Engineering for Human Security and Well-Being

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For some time, I have been studying the combined concept of "human security and well-being," which addresses people's daily lives as a top priority, as well as the concept of "societal innovation." The concept of "human security" was born in the early 1990s, replacing the idea of "common security." Human security covers cooperation between nations toward common threats to the human race as a whole, such as global warming and pandemics. On the other hand, the concept of "well-being" is proactive, encompassing happiness and quality of life (QOL). Societal innovation links science and engineering in information and communications with societal infrastructure, ensuring that new systems that are useful to society emerge and are implemented based on proven technology. This area of study resolves various issues affecting people in general, thus contributing to the good of the whole.

Pressing issues exist today, involving energy, the environment, healthcare (including mental health), education, transportation, food, and aging. In the quest for human security and well-being, societal innovation provides the driving force to resolve these issues. Future urbanization concepts will require a master plan to address all of the issues listed above. Individual methods to achieve such a master plan will require a wide variety of innovations and technological developments.

Given that the original meaning of innovation is "creation through new bonding," the idea of "co-creation" (open innovation) is indispensable in societal innovation. By strengthening links between the humanities, social sciences, and other areas, and by bridging and fusing areas where necessary, new systems will emerge. To this end, the science of brain functions will become increasingly important. This is because the brain is a common information processor for natural science, social science, and the humanities.

For many years, we have pursued various methods to generate synergies in the key areas of measurement, analysis, and control technology. The current pressing issue in this work is to ensure that information and communication technology (ICT) spreads to all areas of societal infrastructure. In addition, connections between science and engineering in the field of life sciences are creating new frontiers for the 21st century. Examples include brain science and regenerative medicine, with a particular focus on induced pluripotent stem (iPS) cells.

Council of Academies of Engineering and Technological Sciences meeting minutes (2011)

On the occasion of the Council of Academies of Engineering and Technological Sciences (CAETS) Convocation, held in 2011 in Mexico City, I was granted the opportunity to acknowledge and thank the CAETS member countries who had extended support and warm sympathy to Japan after the East Japan Great Earthquake of March 11, 2011. My address at the opening of the council meeting was later attached to the CAETS homepage by the CAETS Secretary. After the earthquake, a number of Japanese engineers including myself had to return to basics to guide our way of thinking. For example, does materialistic prosperity ensure happiness or well-being? What is most important to us as human beings? What is the final destination of engineering—the true objective of engineering?

Reconstruction of the Tohoku disaster area

Many Pacific seaside towns in the Tohoku area were completely destroyed by the huge tsunami that hit them on March 11, 2011 (Figure 1). Almost 20 000 lives were lost. Although three years have passed, reconstruction has proceeded extremely slowly in this seaside disaster area. This situation exemplifies the difficulty of new urbanization in the context of human security and well-being.

The original form of a city

The ruin of an ancient Greek city shown in Figure 2 is an example of the original form of a city. Selinunte was a colony of ancient Athens, established in Sicily more than 2500 years ago. This city was situated on a flat hill near the shore of the Medi-

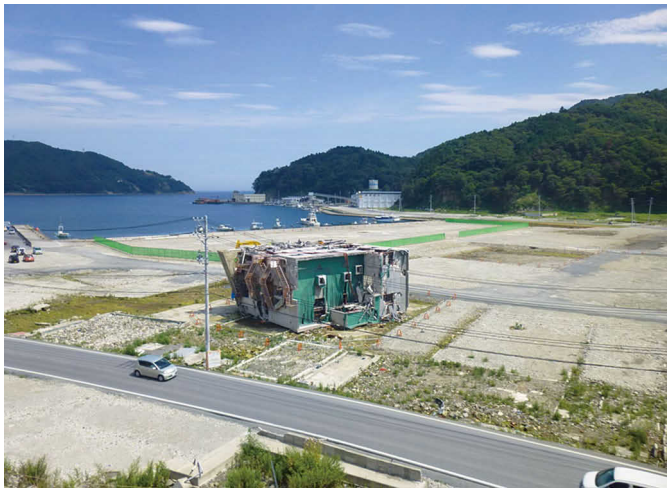

Figure 1. Onagawa Town disappeared after being hit by a tsunami that was over 20 m high, on March 11, 2011. Photo by H. Koizumi, 2012.

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Figure 2. The original form of a city: Selinunte, an ancient Greek city in Sicily (BC 628). Photo by H. Koizumi.

terranean Sea.

The Acropolis was the center of Selinunte; this area was respected by citizens, and city governance was performed here. The whole city was surrounded by high walls for protection, as was usual at that time. The fundamental city form and functions of Selinunte make up an original form of a city, or an archetype as was first pointed out by Goethe in his concept of morphology. A city evolves from its basic form through metamorphosis.

Human-centric design

When discussing the concept of a smart city, we often discuss specific means to achieve it, such as a smart grid or environmental concerns. When we think of a future city, however, we should not start from means but from final objectives. A city is a place where humans live. Therefore, our first priority should be to make such a city "human centric" or "human centered."

What is a future city like? Figure 3 shows a proposal for a human-centered future city. Here, human security and well-being are the key concepts, and societal innovation is used to make optimal city clusters. For optimization we have to consider all the issues of energy, environment, logistics, transportation, healthcare, education, and food production as mentioned later.

The optimization of whole city clusters has not been studied yet. I have been advocating this new transdisciplinary field as a typical example of a new concept that integrates science, engineering, and technology.

SET concept toward innovation

The traditional phrase "science & technology" is not necessarily the best expression to describe practical research and development. I have had the good fortune to invent many new methodologies and discover various new phenomena. In my opinion, there are three orthogonal concepts, science, engineering, and technology (SET), in every kind of research and development.

Modern concepts of science, engineering, and technology

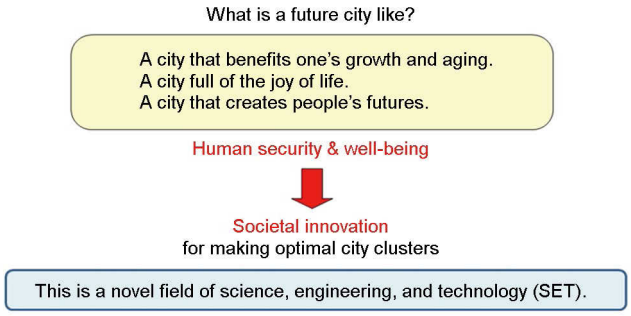

Figure 3. The concept of a human-centered future city[※].

(including the arts) have been nurtured somewhat independently in different fields since the 17th century. Consider the word stem of science, *scie*, coming from the old Greek word *skei*, which means to split or divide. The original meaning of "science" is to know and to understand nature by reduction. The word stem of engineering, *gin*, comes from the old Greek word *gen*, which means to give birth. Therefore, the original meaning of "engineering" is to create human artifacts. The word stem of technology, *techn*, comes from the old Greek word *tekhne*, which means to make or imitate natural existence. The meaning of *tekhne* is the same as that of the Latin word *ars*, from which we get "arts." Therefore, the original meaning of technology is similar to that of the arts.

I have to emphasize that human activities in science are not directly related to ethics. Human activities in engineering, however, should be highly concerned with ethics. Global warming and the tragedy of nuclear bombs are both the results of human artifacts, that is, the results of engineering based on human decisions.

A hierarchical structure for human security and well-being

I have modified Maslow's hierarchy of needs from a human-centered perspective (Figure 4). The first layer, the most basic, consists of energy and entropy. This layer relates to the air, water, and nutrition required for life. The second layer consists of security, such as safety, and various guards for survival. The third layer consists of sociability, such as relationships with others, and life reproduction. These three basic layers are related to the so-called "food, clothing, and housing" needs. The fourth and fifth layers, at the top of the pyramid, are strongly related to human thinking and states of mind, and include concepts such as civilization, culture, and satisfaction. In the lower three layers, happiness is proportional to fulfillment. In the upper two layers, however, happiness is not necessarily proportional to money and material prosperity. Although materialistic values are important in developing human states of existence, mental values become more important in highly developed states.

A human-centered future city

When we consider a human-centered future city, we have to consider energy production and entropy processing from a

[※] H. Koizumi. A vision for future city (Special lecture). Hitachi Forum, Dalian, 2012