The Cost Evaluation Framework on a CAD-based Dismantling Process Simulation System

Jonghwan Lee [a*], Dongjun Hyun [a]
[a] *Korea Atomic Energy Research Institute, 989-111 Daedeok-daero, Yuseong-gu, Deajeon, Republic of Korea*
[*] *Corresponding author: jhl@kaeri.re.kr*

1. Introduction

Nuclear decommissioning should be performed after a comprehensive review of the information related to these processes and technologies [1]. Conventionally, in order to evaluate the economic efficiency of the dismantling process, the cost per unit time, distance, or weight were empirically set for each target to be dismantled, and the cost was predicted according to the unit cost. In general, this cost evaluation process was based on a certain value such as the unit cost or the size of the target, so it could be performed using a simple calculation-oriented spreadsheet or a dedicated calculation program. However, these cost evaluation methods were difficult to intuitively understand the results of detailed dismantling processes, and many additional efforts were needed to evaluate the individual processes in conjunction with the recent popular visual simulation tools for process planning and verification. And it was difficult to integrally manage the results because the simulation tool and the cost evaluation tool were run operated.

In order to overcome these drawbacks and limitations, this study proposes a cost evaluation framework that can be integrated with a CAD-based nuclear dismantling process simulation system to evaluate the cost of the dismantling process in real-time without any other dedicated cost evaluation tool.

2. CAD-based dismantling process simulation structure

The CAD-based dismantling process simulation system developed by the authors provides specialized functions for establishing nuclear dismantlement processes based on a commercial digital manufacturing simulation platform [2]. For example, the concept of cutting process using a robot on the dismantling process simulation system is shown in Fig. 1.

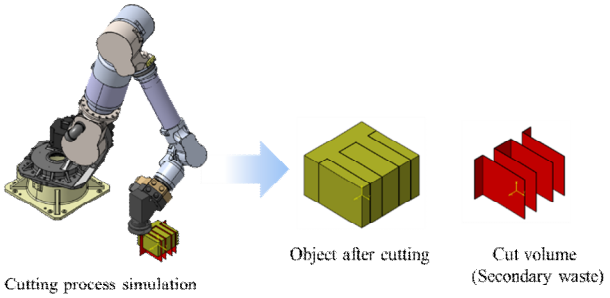

Fig. 1. Cutting process on the CAD-based dismantling simulation system.

Using this dismantling process simulation system, the cutting process can be simulated in real time without a separate 3D modeling tool such as a CAD tool. Therefore, even if a single system is used, it is possible not only to continuously visualize the cutting process simulation, but also to estimate physical factors such as the process time, volume and weight of the object.

In CAD-based simulation system, this dismantling process simulation is built into a PPR (Process-Product-Resource) structure. Fig. 2 shows the case where the left side is the PPR structure before the cutting process simulation and the right side is the PPR structure after the simulation. As shown in the figure, after the cutting process simulation, the object to be cut is divided into objects after cutting and added to the product tree. In the CAD-based dismantling simulation system, the PPR structure can be utilized to construct and simulate the process, and it is possible to calculate the factors necessary for evaluating the dismantling process such as the process time described above. This PPR structure is applied not only to cutting process simulation, but also to all common process simulations, from simple transfer process to complex robot utilization process, thereby providing a basis for obtaining basic data for process evaluation.

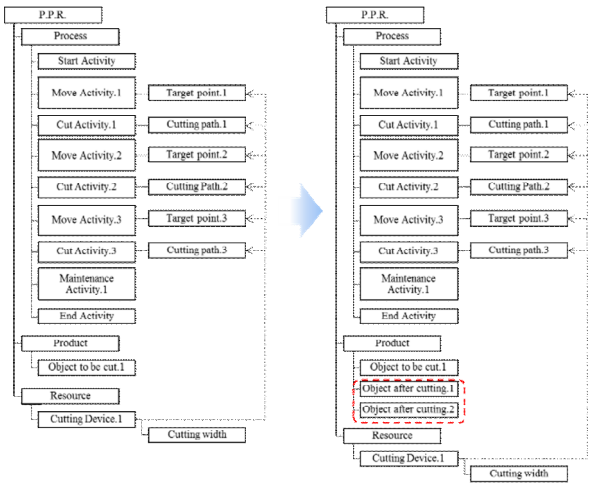

Fig. 2. PPR structure of cutting process simulation

3. Design of cost evaluation framework in CAD-based dismantling process simulation tool

The process simulation module and the process cost evaluation module were separated to design a cost evaluation framework specific to the CAD-based dismantling process simulation system as shown in Fig. 3. In order to evaluate the cost of the dismantling process using various data for each unit process calculated in the PPR structure of the process simulation module, the data of the simulation module is extracted and reorganized in the process cost evaluation module, and various costs to be put into the process are calculated with the reorganized data and the additional constant data. This is a basic framework for evaluating the cost of each unit process as well as the cost of the whole process consisting of each unit process.

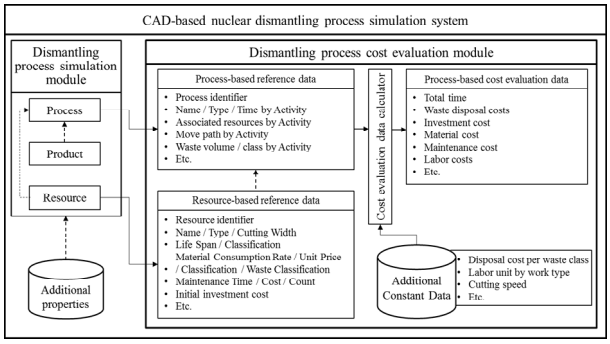

Fig. 3. Cost evaluation framework for the CAD-based nuclear dismantling process simulation system

This framework can be directly integrated with CAD-based dismantling process simulation system and can provide a clear basis for the costs incurred by using physical quantities of consumed or injected materials. In addition, it can smoothly respond to supplementation of cost evaluation system and addition of evaluation items when necessary, and provides a system that can easily link with other tools.

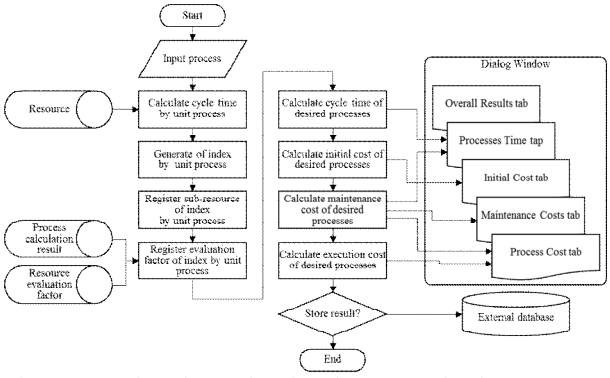

Fig. 5. Procedure for performing the cost evaluation framework

Fig. 5 shows a procedure for performing the cost evaluation framework in the proposed CAD-based dismantling process simulation system. The user of this simulation system establishes the dismantling process based on the PPR structure and simulates the process to obtain the PPR structure after the dismantling process is completed. The calculated data for cost evaluation is constructed in the PPR structure obtained through the simulation, and cost evaluation is performed for each unit process using the calculated data.

4. CONCLUSIONS

This framework has been successfully applied to CAD-based nuclear dismantling process simulation system [3]. By applying this framework, we can provide a clear basis for the cost evaluation items because it is based on data such as process time and material consumed from the dismantling process simulation system. In addition, since the simulation execution part and the cost evaluation execution part are separated in the system, it is possible to smoothly deal with the supplement of the cost evaluative framework, the addition of the evaluation item and the interworking with other tools. This cost evaluation method is performed simultaneously with the dismantling process simulation in one system, so that it is possible to establish the initial dismantling process plan more quickly and efficiently. In addition, it is expected to be useful in carrying out the initial detailed process plan in countries and companies that cannot utilize the various costs built through past nuclear dismantling experience.

Acknowledgments

This work was supported by the nuclear research and development program through the National Research Foundation of Korea, funded by the Ministry of Science and ICT, Republic of Korea.

REFERENCES

[1] J. Lee, G.-H. Kim, I. Kim, D. Hyun, K.S. Jeong, B.-S. Choi and J. Moon, Establishment of the framework to visualize the space dose rates on the dismantling simulation system based on a digital manufacturing platform, Annals of Nuclear Energy, Vol.95, pp.161-167, 2016.
[2] I. Kim, B. Choi, D. Hyun, J. Moon, J. Lee, K. Jeong and S. Kang, A framework for a flexible cutting-process simulation of a nuclear facility decommission, Annals of Nuclear Energy, Vol.97, pp.204-207, 2016.
[3] D. Hyun, I. Kim, J. Lee, K.-S. Jeong, B.-S. Choi and S. Y. Kang, Simulation-Based Evaluation for the Dismantling Scenario of the Reactor Vessel at Kori Unit 1, Proc. of the Korean Radioactive Waste Society SPRING 2017, Vol.15, No.1, pp.323-324, 2017.