fig. 4 shows the estimation of CO_2 discharge (the assessment of carbon dioxide has been conducted in terms of energy consumption, CO_2 emission, usage of toxic materials, and so on.

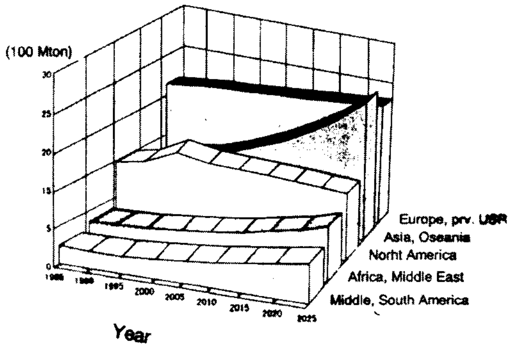

Fig. 4 Estimation of CO_2 discharge

Fig. 5 and Fig. 6 show the yearly variation for NO_x and SO_x concentrations in Japan. For example, the annual average value of SO_2 (sulfur dioxide) concentration is decreasing from 0.037ppm in 1971 to 0.007ppm in 1997.

Fig. 7 shows the environmental load in countries and areas in the world in 1995. The environmental loads are indicated in terms of CO_2 by the unit of million tons. China, USA, India, Japan and Russia are the 5 biggest consumers, and Korea is 10th big consumer.

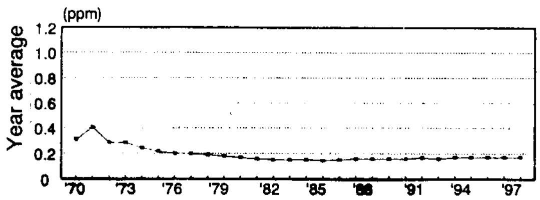

Fig. 5 Yearly variation of NO_2 concentration in Japan

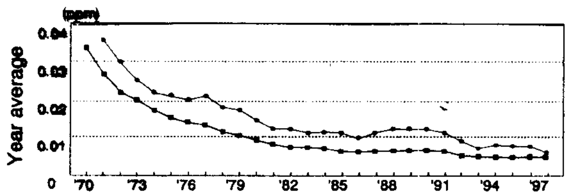

Fig. 6 Yearly variation of SO_2 concentration in Japan

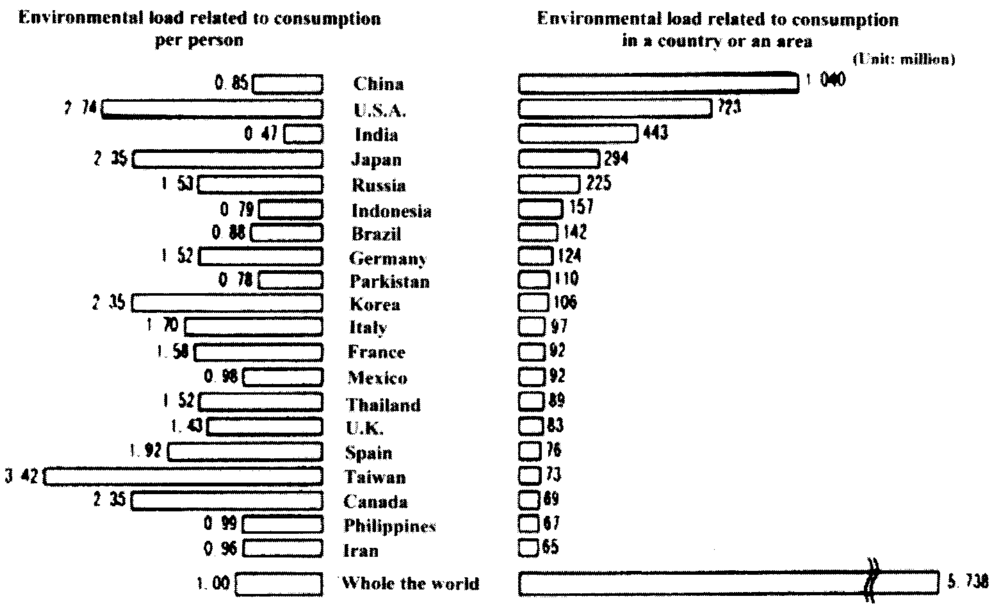

Fig. 7 Environmental load in Countries and Areas in the World in 1995

However, the energy consumptions per person in China and India are smaller than the world average value. Japanese and Korean energy consumptions are the same, and 2.35 times as large as the world average.

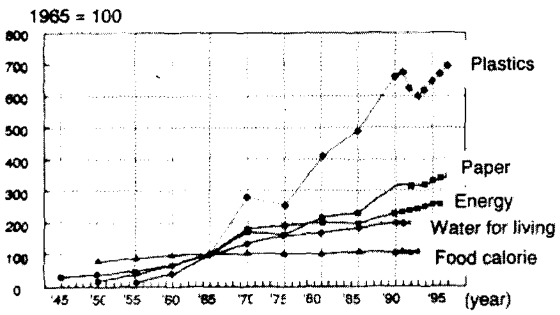

Fig. 8 Transition of consumption of materials and energy per person in Japan

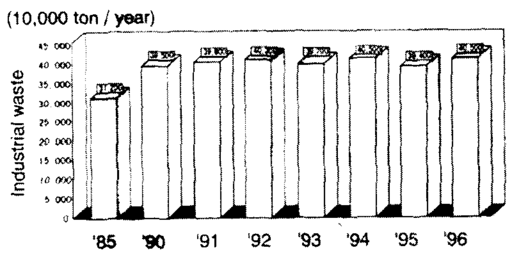

Fig. 10 Yearly variation of total amount of Industrial waste in Japan

The energy consumption per person in Japan is still increasing, and in 1997, it reached 275% of that in 1965 (See Fig. 8). We also use a lot of materials such as plastics and paper.

In 1997, the recovery rate of steel cans in Japan is about 80% and that of aluminum cans is about 72% as shown in Fig. 9. The reuse rate of glass bottle cullet is about 67% and that of paper is about 52%, although the recycle rate of trash is remain around 10%.

The relationship between the global environment and the metal forming/working is not obvious. Furthermore, the fact that the environmental impact assessment for further technology development should be carried out over the whole life cycle of products including production processing, usage and recycling makes it much more difficult to find suitable countermeasures in metal forming processing.

For the sustainable development, 'clean manufacturing', 'green product design', and 'total recycling' have to be considered in environmental manufacturing (see Fig. 11).

The JSTP research committee on environmental issues started its activities from Dec. 1990. The committee consists of about 45 members, and 5

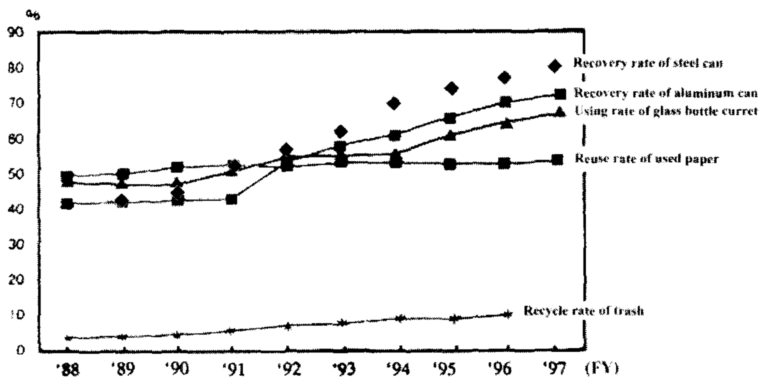

Fig. 9 Annual change of recycle rate in Japan

subgroups were also established to research different aspects such as resource conservation, energy conservation, environmental pollutants, vibration and noise, and new materials. Several meetings have been held so far to deepen the knowledge of the global environment and to find the contribution through metal forming technology.

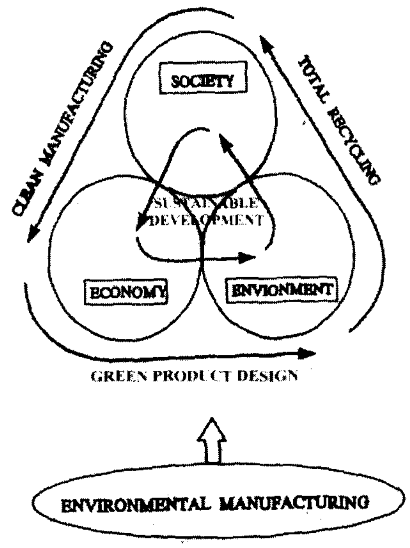

Fig. 11 Environmental manufacturing enables sustainable development

A forum for international community on technology of plasticity for One Earth was held under the sponsorship of the committee at Tsukuba in 1993. Seven lectures were presented from universities and industries, and 3 foreign guests from Europe, USA and Asia were invited. The contents of the forum can be referred to the special issue of an international journal (See Reference 5). In the general discussion, the necessity of an international cooperation research system was discussed.

A joint 2nd international workshop "Ecology and Economy in Metal Forming and Cutting" was held in Aachen, Germany in June 1995. Twelve presentations were made by the participants from Germany, Japan and the Netherlands. After a broad discussion, an international organization, ICEM (International Committee on Environment and Manufacturing), was established. And ideas for the development of ICEM are as follows: (1) international exchange of information about environment-friendly production technology, (2) to organize the international cooperative research work about the development of international standards related with environmental loads, and, (3) to represent the worldwide activity and to hold an international workshop regularly.

After that, ICEM workshops were held in the Unite States (1996), the Netherlands (1997), Japan (1998), Germany (1999), Slovenia (2000) and China (2000). In some of these workshops, the Ministry of Science and Technology of Japan gave some partial financial support. Every workshop published its proceedings. As the objectives, activities and detailed description of ICEM are mentioned in the website of ICEM, more detailed information should be referred to the website (see reference 6).

Well, now I would like to introduce one of my research works concerning ecological problems in metal forming. One of my recent interests in metal forming is forging. There are many important problems to be solved urgently, such as net shape forming of gears, development of Bonde-less (although Bondelube is a typical lubricant in cold forging) lubrication, 3D simulation techniques, exact assessment of die life and so on. Today, I will talk about " An improvement of energy consumption in hot forging process ".

[In the lecture, I presented many kinds of analysis related to energy consumption in forging processes, and also introduced a hybrid heating method that is mixed heating method of high-frequency induction heating and electric resistance heating as one of the improvement related to the problem with energy consumption. However, please refer to the references (7) ~ (9) because of limited space of this paper.]

Finally, I would like to summarize our future problems in ecological manufacturing. Fig. 12 shows some important technical problems to be developed urgently in Japan.

processing, usage, recycling, etc. The material's recyclability is one of the most important factors for the eco material (see Fig. 13).

Steels and aluminum are typical examples of eco-materials. In addition of those, magnesium and light inter-metallic compounds etc. have become of major interest recently. Many technical projects focus not only on the environmental optimization of manufacturing, but also on

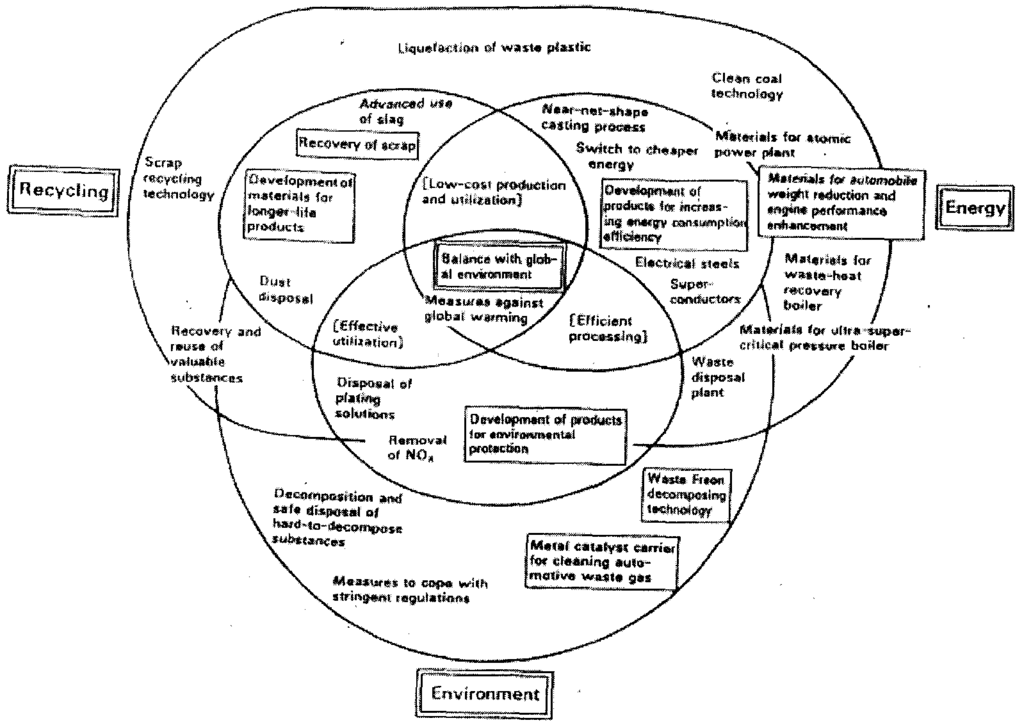

Fig. 12 Important technical problems

The United Nation University proposed the concept of the Zero Emission Research Initiative in 1994. Since then, "Zero Emission" regarding industrial wastes in manufacturing processes has become an important aim. If products have long life in usage, they are also very available for saving energy and resources. Eco-materials are defined as the materials with low environmental impact throughout of their life cycle including production,

the improvement of environmental optimization of performance of products.

For example, the improvement of fuel consumption by the lightweight of car components has been continuing for these years in the automotive industry. There are some possibilities to obtain weight reduction by: (a) application of light weight materials like aluminum or magnesium, (b) design optimization of car structure, and (c) shapebased light weight construction like a hollow or sandwich structure. Research areas including tailor-made blanks, thixo-forming, magnesium and aluminum processing, and hydroforming, etc. become to be very important.

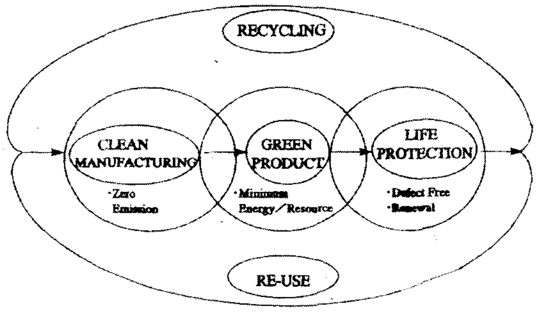

Fig. 13 Life cycle problems for a green product

In Tables 6 and 7, you can see some ideas of future technological targets in metal forming or working. Anyway, it is very important for all the researchers and engineers to keep the mind of Sustainable Development in environmental manufacturing and in society. The international cooperation is also very important for the development of ecological societies in the world.

I really appreciate your kindness for the opportunity to discuss about my humble experience through this precious opportunity. I wish an everlasting and successive development of KSTP.

I sincerely thank Miss Chang-Hui Lee, KAIST, for her kind assistance in preparing this manuscript.

Table 6 Trends of material development in resolving global environmental problems

Global environmental problems	Fields	Countermeasures	New materials	Technology of plasticity
• Global warming	• Transportation	• Improvement of fuel consumption rate	• High-strength steel sheet • Application of aluminum alloy and other materials	• Pressing of hard material
• Acid rain	• Energy	• High temperature boiler and turbine • Magnetic steel • Superconductor • Fuel battery terrestrial heat • Nuclear power, fusion reactor • Solar cell	• Heat-resistance steel, Ni-base alloy, ceramincs • Amorphous, Si-steel • High Tc superconductor • Heat and corrosion-resistance steel, high alloy steel • Recyclable material, insulator • Amorphous	• Forming & working of low-workability material (High temperature forging, superplastic forming) • Powder metallurgy
• Waste • Recycling • Ozone layer destruction	• Industry (in general)	• Long life • Recycling • Lubrication-free forming	• Corrosion-resistance steel, stainless steel • Recyclable material • Lubricated steel sheet	• Surface modification

Table 7 Future technological targets in material forming and working

	Rolling	Sheet forming	Forging	Extrusion/Drawing	Rotary forming/Spinning
Technological targets	• Mushy-state rolling • Continuation of process • Improvement of accuracy • Utilization of thermo-mechanical controlled process	• Forming of high-strength steel and aluminum for light weight automobiles • Homogeneous-strain forming • Flexible forming • Forming with no lubricant and low noise	• Near-net shape forging • Forging materials of low workability • Optimum process design • Core forging • Lubricant recycling and noise reduction	• Powder extrusion • Extrusion and drawing of new materials • Mushy-state extrusion • Tooling and lubrication	• Improvement accuracy • Optimization of material shape • Combined working

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