

Engineering and Construction Techniques for Waterworks and Sewerage Systems

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1. Introduction

Engineering can be defined as means and procedures for promoting system configuration and constructing a plant through the whole process of planning of the plant to its maintenance and management after the completion and depends largely on human intellectual work. Along with the greater sophistication and larger scale of plants, engineering work is rapidly increasing in complexity and scale. Special emphasis has been placed on engineering work because its quality greatly affects the quality and cost of the entire system.

On behalf of the company, a “site superintendent” is given authority and made responsible for onsite construction to complete a job to a purchaser’s satisfaction by the delivery date. It is important to establish construction techniques for this purpose.

In recent years, there have been urgent demands for public works in Japan to reduce cost and guarantee quality in response to the trends toward an improved bidding and contracting system and business globaliza-

tion. Furthermore, relaxation of various restrictions and computerization in the public sector are strongly demanded as part of administrative reform. Increased efficiency and labor savings are also required for public works.

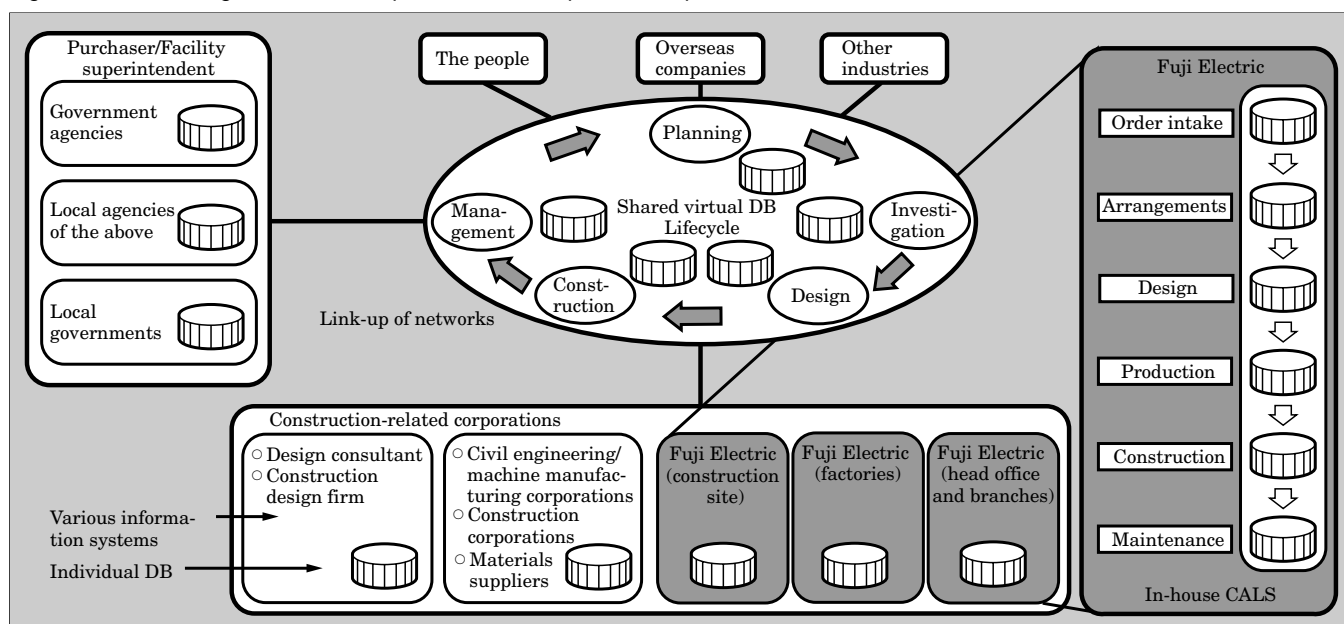
This paper introduces Fuji Electric’s handling of CALS (commerce at light speed), which is of increasing importance to engineering and construction techniques.

2. CALS

CALS was initiated by the Department of Defense (DOD) of the United States and is now performed worldwide led by private sectors.

Within private industry in Japan, CALS is actively performed under the guidance of the Ministry of International Trade and Industry (MITI). Within public works, “basic concepts for upgrading CALS/EC for construction works” have been drafted by the “Study Group for an Integrated Information System to Supporting Public Works” as promoted by the Ministry

Fig.1 Schematic diagram of CALS in public works and private companies



of Construction.

In the CALS/EC for construction works, all stages such as planning, design, cost estimate, bidding, contract, construction and maintenance are performed based on CALS for the purpose of lower total cost, greater efficiency and improved quality. An “action program” was prepared in 1997 and specific field tests are being implemented.

Figure 1 shows a schematic diagram of CALS implementation within public works and within a private company.

3. Fuji Electric's Handling of CALS

Fuji Electric has been participating in committees of the Inter-company Electronic Commerce Promoting

Fig.2 Key system for arrangements of plant components: ACTION

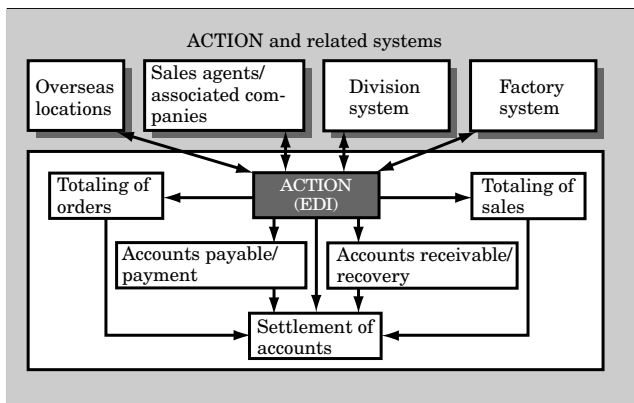
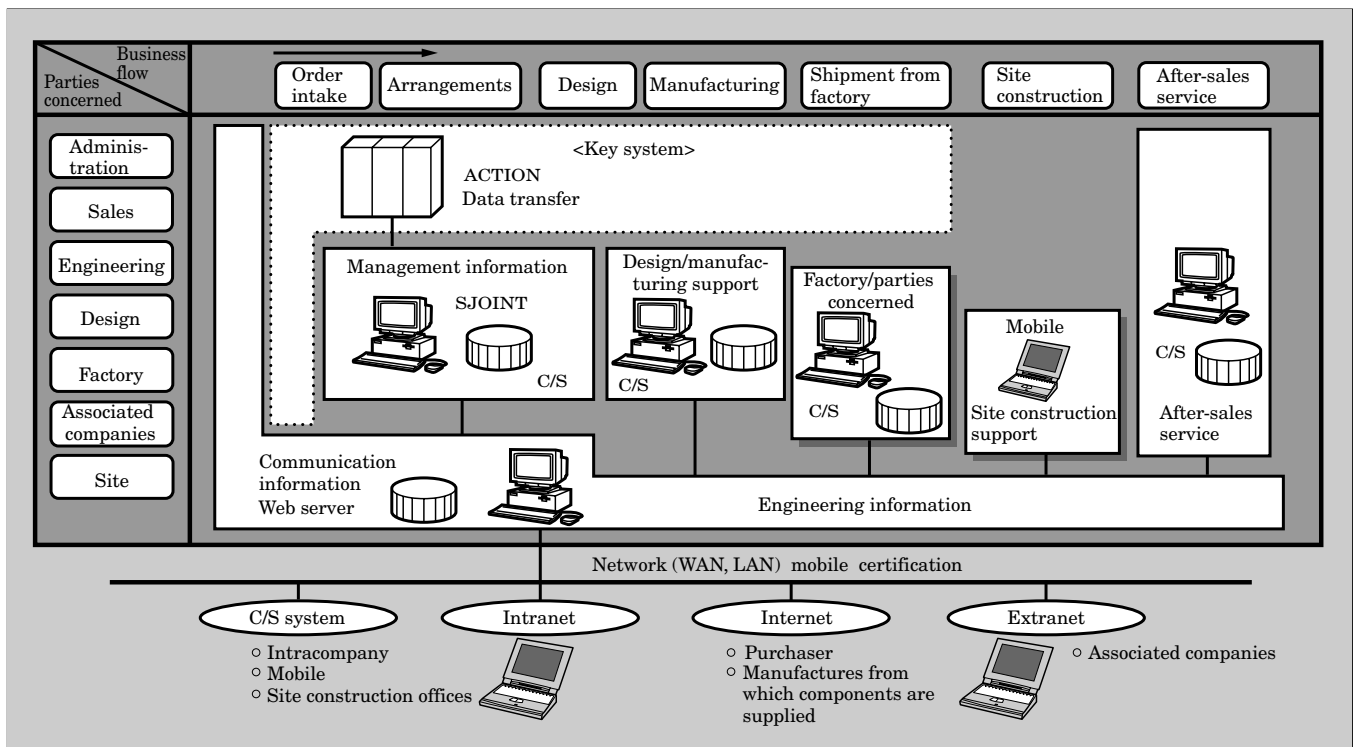


Fig.3 Integrated information system in public systems division



Organization and CALS Promoting Organization, promoted by MITI for the investigation, research, popularization, and education about CALS.

While implementing CALS, Fuji Electric and its associated companies are promoting business renovation of the whole Fuji Group by encouraging an upgrade of the information infrastructure, such as expanding networks and restructuring all key systems, aiming at data digitization, information sharing and paperless business.

3.1 Key system for plant-component arrangements

In corporate management, to restructure all business processes of a group of companies into a whole, cooperation is becoming increasingly important between departments concerned with sales, design, manufacturing, physical distribution and onsite construction.

In the restructuring of key system for plant-component arrangements, the primary objective is to share information within the group and build an integrated system to support order receipt, arrangements, sales and schedule control for the purpose of improving the function (F), quality (Q), cost (C), delivery (D), safety (S), and efficiency in overhead departments. Information sharing can be achieved by linking key system with systems of various departments in the company and its associated companies. (refer to Fig. 2)

3.2 Integrated information system in public systems division

In public systems division, purchasers are the

Fig.4 Example of intranet homepage



ministries, their agencies and local governments throughout Japan. Since many sales locations and sites are scattered throughout the country, business liaison through networks is very important.

Due to company-wide computerization, internal and external company telecommunication infrastructures such as intra-company networks and ISDN were dramatically improved, and information processing technologies such as the internet and mobile communication have made great advancement. This allows the integration of conventional business support systems and the construction of an integrated information system (Fig.3) that covers all relevant departments, site construction offices and associated companies, contributing to improved engineering work.

In public systems division, an intranet and an extranet were constructed as corporate CALS systems and put into operation. The former handles information ranging from order intake and site construction to maintenance throughout product lifecycles (information about communication, management and engineering). The latter handles information transfers and business liaisons with associated companies.

The sharing of information through the intranet is described below.

(1) Sharing of communication information

Communication among participant members is very important for unifying members' desires in the same direction and attaining an objective. A networked system and digitization eliminates location and time restrictions.

E-mail, a bulletin board system, an electronic conference room and schedule management are configured on the intranet as part of the shared communication information.

(2) Sharing of management information

Within the public systems division, an information system (SJOINT) was formed in 1993 that has been utilized for the division's business. It is consistent

information, from order intake through site construction for individual projects, in order to increase the efficiency of paperwork and share the information with other concerned parties.

ACTION system is only used to enter the data of arrangements information, avoiding duplicate entries. Not only the division's data but data from factories are automatically transferred from ACTION to SJOINT, where updated data is always available.

(3) Sharing of engineering information

In the manufacture, construction and maintenance of a plant system, not only is communication and management information necessary, but engineering information such as communication notes, specifications and drawings is also essential.

The aforementioned information is processed and altered, new information is created over the course of plant processes from order intake through site construction, and an enormous amount of data is transferred from upstream to downstream divisions. Great care must be taken so that no errors occur during processing and alteration.

For these reasons, the company constructed a system using CASE (computer aided system & software engineering) and has been improving the productivity and quality of delivered systems.

The above activities are, however, information sharing between limited sections, and still much effort must be expended to exchange engineering information between organizational groups.

Information used while conducting a plant's business includes a variety of documents, drawings, photographs, videos, spreadsheets and databases. There are many technical challenges to the distribution of digitized information of the above, and to the digitization, distribution and exchange of past information assets, for which high expectations are placed upon the realization of EDI (electric data interchange) to standardize information exchange.

Figure 4 shows the top page of an intranet.

3.3 Project homepage

In this intranet system, all the members concerned with the project share information from order intake to shipment and maintenance. Information is managed for each project to increase the information transfer speed, to attain instantaneous information and to promote each project smoothly.

Shared information about each project can be entered in the form of a homepage (Fig. 5) and all the information about that project can be obtained on the homepage.

Communication information and information created by the support and management systems to be described later can be shared by making the information public as FQCDS information.

However, specifications and working drawings, which are the result of engineering, have not yet been

Regarding the distribution of drawings, since CAD tools are not standardized there are many challenges to be overcome for the exchange of such information, including data exchange.

In addition, management and database information entered through a C/S (client/server) system is available and can be viewed with a Web browser by connecting a Web server and database. This contributes to improved management of various divisions based upon correct and wide-ranging information.

There are many types of content and information media to be shared in engineering tasks. It is required to develop CALS constituent technologies such technology to digitize content and information, workflow techniques (seal of approval, confirmation), technology to control altered information and security technologies.

Design, manufacturing and testing have been mechanized and automated.

Fuji Electric constructed and has been utilizing an engineering environment which can provide integrated support not only to a monitoring and control system for water treatment FAINS but also to control systems for

The diagram illustrates the proposed document control system. The process flow is as follows:

- Purchaser** (represented by a person icon) provides **Control specifications** (represented by a document icon) to the **Editor** (represented by a person icon).
- The **Editor** uses the **Documentor** (represented by a computer icon) to create the **Monitor** (represented by a computer icon).
- The **Monitor** sends a **Program** (represented by a document icon) to the **Controller** (represented by a circuit board icon).

A dashed box on the left contains detailed flowcharts and a table, representing the system's components:

- Switch flow**: A hierarchical flowchart showing the sequence of operations.
- Logic flow**: A flowchart showing the logical sequence of operations.
- Data flow**: A flowchart showing the flow of data between components.
- Control flow**: A flowchart showing the control sequence of operations.
- Logical table**: A table with 8 rows and 2 columns, listing instructions and their corresponding control signals.

The **Conventional process** (represented by a box with a large 'X' over it) is shown for comparison. It contains a document with a table:

1.	INSTR
2.	INSTR
3.	INSTR
4.	INSTR
5.	INSTR
6.	INSTR
7.	INSTR
8.	INSTR

The proposed system offers the following advantages:

1. Productivity improvement
2. Quality improvement
3. Match between documents and specifications

The support system aims at improving quality and productivity of engineering tasks by automatically generating downstream information from upstream information. Basic concepts for system design, software design and test scheduling to achieve this goal are listed below.

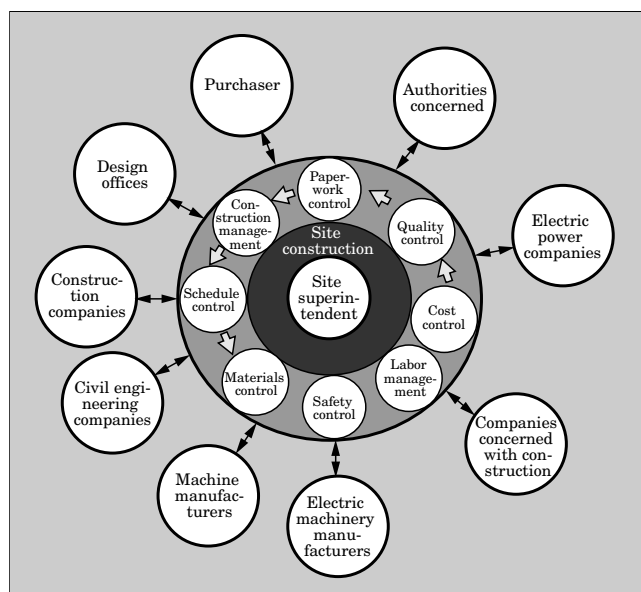
- These concepts create an environment for a common platform that can be used uniformly with various packages. Generated information is publicly displayed on a project homepage, conveyed to other divisions, and utilized for copying and processing by downstream divisions.

3.5 Site construction support system

Site superintendents must always exercise leadership in solving problems, give accurate instructions and orders to subordinates and workers, and must also complete the construction smoothly by effectively communicating with purchasers, design engineers, construction companies and machine manufacturers

In response to this situation, along with the

Fig.7 Management tasks for site construction



construction of a mobile network environment, Fuji Electric has constructed and started operation of an environment where company divisions and remote sites can exchange information interactively. Site support systems are intended to improve quality and reduce costs of construction management, allowing site superintendents to perform efficient jobs and all parties concerned to convey information at higher speed.

Collection of site construction information for each project on the project homepage allows company divisions and remote sites to share information, and makes it easy to post and to reuse various drawings and materials onsite.

In addition, laws and regulations related to site construction, internal regulations for safety and sanitation, and job manuals are posted on the homepage so that they may be thoroughly understood by site superintendents scattered across the country. The support system reduces jobs in administrative departments that handle the distribution of documents and notification of their alterations. The time required for information conveyance can be considerably reduced by

Fig.8 Example of homepage for weekly schedule and performance

the system compared with mail or home delivery in the form of paper.

Figure 8 shows an example homepage for a weekly schedule and performance.

4. Conclusion

This paper has presented Fuji Electric's approach to engineering and construction techniques for waterworks and sewerage systems, focussing mainly on Fuji's support system from the viewpoint of information sharing.

Browsing, processing, conversion and generation of digitized information are performed throughout the lifecycles of products and facilities according to the CALS concept, "data is only once created and used as many times as possible." Introduced as an example in this paper is the CALS implementation from order intake to delivery and maintenance of waterworks and sewerage systems products in a group of companies.

Application of ISO9000S (quality ISO) and ISO14000 (environment ISO) to public works are under study. Fuji Electric is pushing hard to obtain more ISO certifications. CALS is an efficient means of handling the thorough documentation (procedures, evidences) required for obtaining ISO certification.

Fuji Electric's CALS has just begun. Fuji Electric will continue to promote and spread CALS applications within companies, capitalizing on experiences and techniques accumulated in CALS activities.



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