Recent Trends of Dynamic Simulator Applications and Prospects for OmegaLand

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Omega Simulation Co., Ltd. (OSC) was established in 1997 as a joint venture of Yokogawa Electric Corporation and Mitsui Chemicals, Inc. OSC's mission is to help customers improve their plant operations, by using advanced technologies integrating instrumentation/control technologies from Yokogawa, and modeling/simulation technologies from Mitsui. The OmegaLand integrated dynamic simulation environment, and its core technology, the Visual Modeler plant simulator, are a software package developed by OSC. In recent years, dynamic simulation technologies are increasingly used for multiple purposes in each phase of the plant lifecycle. To respond to this trend, OSC is working with Yokogawa and Mitsui to develop MIRROR PLANT, which applies dynamic simulation to the online real-time environment, in order to improve plant operation. Its demonstration has shown remarkable, excellent results. This paper outlines new applications of these dynamic simulation technologies, as well as the goals of OSC and OmegaLand.

INTRODUCTION

A dynamic simulator is a software tool for building a virtual plant in a computer by modeling an existing plant or a plant to be built. With a dynamic simulator, the following can be achieved:

1) Carrying out of various design and engineering programs for a plant which is prior to or else under construction, as if it actually existed
2) Performing operations in a virtual plant which cannot be tried in an actual plant
3) Visualizing or estimating conditions in the plant, and predicting plant behavior based on the current plant conditions

Examples of the first category include the applications of a dynamic simulator to the verification of the logic in the plant design, control systems, and safety systems, and to the configuration and evaluation of operational procedures, during the front end engineering design (FEED) and engineering procurement and construction (EPC) phases in plant construction. One application example of the second category is the operator training simulator (OTS), which is currently one of the major applications of a dynamic simulator. Another example is to use a dynamic simulator for pre-verification of the advanced control logic before applying it to an actual plant. Various applications of a dynamic simulator during the actual operation phase as in the third category can be implemented by connecting a dynamic simulator to the actual control and safety systems online and using real-time data. In this way, dynamic simulators can be used effectively during the respective phases of a plant lifecycle, from the upstream plant design and construction phase, to operational improvements after having started actual operations.

The OmegaLand integrated dynamic simulation environment, which was developed and is provided by Omega Simulation Co., Ltd. (OSC), is a packaged software that can be used for various applications including those mentioned above. The Visual Modeler plant simulator, a core component of OmegaLand, offers a steady-state simulation function in addition to the dynamic simulation function. The Visual Modeler can cover a wide range of applications that are included in the ellipse in Figure 1.

This paper outlines the current business environment of the process industries, and then examines the roles of plant simulators in applying dynamic simulation technology as its core in solving various problems. First, the effectiveness of plant simulators across a plant lifecycle will be outlined. Then, the prospect of the operator training simulator, considering its actual applications and what the MIRROR PLANT is aiming for, are introduced. The MIRROR PLANT is an online plant simulator jointly developed by OSC, Mitsui Chemicals, Inc. and Yokogawa Electric Corporation. Finally, this paper will describe OSC's future plans. Respective papers of this special issue are intended to explain the technical and application aspects of various applications mentioned above in detail. Readers will be able to gain a more specific understanding

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of the products, including plant simulators, as well as of how various applications are implemented and what effects they create.

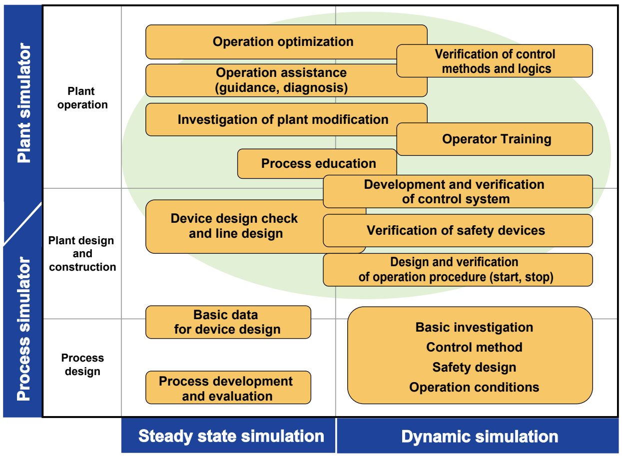

Figure 1 Applications of plant simulators

BUSINESS ENVIRONMENT SURROUNDING THE PROCESS INDUSTRIES AND THE EFFECTIVENESS OF PLANT SIMULATORS IN A PLANT LIFECYCLE

Global competition is intensifying in the process industries as in all industries. Companies in the process industries are striving to achieve ideal plants and operations for survival. Major challenges in this efforts are as follows:

1) Achieving safe and stable operations, and preventing accidents
2) Rapid plant start-ups
3) Improving profitability
4) Optimizing plant operations
5) Improving and propagating the skills of experienced operators
6) Conserving the environment

As a way to resolve these challenges, not only control and safety systems but also various software packages and engineering techniques have been devised and practically implemented. However, most software can only be applied to a single problem in a single phase. In addition, it is often difficult to combine software tools from different vendors.

Because a plant simulator builds a virtual plant on a computer, the simulator itself and the control and safety systems connected to it can be said to approximately replicate the actual plant, even though its accuracy depends on the strictness of the model. In practice, it can serve as a unified platform for providing comprehensive solutions across a plant lifecycle by adding peripheral functions to them for resolving respective challenges.

Plant simulators play an important role in the engineers' work during the plant design and construction phases to help achieve a rapid and flawless start-up. Yokogawa has been effectively using the Visual Modeler for engineering for control and safety systems to improve the efficiency and quality in various operations during the plant design and construction phases shown in Figure 1. This can shorten the time for inspection and commissioning compared to conventional engineering techniques, and reduces risks, achieving a more complete start-up, with its production efficiency maximized as well as secure and safe operations.

Plant simulators are used for the validity verification of control systems during the commissioning and actual operation phases included in the plant operation phase shown in Figure 1. They virtually implement the relationship between the plant and operators, and this is helpful for operator training and creation of operation procedures for safer and more stable operations. The prospect of this application will be described in the following section.

Effective use of the plant simulator for operation assistance and operation optimization by recognizing and predicting plant and process conditions in the past, present and future will be one of its major applications. New efforts for connecting a dynamic simulator to control and safety systems online are described below.

As described above, to effectively use a plant simulator over a plant lifecycle, it is necessary to implement required functions with required accuracy in respective stages of the lifecycle by improving dynamic models in line with the advance of the plant lifecycle. By combining various systems and tools on the basis of an evolving virtual plant, managers, engineers and operators can cooperate to resolve various latent issues while carrying out Plan-Do-Check-Action (PDCA) cycles. This method is extremely reasonable. From these viewpoints, the process, solving various problems across the entire plant lifecycle through the simultaneous evolution of an actual plant and its model, and consequently achieving ideal plant operations, will be an example suggesting future trends.

FUTURE TRENDS OF TRAINING SIMULATORS

Dynamic simulators are widely used for operations training. Training with OTS systems is highly effective for responding to the necessity of the operational know-how propagation resulting from the aging of operators, energy and resources conservation, accident prevention due to human errors, and so on [(1)]. In particular, because it is difficult for inexperienced operators to select the most suitable options in the case of non-steady state operations and responding to abnormal states without any training, they must acquire knowledge and experience in possible situations in advance, not through OJT. Many recent accidents are caused by human errors such as poor understanding of fundamental rules and principles, insufficient knowledge of plants and equipment, wrong judgment due to lack of experience, etc. To appropriately cope with natural disasters, training must be based on a wider range of assumptions. In any case, operators must understand the current situation based on GOGEN shown in Figure 2 and must take countermeasures to face them. GOGEN (five Gens) is a Japanese concept in improvement activity, KAIZEN, including five key words, Genba (actual place), Genbutsu (actual thing), Genjitsu (actual situation), Genri (principles) and Gensoku (fundamental rules).

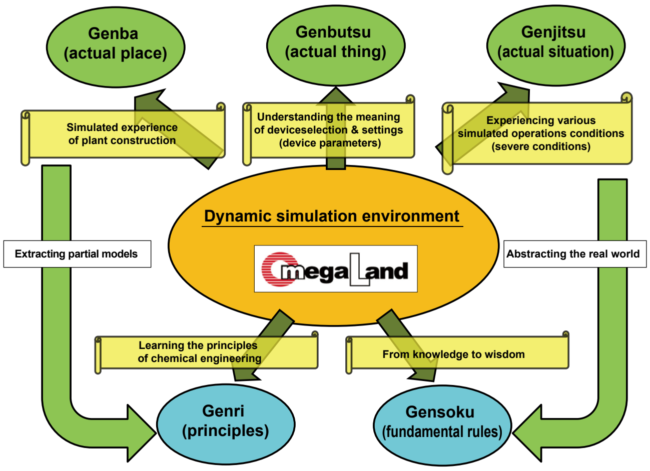

Figure 2 Necessity of operator training based on GOGEN

In contrast to training in classrooms, training giving a more realistic feeling will be required for field operations, maintenance work and so on. New training methods to achieve this are expected to increase, in which a 3D environment will be created on a computer and trainees will manipulate a copy of themselves or an “avatar” in that environment. A 3D model can be created by using 3D CAD, for example. There is another advanced training method which gives further realistic feeling, in which field operators themselves wear a head-mounted display and act in the virtual reality environment. These applications have previously been implemented in the aerospace industry and military training. At present, few examples are found in the process industries due to the high costs. However, training in an environment more similar to the actual place, actual thing and actual situation is a more effective practice. This is one of the notable applications for the near future.

Another new trend is found in changes in the environments for conducting OTS-based training. So far most OTS systems are stand-alone type systems assuming training in classrooms. Because OTS systems use dynamic simulators and control systems and thus they are relatively large in scale and their loads are high, a stand-alone type has generally been used up to now. However, as a result of the rapid development of information infrastructure in companies and the improvement in its performance, there is an increasing demand for client-server model OTS systems, which require higher speed and more compact simulators, and for training over in-company networks. In this environment, the training will be conducted in a distributed manner where one instructor and several trainees use each client computer and use the OTS system installed in the server on the network. Self learning by trainees without instructors is possible. There is no need for all involved persons to gather at one place, and trainees can proceed with training at their desks.

Company-wide online learning (e-learning) is widely spreading and many companies are introducing systematic training courses using the learning management system (LMS). By utilizing OTS from the LMS, training status, training results, and training scheduling can be centrally managed. Expanding their applications further, training simulators have the possibility to evolve beyond in-company networks to cover training over the Internet, including training at home and training using mobile devices.

Supposing such usages as described above, OSC has developed the OmegaLand OTS Enterprise and started to offer functions that allow OmegaLand to be used in the above mentioned environments.

ONLINE USE OF PLANT SIMULATORS

By connecting a plant simulator to an actual control system used for plant operation and using it so that real-time data can be used online, the plant simulator can be used in various applications during the actual operation phase as shown in Figure 3.

However, simply adding online functions alone to the current dynamic simulator mainly used for OTS applications is not sufficient to be used in such applications, as the following functions are required:

1) A modeling function to build a more rigorous model
2) Seamless integration of dynamic simulation and steady-state simulation
3) Computation capability to solve the rigorous model at high speed
4) A data reconciliation function with dynamic compensation
5) Robustness as an online system

Accordingly, a more refined simulation is required, thus barriers for dynamic simulator vendors to enter this area are high.

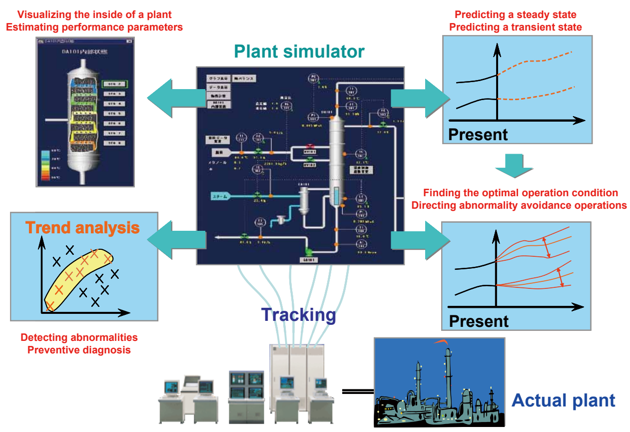

Figure 3 Functions achieved by MIRROR PLANT

OSC is jointly working with Yokogawa and Mitsui to develop MIRROR PLANT, a Visual Modeler plant simulator equipped with the required functions above. Its field tests have been conducted at an actual Mitsui plant, where satisfactory results were obtained and its effectiveness has been proven [2].

The MIRROR PLANT not only optimizes a steady state as does a commercially available optimizer, but also can predict a transient state and optimize a plant operation system by using its rigorous dynamic model. This helps operators predict behaviors and possible abnormalities of the plant and take preventive measures, which ensure safer and more stable operations and reduces mental stress of the operators.

When building a specific MIRROR PLANT in a computer system, deep understanding and detailed modeling of the plant are required. During this process, staff's knowledge based on principles and fundamental rules, staff's knowledge of design, and operators' knowledge and experience obtained through daily operations are fused and systemized. This series of tasks not only build a MIRROR PLANT as a result, but also deliver educational effects such as sharing knowledge by making tacit knowledge explicit and improving techniques and skills of personnel for more advanced operations.

Although the effectiveness and efficacy of the MIRROR PLANT have been confirmed through field verification testing, and it can be applied to practical uses, there is still room for improvement. However, OSC believes that the technologies of the MIRROR PLANT will be a breakthrough for innovation of plant operations. Prioritizing from the viewpoint of contributing to customers' businesses and creating new value, OSC will continue the development of the MIRROR PLANT.

CONCLUSION

As described above, a plant simulator based on dynamic simulation technology has the potential capability to be more effectively used in every stage of a plant lifecycle. Targeting from the EPC phase to the actual operation phase in a plant lifecycle, OSC will grow the plant simulator as a core for solutions with Yokogawa, while improving the development capability of truly practical software and its ability to offer solutions. Our mission is to contribute to customers in improving their capability in industrial technology and achieving their operational innovations, by evolving the common technology of plant simulation to solutions which can offer comprehensive improving effects throughout a plant lifecycle. For that purpose, OSC will continue to enhance the functions of OmegaLand and Visual Modeler.

Meanwhile, OSC is confident that the MIRROR PLANT is an advanced challenge which has yet to be seen in the world. Towards its practical use, OSC, in collaboration with Yokogawa and Mitsui, will actively exchange technologies with customers who acknowledge the value and possibilities of this technology and promote activities with a view to establishing a new collaborative framework for expanding the use of the MIRROR PLANT. OSC hopes that customers who have interest in or ideas for the MIRROR PLANT, such as problem solving opportunities and ways to create good solutions, will consult OSC freely. OSC wants to advance together with their customers, aiming for the enhancement of their respective international competitiveness through activities that transcend the boundary between users and vendors.

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