Thermal Power Plant Asset Management with Asset-centric Data Model

● Naoyuki Fujisawa ● Shuichi Matsuo ● Yukio Yamamoto ● Kazuki Nonaka

Up until recently, electric power suppliers in Japan had been working on various strategies to provide an inexpensive and stable supply of electric power, and they had largely succeeded. However, the tight energy supply brought on by the Great East Japan Earthquake has created an opportunity for Japan to review the risks of depending on large-scale power plants for its power supply and has accelerated discussion on reforming its electric-power supply system. The trend is now toward greater dependency on thermal power generation and liberalization of the industry by legally separating the power-generation component from the transmission-and-distribution component. As a result, electric power suppliers find themselves in a difficult situation because they must now make management more efficient and reduce costs while still providing a stable power supply. Fujitsu has developed an asset management solution for thermal power plants to help suppliers reduce their equipment maintenance cost. This paper describes the asset-centric data model of this solution, the organization of asset-management work based on that model, and the usefulness and importance of an asset-centric data model.

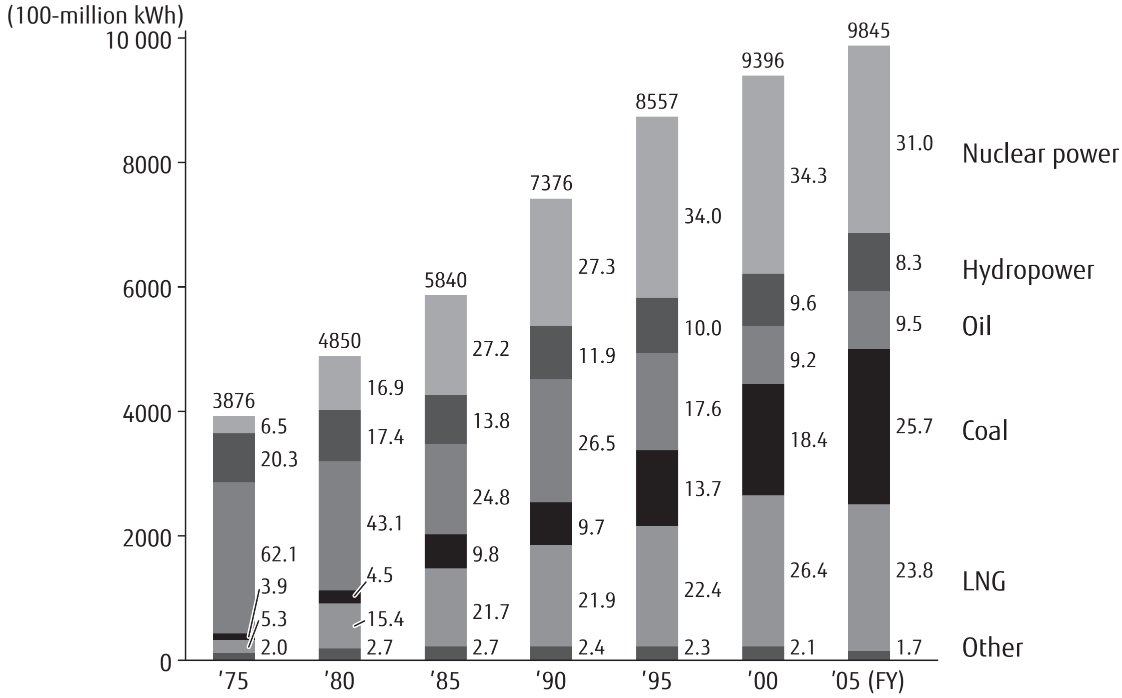
1. Introduction

In Japan, a country poor in natural resources, the two oil crises in the 1970s marked a major turning point toward a more diversified use of energy sources for generating electricity. Up until then, the country depended on oil for 60% of its energy, but 20 years later in the 1990s that dependency dropped to about 20% (**Figure 1**).[1] The major contributor to that drop was nuclear power generation, which by 2005 was supplying 30% of the country's electric power needs. Electric power suppliers likewise went on to promote a diversification of energy sources, but at the same time, they strived to make business operations more efficient and succeeded in reducing non-fuel expenses by about 30% (**Table 1**).[2] Indeed, they achieved their stated goal of supplying electric power inexpensively and stably and greatly contributed to Japan's economic development.

Nevertheless, the disaster at the Fukushima No. 1 nuclear power station brought on by the Great East Japan Earthquake prompted calls for rethinking the popular notion that nuclear power generation is a superior source of energy in terms of cost and the environment.

As a result, renewable energy such as hydropower and solar power has been attracting attention as an alternative to nuclear energy. However, it cannot be denied that making a hasty change to such alternative energy sources without ensuring a stable power supply and resolving other issues could have a major impact on our daily lives and economic activities. Thus, at this point in time in which almost all nuclear power generation in Japan has come to a halt, there is no other choice but to rely on thermal power generation using fuels such as natural gas, coal, and oil that continue to be expensive. This is creating a serious problem for electric power suppliers. In addition, discussions are now being held to liberalize the industry by legally separating the power-generation component of the industry from the transmission-and-distribution component by 2018. These changes are creating a situation in which business operations must be made more efficient.

This paper describes Fujitsu's plant asset management solution for thermal power plants, which is aimed at reducing costs in the "repair expenses" category, which includes costs that contribute to not a small part



Note 1: “Other” includes gas, LPG, geothermal, bituminous mixtures.
Note 2: Composition percentages in each column may not total 100 due to rounding.

Source: Agency for Natural Resources and Energy, “Outline of Japan’s Electric Power Supply”

Figure 1
Trends in electric power generation.

of the electricity rate in Japan.

2. Importance of asset information

As can be seen from Table 1, the ratio of costs related to assets (repair expenses and depreciation) is high if the costs related to fuel (fuel expenses and purchased power) are excluded. This makes sense given that many large-scale assets are required to generate power. Consequently, information on assets targeted for repair and information on depreciation is essential for increasing the efficiency of business operations.

At the same time, measures taken to reduce costs must not sacrifice a stable power supply or jeopardize safe operations, i.e., must not lead to accidents or loss of human life. Technologies related to safe operation and asset inspections and to asset repair are especially important for preventing such problems from occurring. Such technologies also promote skill acquisition, provide hands-on experience, and facilitate asset-related studies, which should eventually improve work efficiency and reduce labor costs.

In short, asset information is essential to simultaneously achieving two somewhat contradictory goals: maintaining and improving stability and safety and reducing costs.

3. Fujitsu’s view of asset management

The work of asset management and asset-information management is not simply the work of managing an “asset ledger.” As described above, the management of asset information is connected to reducing costs and maintaining stability and safety, so asset management must encompass a full range of work including core work, decision-making, and knowledge acquisition, all based on asset information (**Figure 2**).

By storing asset information—the nucleus of asset managemen t—in a management system, we can draw associations from diverse types of information, from information related to the planning and design of construction work, which involves the planning of maintenance work, i.e., core maintenance, to information

Table 1
Transition in breakdown of electricity rates (average cost basis of business expenses per kWh of ten power companies).

(yen/kWh)

		1996	1998	2000	2006	2008
Breakdown	Fuel expenses	2.25	2.49	2.47	3.13	5.04
	Purchased power	2.15	2.15	2.21	2.11	2.28
	Labor expenses	2.08	2.00	2.08	1.77	1.56
	Repair expenses	2.56	2.39	2.23	1.84	1.73
	Depreciation	3.66	3.70	3.36	2.47	2.26
	Tax and public dues	1.61	1.56	1.41	1.26	1.17
	Other expenses	2.77	2.84	2.90	2.64	2.35
Total		17.08	17.14	16.66	15.21	16.38

(%)

Cost ratio of fuel expenses	26	27	28	34	45
Cost ratio of non-fuel expenses	74	73	72	66	55

*1 Total of figures in each column may not match total shown due to rounding.
*2 Figures for "cost ratio of fuel expenses" include "purchased power" in addition to "fuel expenses."
*3 "Purchased power" refers to expense of paying for electric power from independent power producers (IPPs) and other power companies.

Source: Agency for Natural Resources and Energy, "Comparison of Electricity Rates Among Various Countries"

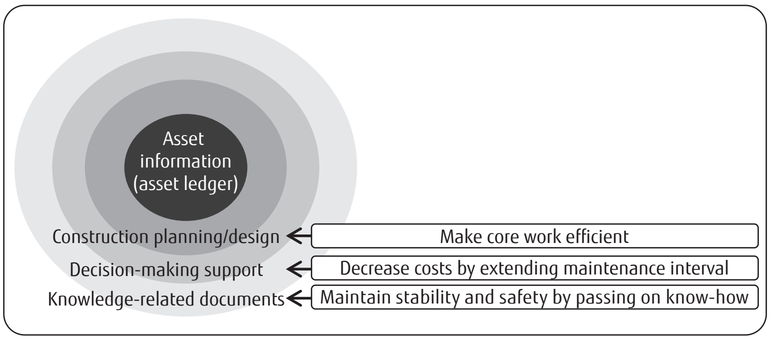


Figure 2
Range of asset management work.

about past results. This not only makes it easier to reference asset information at the time of planning but also enables work history and past procurement conditions similar to those of the target asset to be checked, which can help make planning more efficient and accurate. Furthermore, as a management system based on accumulated data in which "equipment = inspection target," checking on the procurement conditions of construction work makes it easy to isolate those targets for which cost-reduction measures must be taken.

Such checking may simply be a study on reducing costs in units of inspection targets, but it can also be a study on the need for construction work in units of inspection targets by switching from time-based maintenance (TBM), a maintenance technique in which repair work is performed at fixed intervals, to condition-based maintenance (CBM), a maintenance technique in which repair time is determined by diagnosing the condition of target equipment.

Why is it that equipment diagnoses and decisions on the need for equipment maintenance are facilitated by using asset information in an "equipment = inspection target" management system? The answer lies in the fact that the condition of an asset, such as the thickness of a pipe, recorded in an inspection (target = equipment) history and the cause and effect of an equipment-related accident recorded in a problem history are important pieces of information when diagnosing a piece of equipment and determining the need for maintenance work. Such information can be managed from an asset-centric viewpoint and used when applying accident prevention measures, thereby achieving stable and safe maintenance operations.

4. Fujitsu's solution

Fujitsu provides an asset management solution for thermal power plants based on the above considerations. This solution consists of an interval package function based on a data model that describes an "equipment = inspection target" management system and a systems engineering (SE) service for implementing that function. The following describes this solution in more detail.

4.1 Data model describing "equipment = inspection target" management system

Although the stated goal here is to achieve an "equipment = inspection target" management system, this is not simply a matter of grouping equipment targeted for inspection and managing information on that equipment. For example, in asset-maintenance work that involves medium- and long-term planning, budget drafting, placing of orders, and making of contracts, there is also a need for information that can be used to assess the suitability of such budgets and plans. At the same time, work related to accepting and completing inspections requires information on the condition of target equipment brought to light in an inspection in addition to historical information on work period, expenses, etc. Also needed is equipment-related information such as equipment manufacturer, year/month/date of manufacture, and equipment problems for use in identifying the cause of an accident.

The "equipment = inspection target" information depends on the type of work performed. Consequently, if equipment information is prepared and managed for each type of work, that information will become scattered about the system, making it difficult to coordinate information between different types of work even for the same asset (equipment). This situation can not only hinder efficient operations but also lead to inappropriate maintenance work. To prevent these problems from occurring, there is a need for a data model having a multifaceted structure that can facilitate the uniform management of "equipment = inspection target" information and for a multiphase data structure that satisfies user needs.

"Kaname Analysis" is useful in establishing a foundation for such a data model. This is a technique formalized by Fujitsu for system development work and inspired by the book "Success by Analyzing Things and Objects—Simple Method for Conceptualizing Work"[3) by Zentaro Nakamura, Professor Emeritus of Keio University. It can be used for a variety of scenarios, from upstream processes such as work analysis to system construction based on a service-oriented architecture (SOA).

Kaname Analysis clarifies the nature of each type of work associated with "equipment = inspection target" and also clarifies what "equipment = inspection target" information should be managed and at what level of detail while making associations between that information and the various types of associated work.

4.2 Interval package function

The interval package function operates a work system based on the above data model. The work system manages inspections and construction planning and results, which are the most important components of asset management work envisioned by Fujitsu.

In the interval package function, the inspection interval table lies at the center of work for managing inspections and construction planning and results, as shown in **Figure 3**. The function is configured so that "equipment = inspection target" information can be referenced, registered, and modified from that table.

The inspection interval table screen (**Figure 4**) enables the user to display ten years worth of work-item planning and subsequent results at the time of periodic inspections in terms of "equipment = inspection target" and of construction-work planning and subsequent results with respect to equipment. In addition, planning can be automatically updated when additions or changes are made to inspections or construction work.

The equipment details screen (**Figure 5**) can be used to refer to information on equipment targeted for inspection. When adjusting inspection plans, displaying required equipment information in a simple format enables the user to visualize the equipment in an intuitive manner.

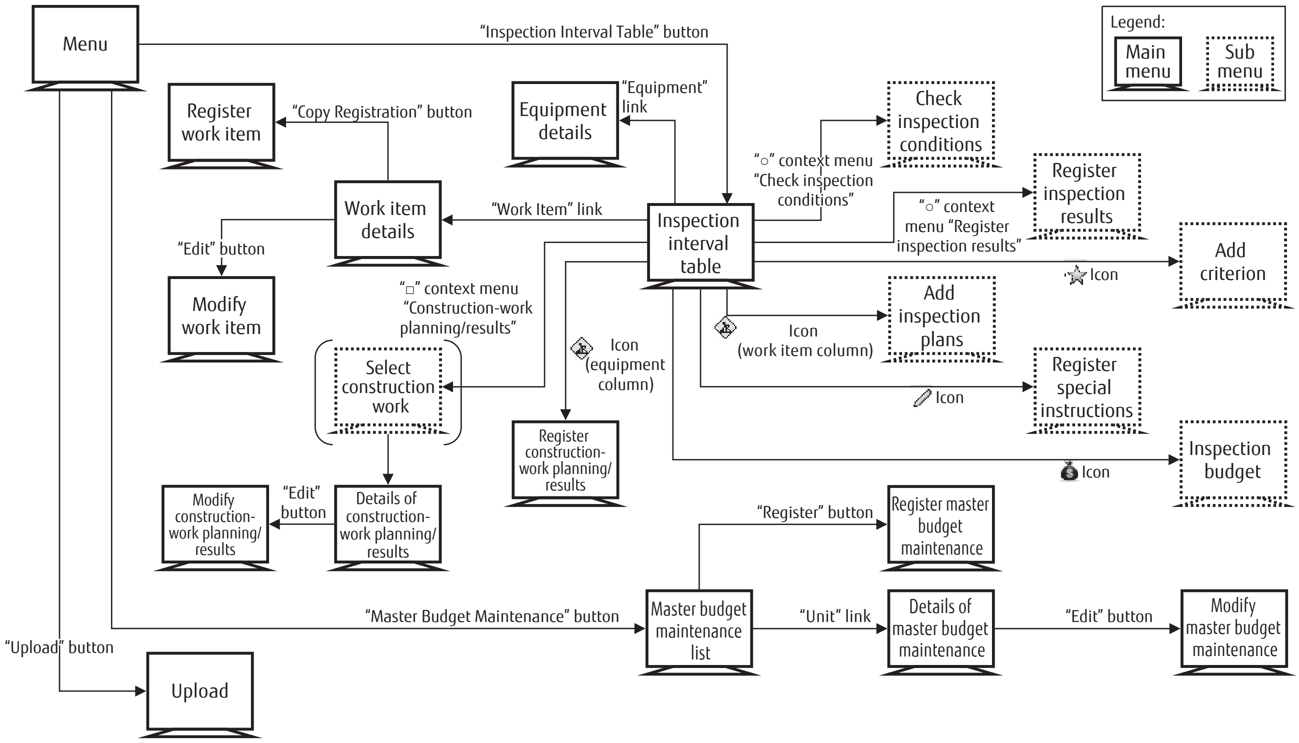


Figure 3
Overview of interval package function.

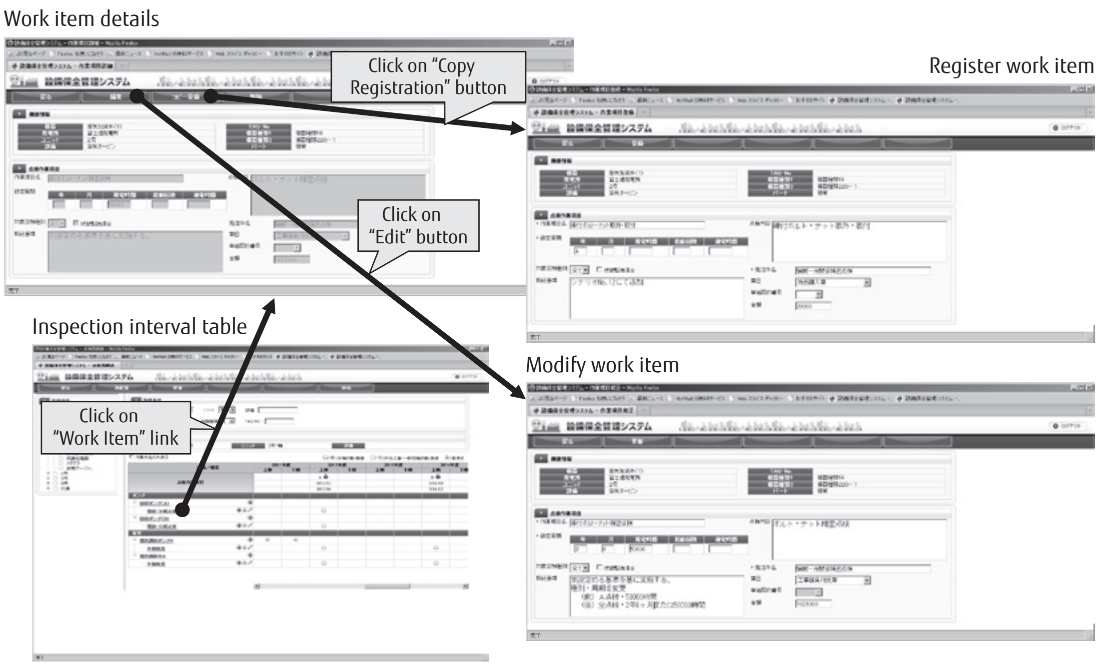


Figure 4
Inspection interval table screen (interval package function).

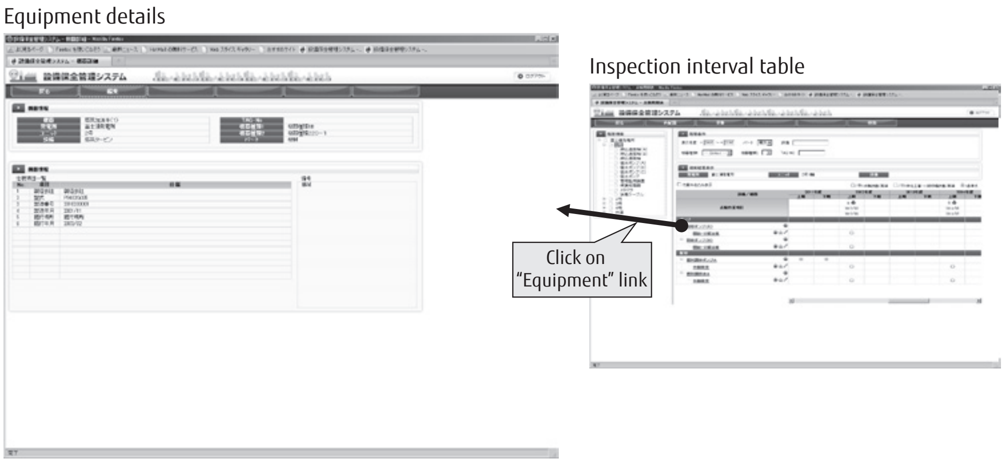


Figure 5
Equipment details screen (interval package function).

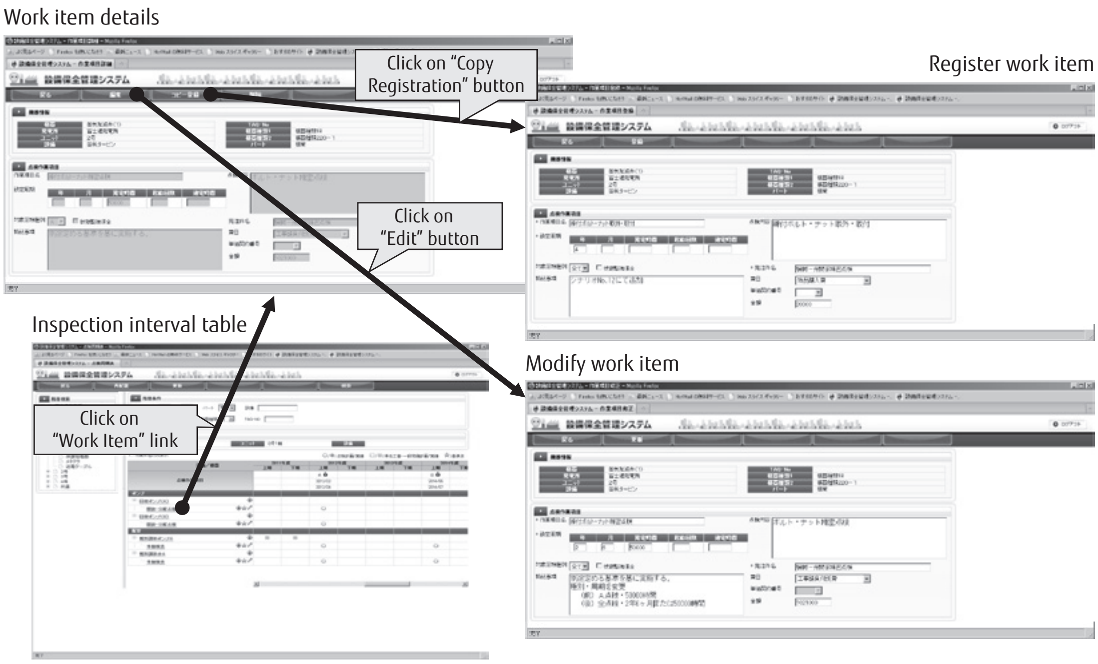


Figure 6
Work-item registration, detail, and modification screen (interval package function).

The work-item registration, detail, and modification screen (**Figure 6**) provides functions for referencing, registering, and modifying the contents of work that is carried out at the time of a periodic equipment inspection. Similarly, the construction-work registration, detail, and modification screen (**Figure 7**) enables the contents of equipment construction work to be referenced, registered, and modified. The contents of the work-item registration, detail, and modification screen or the construction-work registration, detail, and modification screen are instantly reflected on the inspection interval table.

The master-budget-maintenance-list registration, detail, and modification screen (**Figure 8**) enables uniform management of master budget data such as incidental work required for periodic inspections and

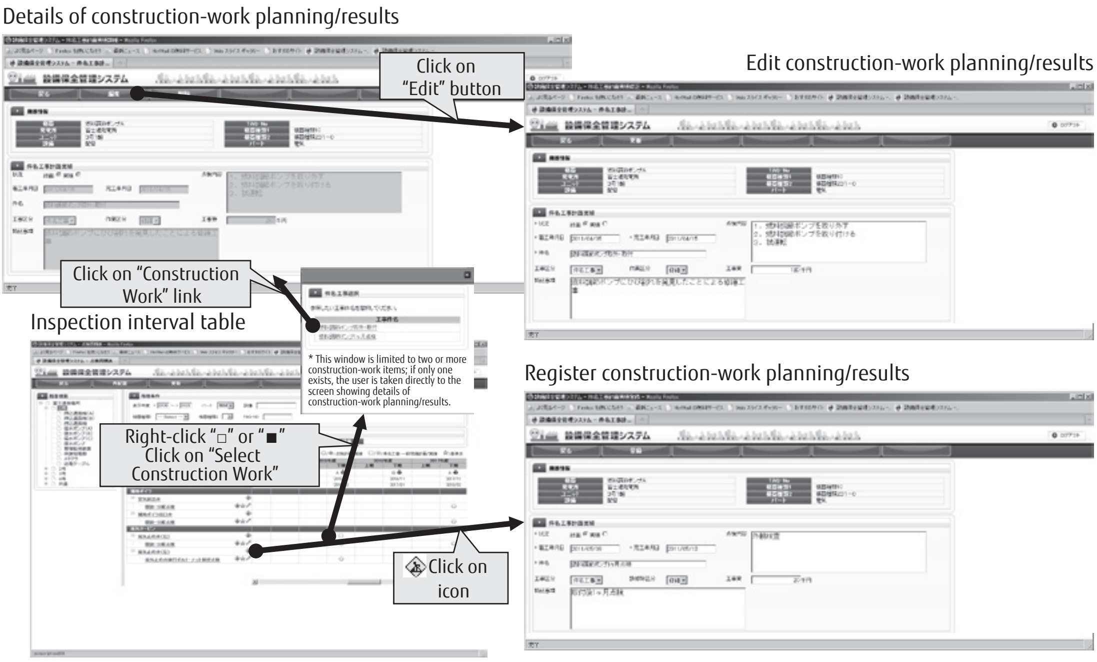


Figure 7
Construction-work registration, detail, and modification screen (interval package function).

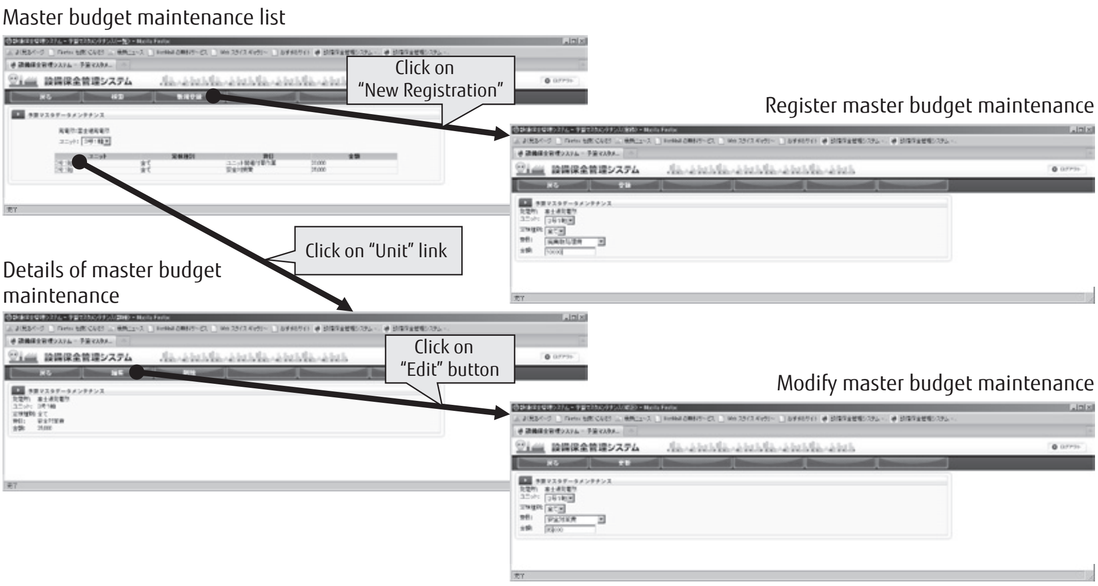


Figure 8
Master-budget-maintenance-list registration, detail, and modification screen (interval package function).

expenses associated with safety countermeasures. Combining the information shown on this screen with other information like construction expenses set for certain work items enables the budget for periodic inspections to be roughly estimated.

The interval package function can run in a stand-alone manner on a personal computer—there is no need to deploy a large-scale system. It does, however, need data to operate. We can therefore envision cases in which new data will have to be prepared. However,

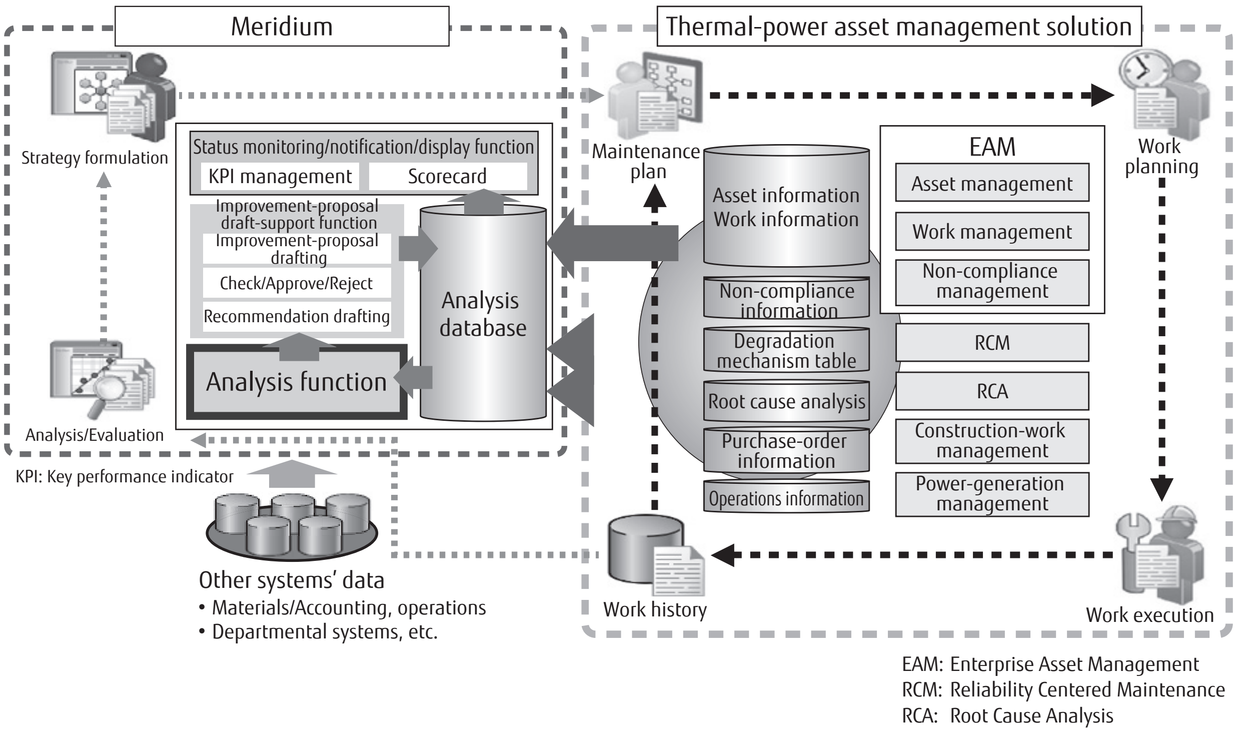


Figure 9
Meridium APM solution.

conventional asset management work does leave behind traces of the data needed. In most cases, all that is needed to implement the interval package function is to simply change the names assigned to various types of data or to substitute required data with other types of data in the existing system. Fujitsu provides these capabilities in the form of a data migration service.

The plant asset management solution for thermal power plants is aimed at mission critical work corresponding to conventional TBM. However, to support CBM and risk-based maintenance (RBM: a maintenance technique in which the repair-work cycle is determined by risk factors associated with the condition of equipment), Fujitsu provides its solution in combination with the Meridium APM solution from Meridium Inc. (**Figure 9**). This combined solution includes elements associated with management accounting and business strategy and helps uncover relationships between costs and asset conditions, supporting the transition from TBM to CBM and RBM. This combined solution is thus particularly effective for the power-generation component of the industry.

5. Conclusion

This paper described a data model and an interval package function based on that data model for configuring an asset management solution for thermal power plants for use in reducing repair expenses.

Electric power suppliers have long faced external factors such as jumps in the price of fossil fuels and fluctuation in the exchange rate that impeded their efforts to supply electric power inexpensively and stably. Nevertheless, they survived major ordeals including two oil crises and managed to eventually provide the Japanese people with an inexpensive and stable supply of electric power.

Changes in the power-generation environment brought on by the Great East Japan Earthquake have underscored the need to rethink the way that electric power is supplied in Japan and placed the country on the path to reforming its electric-power supply system. For electric power suppliers, this means that a new challenge must be met, but looking forward, there is no doubt that they will again provide an inexpensive and stable supply of electric power. Fujitsu is confident that its plant asset management solution can contribute to realizing this goal.

References

1) Agency for Natural Resources and Energy: Energy in Japan 2010.
http://www.enecho.meti.go.jp/topics/energy-in-japan/english2010.pdf

2) Agency for Natural Resources and Energy: Comparison of Electricity Rates in Various Countries (in Japanese).
http://www.enecho.meti.go.jp/denkihp/shiryo/110817kokusaihikakuyouin.pdf

3) Z. Nakamura: Success by Analyzing Things and Objects—Simple Method for Conceptualizing Work. Nikkan Kogyo Shimbun, 2003 (in Japanese).

Naoyuki Fujisawa
Fujitsu Ltd.
Mr. Fujisawa is engaged in system development in the electric-power and gas industries.

Yukio Yamamoto
Fujitsu Ltd.
Mr. Yamamoto is engaged in system development in the electric-power and gas industries.

Shuichi Matsuo
Fujitsu Ltd.
Mr. Matsuo is engaged in system development in the electric-power and gas industries.

Kazuki Nonaka
Fujitsu Ltd.
Mr. Nonaka is engaged in system development in the electric-power and gas industries and system development related to smart meters.