Special Feature 1:

Mottainai in civil engineering

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Mottainai

Upon visiting Japan in 2004, Nobel Peace Prize winner Wangari Maathai, of Kenya, was impressed by the deep significance of *mottainai*, a word that is not found in English or European languages. She began a movement to promote *mottainai* as a common international expression that sums up the spirit of "reduce, reuse, recycle" in a single word. The origin of the word *mottainai* is said to be related to the traditional Japanese reverence for the gods as present in all things. The dictionary *Kojien* [in Japanese] defines *mottainai* as "a sense of regret concerning waste when the intrinsic value of an object or resource is not properly utilized."

What is *mottainai* in civil engineering?

In the field of civil engineering, what is meant by *mottainai*? I will list some examples that have occurred to me while considering the basic concept of civil engineering as the work of creating structures.

[1] Wasteful use of materials and machinery when creating structures is *mottainai*.

[2] Wasteful use of money when creating structures is *mottainai*.

[3] If the created structure fails to harmonize with its surroundings, that is *mottainai*.

[4] Concerning functions and performance during a structure's anticipated service life:

a) If the structure fails to function and perform as needed, causing a detriment to users or even becoming completely unusable, that is *mottainai*.

b) If the structure provides greater functions and performance than are actually required, that is *mottainai*.

c) If the need for the structure ceases to exist, so that it falls into disuse, that is *mottainai*.

First, regarding category [1], efforts have been made since long ago to reduce waste at construction sites by reusing forms and so on. The use of the world's most advanced energy-saving technologies in the cement industry and railroad industry also falls under this category. Many additional endeavors have begun in recent years, including the recycling of waste construction materials, and zero-emission construction sites.

Category [2] is the issue of cost-effectiveness, which has helped certain governors to get elected. It seems that this problem ought to be resolved if the effects are clearly explained and understood. The current trend among the general public is to consider all public works of civil engineering as wasteful spending. In response, we in the field of civil engineering need to clearly describe the effects of these projects, and to present the

viewpoint of why they are not, in fact, wasteful. The approach of showing why these projects are not wasteful essentially falls under parts b) and c) of category [4].

Category [3] includes structures that fail to harmonize with the surrounding scenery, natural environment, or ecology. As illustrated by the debate concerning the cityscape of Nihonbashi, Tokyo, opinions vary among persons in differing positions, and this can be quite a difficult issue. This has been addressed by various endeavors in recent years, such as taking scenic and ecological aspects into consideration during the planning and design process, and building a consensus with surrounding residents prior to construction.

Last, category [4] deals with functions and performance. Functions include intangible aspects such as economic effectiveness and user satisfaction. When considering this type of *mottainai*, it is important to remember that in the case of civil engineering structures, many years elapse from the planning and construction stage until the end of the structure's service life; and the functions and performance demanded of the structure will change over time. Part a) includes cases in which the structure is unable to handle increased demand subsequent to its construction, or its performance declines because of deterioration over time, or it is damaged by an earthquake and no longer operational. Part b) refers to cases in which the actual demand is much lower than anticipated at the time of construction; and part c) indicates the further worsening of this demand deficit until the structure is no longer used at all.

The worst kind of *mottainai*

In civil engineering, what is the worst kind of *mottainai*?

I'm sure that the answers would vary, since people have different values. However, considering that civil engineering structures require vast expenditures and labor in their construction and need to remain functional for a very long period of time, one of the worst kinds of *mottainai* is certainly the waste of a structure when its functions are no longer utilized during its anticipated service life, as in parts b) and c) of category [4] above.

As people change the places where they live, lifestyles, values, and modes of transportation, civil engineering must adapt to those changes in order to avoid significant problems of *mottainai*. Ultimately, regarding *mottainai* in civil engineering, the issue is to predict the future situation of Japan, including how and where people will live and how people and goods will be transported, or to ensure future flexibility regarding those aspects that cannot be predicted in advance.

Japan in the future world

Japan has continued on basically the same course over the past fifty years. However, considering recent trends in Japan and the world, it seems likely that the next fifty years will not be a mere extension of the same course.

Japan today imports 96% of its primary energy (including nuclear power), 60% of its food, nearly all of its mineral resources, and over 80% of the lumber it uses, while earning foreign currency by exporting automobiles and high-tech equipment. Most of the goods that support our lifestyles and industries are imported. Meanwhile, as the earth's limits are beginning to emerge in many areas, and resource nationalism is on the rise in many countries, there is concern as to whether it will always be possible to buy whatever we need from overseas as long as we have enough money.

At the forefront of the issues that may affect the future lifestyles of the Japanese people is the risk of reduced vitality due to Japan's low birthrate, aging society, and declining population. This issue is often brought up in the field of civil engineering as well. But since Japan is dependent on imports for most of the goods that support our lifestyles, any discussion of domestic issues must also incorporate global issues such as the world's population issues, resource and energy issues, global warming, agricultural and food related issues, and issues of water resources. Although these issues may be discussed individually in the respective fields, they are all mutually interrelated; and since they affect the places where people live, lifestyles, and modes of transportation, ultimately they are also issues of civil engineering. The relationship between civil engineering and the rest of the world is not limited to overseas projects.

The systems theory approach

When it was published in 1972, a book entitled *The Limits to Growth* drew a storm of worldwide attention for its predictions concerning the future world according to a simulation based on the theory of system dynamics, which had been developed at MIT. Although the book has received various criticisms since then, an increasing number of people believe that the world is changing along the very lines of the scenario predicted by *The Limits to Growth*.

In this scenario, the world will reach its limits as a supplier of resources and absorber of wastes, including carbon dioxide. Thereafter, the costs of obtaining resources and disposing of wastes will increase; and as a result, economic activity will stop growing and begin to decline. In this simulation, the interactions among individual elements such as population, industrial capital, pollution, and agricultural land are modeled in the form of feedback loops, analyzing the entire world as a single integrated system.

The mission of civil engineering is to build the infrastructure for society. Therefore, civil engineers need to pay attention to all of the factors that can affect people's lives, determine the interactions among these factors, and understand the future Japan as an enormous integrated system composed of all of these interactions. In other words, we need to think in terms of systems theory.

Many of the projects that are currently being planned or built are expected to still be used in the year 2050. What will Japan be like in 2050? Civil engineers need to take the lead in carefully considering the future of Japan and the world on the basis of systems theory.