R&D ACTIVITIES ON FUTURE CONSTRUCTION SYSTEMS IN JAPAN

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INTRODUCTION

R&D activities on construction technology in Japan are mainly carried out by large general contractors. They have their own R&D staffs and facilities. Almost all subjects of their R&D are related to the improvement productivity and quality. In this paper I mention about R&D activities on productivity improvement of construction.

Productivity improvement technology includes two kinds, hardware and software. Hardware means construction material, construction equipment, and construction method, and so on. Software means construction planning, control, management, and so on. Harmony of hardware and software is very important for construction productivity. I introduce construction automation technology as hardware, and CALS(Continuous Acquisition and Life-cycle Support/Commerce At Light Speed) as software.

As examples of efforts for more futuristic technology, I mention about space construction as hardware and IMS (Intelligent Manufacturing Systems) which is an international collaboration proposed by Japanese MITI (the Ministry of Trade and Industry).

CONSTRUCTION AUTOMATION

Some general contractors in Japan started the basic research about construction robotics more than 20 years ago and have proposed many prototype robots. One of the prototype robots in those years is the Fireproofing Spray Robot developed by Shimizu. The development of this robot might be a sort of trigger for Japanese R&D activities in this technology field.

In the 1990s, various types of construction robots are developed in Japan. Some robots are very useful in construction sites. Many of them, however, were applied to limited numbers of projects as prototype models. For getting cost effectiveness of these robots, we have to get larger market. In this sense it is not effective that many general contractors develop their own robots separately. In this view point we tried to establish a consortium which carry out development of common construction robots.

In these years several automated construction systems for tall buildings have been developed by some general contractors and applied to several actual projects. These systems have temporary roofs to allow weather-free construction. Some of them can be called site factories. Man-power and time productivity of these systems are very good, but cost productivity depends on building shape. For

example, such a system would be ideal for a simple shaped tall building more than 20 stories. This means that it would be very difficult to reduce cost where the plans of the building are complicated or the building height is not so tall. For more common applications of these systems, their facility cost should be improved much more.

One example of these systems is "SMART SYSTEM" developed by Shimizu. The first project applied this system was completed in 1992 in Nagoya City, and the second one in 1996 in Yokohama City. The third project was completed last year in Kawasaki City, which was modified so much from a original system to reduce cost. Although the technological level of automation was going behind a little bit, they could enjoy much cost merit.

SPACE CONSTRUCTION

In this year the construction of the International Space Station will start actually, which will be completed expectedly in 2002. After this project many space missions will be hopefully planned, including the construction of large space structures and lunar base.

Studies on construction systems in space are very interesting, including many futuristic technological subjects.Since transportation cost from the earth to space is extremely expensive, space structure should be designed to be lighter and smaller as much as possible during space transportation. Therefore, deployable and inflatable structural systems are very useful.

Deployable systems are those that are mechanically folded in space transportation vehicle and deployed in space. In case of inflatable structures, textile material skin structures are inflated by gas. These structural systems will be very useful also for terrestrial prefabricated building systems.

In space construction, robot technology is essential, because work environment is too bad for human. Especially control systems are very important. Since communication between the earth and space requires much longer time, very much advanced remote control technologies are needed.

In Japan Engineering Test Satellite No.7 (ETS-7) was launched last year. Shimizu has developed an experimental truss unit for this mission. The actual experiment will be carried out in this Spring. This project will be useful for establishing robotic engineering for the future large-scale orbital structures.

Through these studies many creative ideas will be generated.

CALS

For improving construction productivity, information/communication technology would be very important. Therefore many Japanese construction companies have made efforts to organize their own integrated information systems for construction engineering. The concept of CALS (Continuous Acquisition and Life-cycle Support/Commerce At Light Speed) is the similar idea in more extended environment.

The objective of CALS is to rationalize business works by utilizing the electric data exchange system. When CALS infrastructure is established, we can realize concurrent engineering and electric commerce, so that we can expect to improve productivity in cost, engineering man-power, and/or time.

CALS was developed in the USA, but the term "CALS" is not commonly used there. In Japan, where the term is used in a wider meaning, it is met more favor by the Japanese government and industry. In 1006 the Ministry of Construction in Japan started a national project called "Construction CALS". As a member of the steering group, I am deeply involved in this three year project. The goal of this project is to develop the frame work of CALS.

The Ministry of Construction established their goal of CALS/EC toward 2004 last June.In this goal, they mention that they will execute all public construction works managed by central government in CALS/EC environment. This influence whole Japanese construction industry so much, and the style of construction business will be changing so rapidly.

Regarding the effectiveness of CALS, the larger we can consider the scope of production system, the more effective. Company wide activity is better than project wide activity. Industry wide is better than company wide, and national wide is better than industry wide. In this sense, we have to extend the scope of construction to manage as much as possible.

NEW PARADIGM

In these years sustainable economy or sustainable development is discussed frequently. Mass production and mass consumption using large amount of materials and energy create many kinds of terrible problems. Thus,we have to consider more about building life, recycling of structures, and social/natural environment of construction industry.

Related to these problems, one of interesting program would be IMS (Intelligent Manufacturing Systems), which is 10 year long international collaboration proposed by Japanese MITI (the Ministry of Trade and Industry) . Currently, six regions (Japan, EU, EFTA, Canada, USA, and Australia) are participating in this program. The objective of this program is to research on future production system considering sustainability. Several Japanese large general contractors are involving in this program, because they think the future of construction industry should be discussed together with manufacturing industry.

In case of Shimizu, we are joining 4 projects, one is an international project and three are national projects going to international ones. I am presently involved in an international project called "GNOSIS", which is a research on the systematization of knowledge for the future manufacturing systems.

This project focuses on how to realize PMPP (Post Mass Production Paradigm). PMPP is a basic thought to make dematerialization while maintaining economic activity. Future manufacturing systems in PMPP will require much more flexibility in both product and production, which we call softness.

In these discussions, the most important point is that sustainability or PMPP adaptability should not be thought as negative factors in productivity. Although these factors might be negative in the conventional sense of productivity, they should be positive in a new production paradigm, which we have to create.

CONCLUSION

I mentioned some topics about R&D activities on future construction systems in Japan. All these technologies cannot be promoted by an independent company, but by the coordination of whole construction industry together with government. For getting new paradigm of construction industry, many kinds of international collaborations would be essential.