

# INFORMATION UNIFICATION BETWEEN ENTERPRISE RESOURCE PLANNING SYSTEM AND PRODUCTION CONTROL SYSTEM

SEKI Yutaka \*1

---

*We have developed a communication software package, LinkforSap, that enables direct connection between the SAP R/3 enterprise resource planning (ERP) system and the CENTUM production control system. We also offer software packages for the manufacturing execution system (MES) that close the information gap between the ERP system and production control system and also serve as a real-time business model of the manufacturing enterprise. LinkforSap is a key component of these MES software packages. This paper describes the features of and introduces the functions of LinkforSap.*

---

## INTRODUCTION

The business world surrounding the manufacturing industry is undergoing rapid and drastic changes. Achieving production activities that can respond swiftly to such environmental changes has become an urgent task. This trend has focused attention on the integration of information between the ERP system and production control system. Information integration has become an important issue for applying the enterprise business model to real-time management. Now, customers can benefit from Yokogawa's Manufacturing Execution System (MES). MES links up the ERP system and production control system in order to realize the information integration. The following is an overview of a software package developed by Yokogawa as a key component for MES and its role as a direct, hot communication link between the two systems.

## BACKGROUND OF DEVELOPMENT

### Problems in System Architecture in Production Field

Due to structural changes in the industry, the automation and

labor-saving systems in the production site of the process industry are now highly advanced. While business systems at management headquarters have indeed expanded to cover production management, i.e., so called logistics, the ERP system at management headquarters and the production control system in the plant site have advanced separately and become quite different, from the viewpoint of an overall enterprise system hierarchy. Not only this, but since each division is responsible for adopting its own system, no consideration has been given to the exchange of information between systems. The lack of compatibility between the systems means that there is an information "gap domain," as is shown in Figure 1.

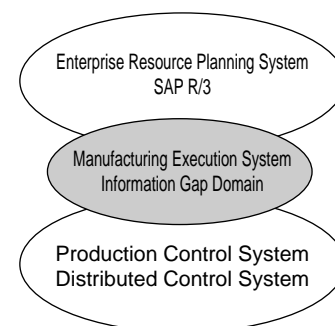
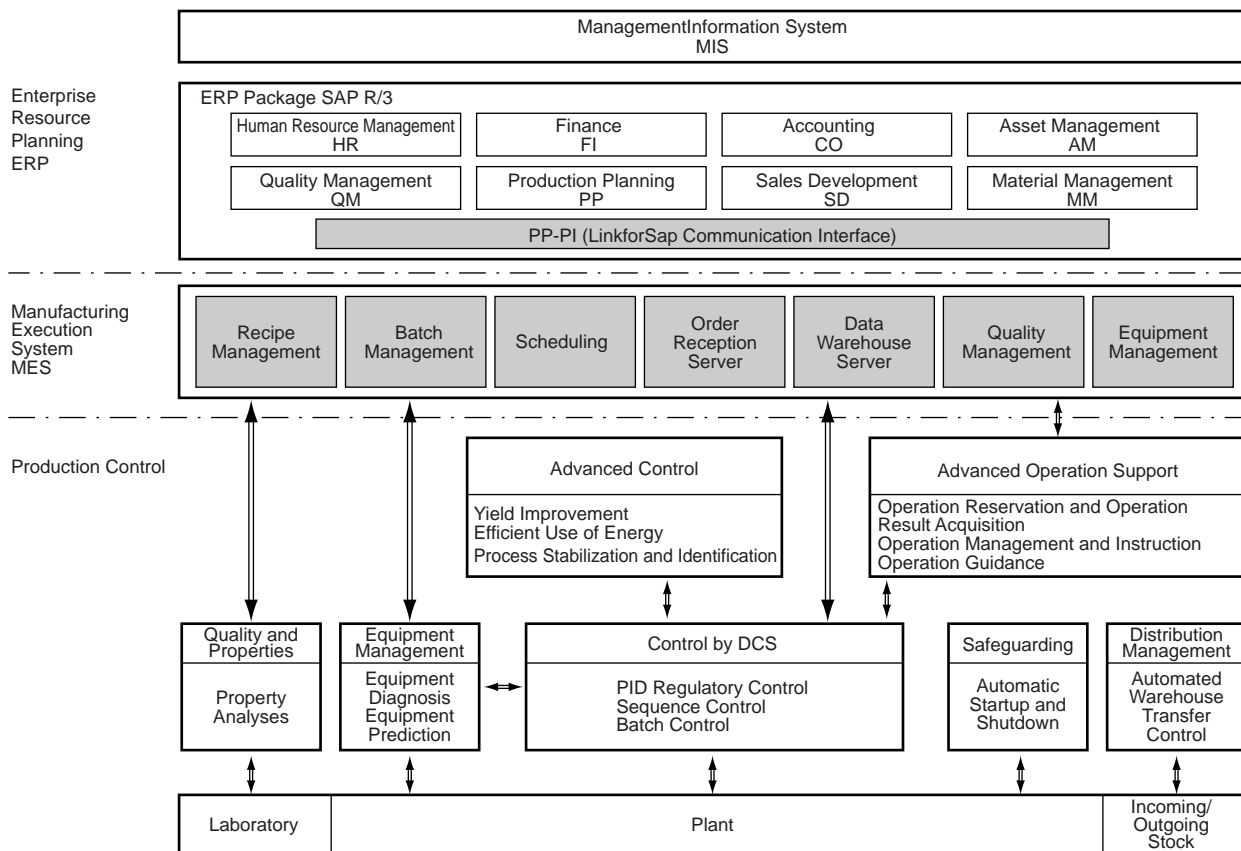


Figure 1 Presence of Gap in Information

---

\*1 PIM Center, Industrial Automation Systems Business Div.



**Figure 2** Solution for Process Industry

### Information Integration by Manufacturing Execution System

As the solution for this problem, namely, the solution for closing the gap between the systems, Yokogawa offers to eliminate the differences in information and the suspended information flow between the enterprise resource planning system and production control system. This will be achieved using the MES function shown in Figure 2 and by flexibly connecting these functions to each other.

### AP R/3 Enterprise Resource Planning System Package

Recognizing that a package achieving on-line communication between the ERP system and production control system was required and would therefore become the key component of the MES packages, Yokogawa decided to develop the package as a product.

Yokogawa focused on the SAP R/3 from SAP AG, Germany as the ERP system, since it is one of the best selling ERP packages in the world and is presently used in major industries all over the world. SAP R/3 has Production Planning for Process Industries (PP-PI) which covers continuous and batch processes in the manufacturing industry. Yokogawa's CENTUM distributed control system, the production control system, also boasts a huge number of users worldwide in the field of process control. Thus, we have developed and released LinkforSap, a software package directly connecting a CENTUM production control system and the PP-PI of SAP R/3.

### FEATURES

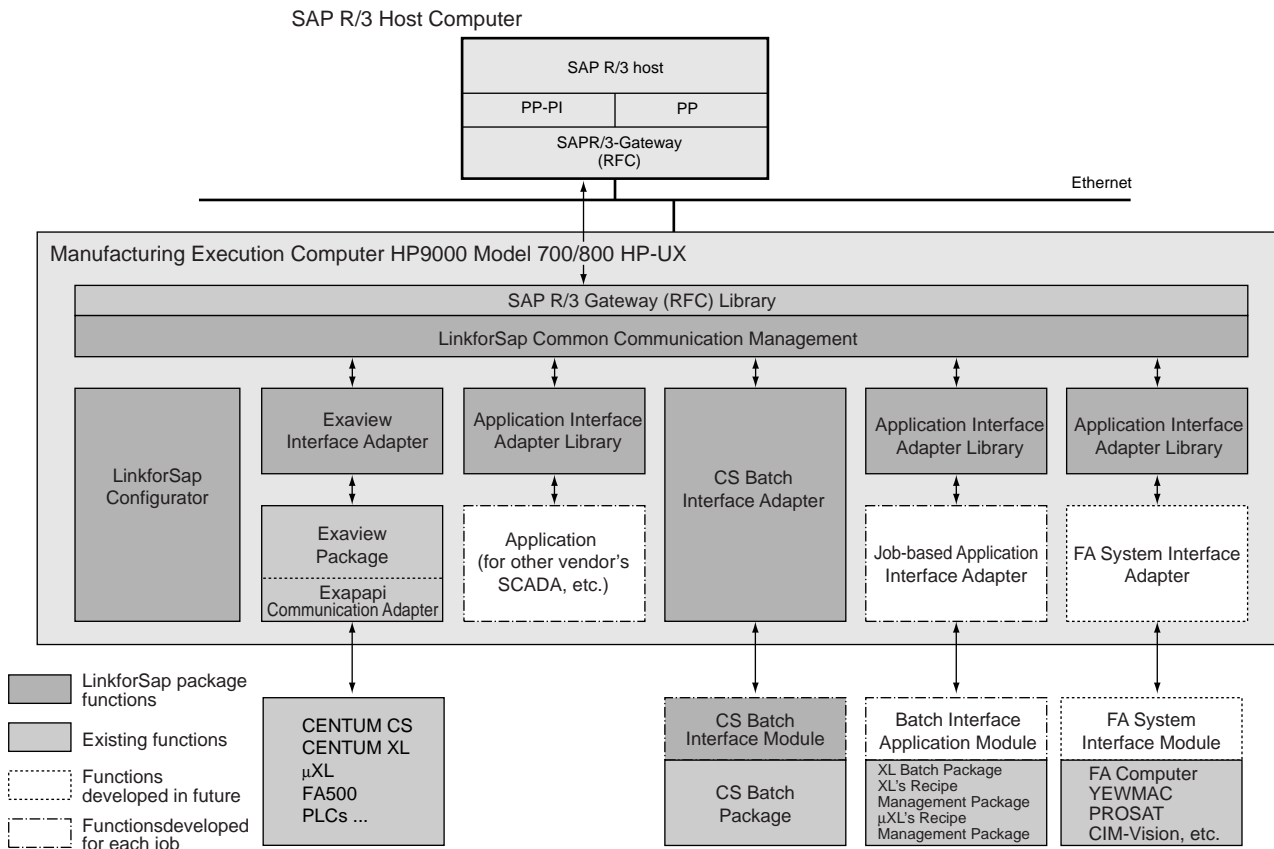
The first version of LinkforSap was designed to develop functions that will cover continuous and batch processes since they are the most common in the process industry. Therefore, data that can be accessed in the control system are set as the data in Yokogawa's Exaview process data acquisition package for continuous processes and the data in Yokogawa's CS Batch integrated batch management package which complies with ISA SP88 batch process control standards. Despite this current specification, LinkforSap has a modular structure so that communication functions for other control systems (especially for discrete process control systems) or customized functions for particular job requirements can be added easily.

The standard functions mean that a user program is unnecessary, as simply setting up the parameters using the object-oriented configurator tool will realize the communication data transfer. For the communication protocols, open protocols such as the remote function call (RFC) and file transfer protocol (FTP) are used, assuring the high system-compatibility and reliability.

### SYSTEM CONFIGURATION

#### Hardware Platform

The LinkforSap communication package is designed to run on the same hardware with Yokogawa's MES packages. In order to run both packages at the same time with the closely related



**Figure 3** LinkforSap Software Configuration

packages such as the Exaview plant data acquisition package and the CS Batch batch management package, an HP9000 is selected as the hardware platform.

### Software System Configuration

Figure 3 shows the software configuration of LinkforSap. For communication with the PP-PI of SAP R/3, the remote function call (RFC) and transactional RFC (tRFC) based on the TCP/IP are used according to the proposal by SAP AG. These RFC and tRFC protocols have functions enhanced from those of conventional RFC, and feature the communication re-connection function and measures against transient errors which both lead to high reliability.

The dynamic data exchange (DDE) server function on the side that communicates with the control system, is supported by the Exaview process data acquisition package as an open data access interface for a client PC and is used for communicating with Exaview. A file transfer protocol that is supported by the CS Batch package with the same standard features as the protocol, is used for communicating with a supervisory computer.

LinkforSap is composed of three kinds of modules:

- LinkforSap common communication management module which controls the communication with the SAP R/3;
- Interface adapter modules which perform connections with respective control systems; and
- Configurator module which defines the parameter setups for the LinkforSap package.

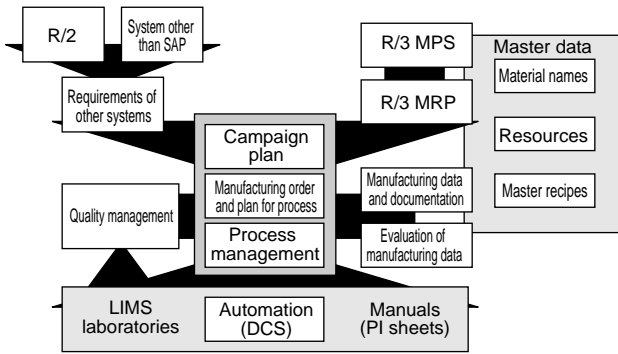
The first version of LinkforSap has two interface adapter modules: the Exaview interface adapter for connection with the Exaview, and the CS Batch interface adapter for connection with the CS Batch package. This modular structure of LinkforSap allows interface adapters to be added according to possible requirements in the future to connect various other control systems. Besides, considering additional interface adapters and special requirements that cannot be met by the standard package functions, the application interface adapter libraries are supplied to facilitate the development of additional adapters.

### FUNCTIONS

The functions of the SAP R/3's PP-PI module are introduced briefly and then the functions of LinkforSap are outlined.

#### Functions of SAP R/3's PP-PI

Figure 4 illustrates the functional overview of the SAP R/3's PP-PI module. The PP-PI module calculates the required quantities of individual products based on the sales and order records using the manufacturing requirement planning (MRP) module. Based on the promotional campaigns of the manufactured products and the information on resources such as the processes and personnel, the calculated manufacturing requirement quantities are broken down into a detailed production schedule by product batches, and manufacturing orders are generated accordingly. The PP-PI module issues



**Figure 4** Functional Overview of SAP R/3's PP-PI

manufacturing orders to the production control system as the manufacturing schedule data. The production control system that controls the manufacturing processes returns the manufacturing results data to the PP-PI module, which assesses and manages production data in reference to the production plan.

### Functions of LinkforSap

As mentioned previously, the functions of LinkforSap are composed of the LinkforSap common communication management functions, CS Batch interface adapter functions, Exaview interface adapter functions, LinkforSap configurator functions, and so on. For data transmissions with the SAP R/3's PP-PI, data structures called categories which are designed according to the object-oriented technology, are defined as the communication protocols. Each communication application selects a category pattern (transfer tray). The communication method is thus standardized.

### LinkforSap Common Communication Management Module

The main function of this module is to connect the RFC of the

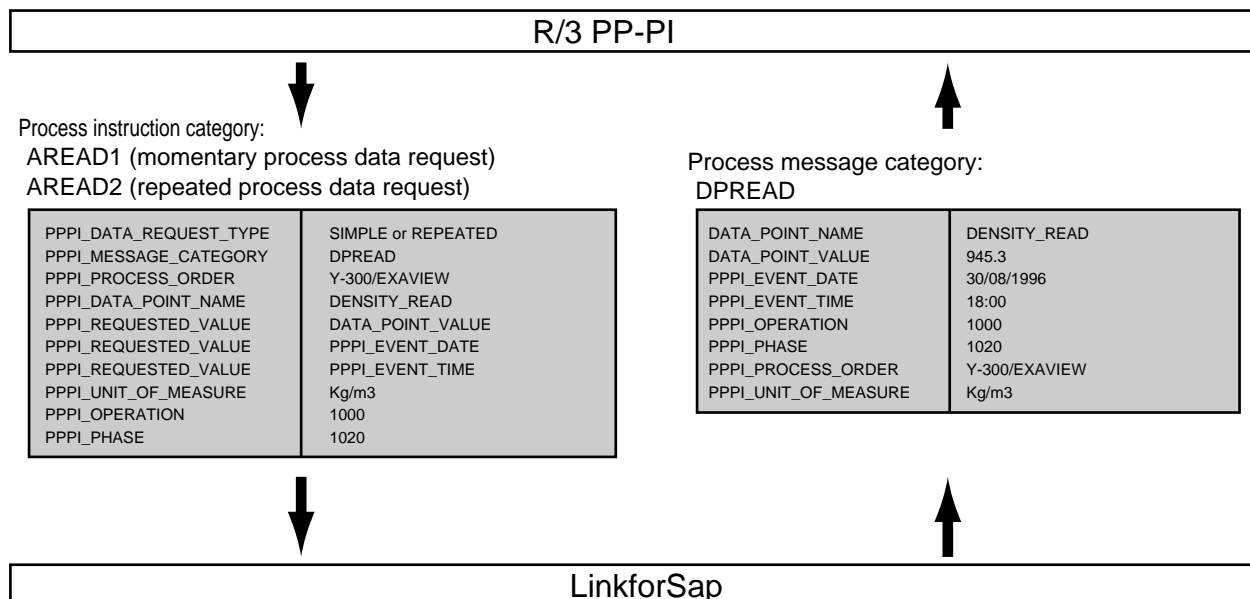
SAP R/3's PP-PI module, that is, to perform as the communication common adapter. This common module distributes communication data to each interface adapter module and controls both the communication flow and communication line. Up to 16 SAP R/3 systems can be connected when multiple SAP R/3s are used, and up to 32 different interface adapter destinations can be assigned.

### Exaview Interface Adapter

The Exaview interface adapter is designed to connect multiple Exaview systems to the SAP R/3. Namely, a single Exaview interface adapter can connect the distributed Exaview databases using the Exaview remote data access adapter option. By connecting the Exaview, acquisition data such as manufacturing results and stock quantities, and the trend data of specified points can be uploaded. Exaview acquisition data can be uploaded by specifying parameters such as the tag name (measured point name) of the data, the data type (snapshot data, average, integrated value, etc.), and the data acquisition and data saving schedule (snapshot, hourly, shiftly, etc.). Figure 5 shows the flow of data when uploading from the Exaview interface adapter. Periodic data transmission requests can also be set up. In addition, event messages such as process messages and operation messages can be uploaded.

### CS Batch Interface Adapter

This interface adapter module is used to download production schedule data to and upload manufacturing result data from the CS Batch management package. Like the Exaview interface adapter, this single adapter can also connect multiple CS Batch systems—up to eight. The process instructions from the SAP R/3 and the recipe data in the CS Batch package (complying with ISA SP88) differ in structure and expression. Hence, the adapter needs to perform data conversion and match these two. This



**Figure 5** Data Flow at Exaview Interface Adapter

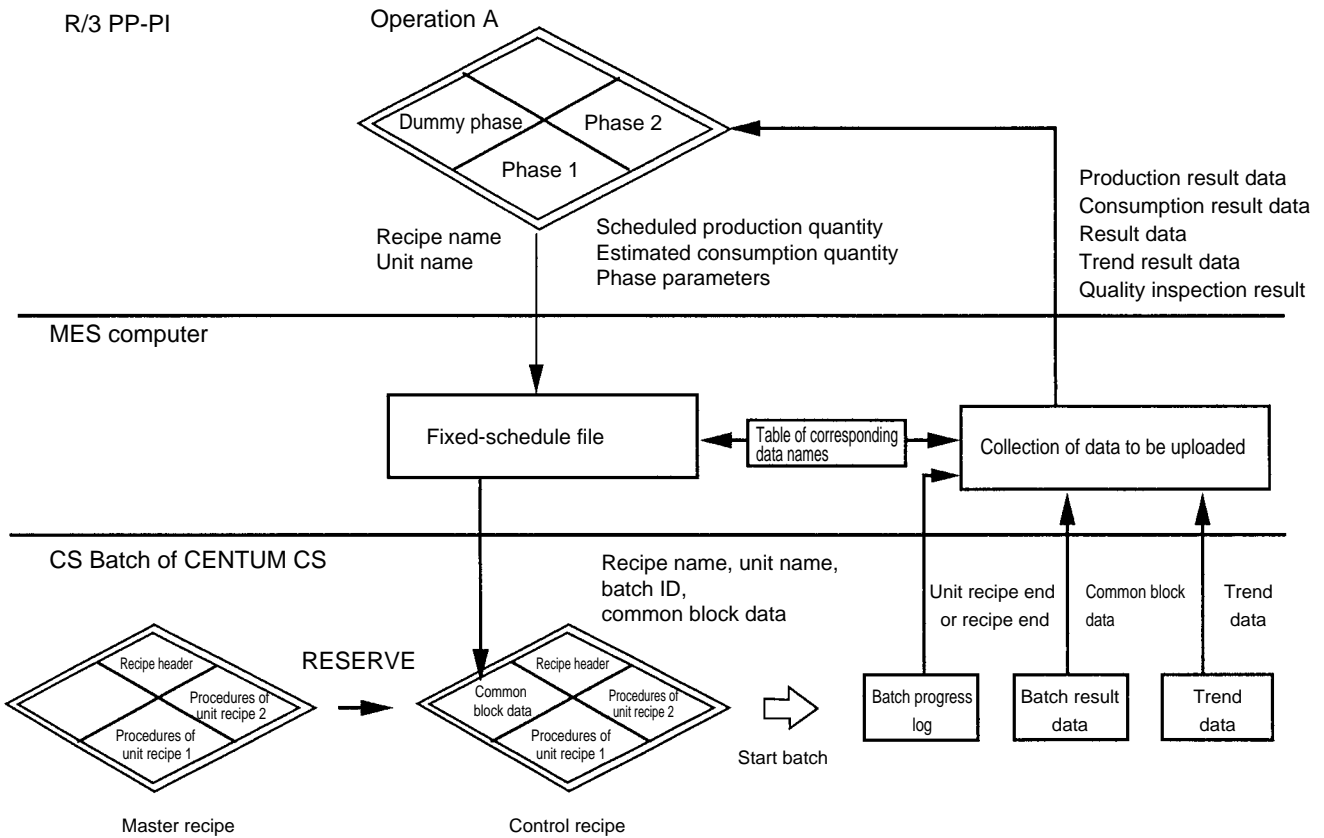


Figure 6 Data Flow at CS Batch Interface Adapter

involves making the phases in the hierarchical data structure of the SAP R/3's process instructions correspond with the unit recipes in the hierarchical data structure of the CS Batch package recipes.

In the PP-PI, all data are handled in units of blocks within data structures called phases. The data mapping function of LinkforSap can make the unit recipe data in the CS Batch package and the data in phases of the SAP R/3 correspond. The data for each recipe can be exchanged through a virtual dummy phase prepared inside the SAP R/3.

(1) Download of control recipe

A control recipe sent from the R/3 PP-PI to the CS batch interface adapter may consist of control recipe parameters, a result data request, a status message request, and so on. Control parameters are sent using the process instruction called "process parameter" in a control recipe, while a result data request and a status message request are sent using the process instruction called "process data request" or "message reservation" in a control recipe.

a. Control recipe parameters

Process parameters in a control recipe are converted to a fixed-schedule file and sent to the CS Batch package via the CS Batch scheduler interface for the supervisory computer. This file contains two kinds of data: the schedule data including the recipe name, unit name, and scheduled starting

time, and the setup data which includes the scheduled production quantity, estimated consumption, and phase parameters. Figure 6 shows the flow of data.

b. Control parameter request

A control parameter request sent from the R/3 PP-PI before the start of production specifies what kind of data the CS Batch package should upload as the result data. The process instructions made by the PP-PI include a result data request, trend data request, production result data reservation, consumption result data reservation, and quality inspection result request. When a unit recipe corresponding to a phase has been produced in the CS Batch, uploading of the specified data starts.

c. Status message request

When the status of the recipe changes, the control recipe status, operation status, phase status, and other statuses are uploaded to the R/3 PP-PI.

(2) Uploading of result and status data

The specified data are fetched from a file in the supervisory computer interface of the CS Batch's information management system and uploaded to the R/3 PP-PI as a process message. Such data include the batch result data, batch trend data, and statuses of the control and unit recipes. Uploading is performed when the production of the control



**Figure 7** A Configurator Window for Exaview Interface Adapter

recipe or unit recipe which is defined by its correspondence with the operation or phase in the control recipe, is complete in the CS Batch package.

**a. Batch result data**

Among the recipe data collected when a control recipe or unit recipe is produced, the result data, quality inspection data, production result data, consumption result data, etc. are uploaded to the R/3 PP-PI.

**b. Batch trend data**

The trend data of the specified data items collected by the CS Batch package are uploaded at once.

**c. Statuses of control and unit recipes**

The control recipe status and unit recipe status are converted to the operation status and phase status of the PP-PI formatted, and then uploaded to the R/3 PP-PI.

**Configurator Module**

Complete configurators are included so that the user can build up the LinkforSap functions without having to develop a new program. The functions provided with the configurator windows include setting up, starting and stopping communication; and configuring the Exaview's process data transmission and the CS Batch data transmission. Figures 7 and 8 show the configurator windows for transmission of the Exaview interface adapter and CS Batch interface adapter.

**High Reliability**

Reliability is considered crucial in the design of the function so that the system is durable for continuous operations over the long term. Process result data must never be lost even when the system is shutdown for a long time during upgrading of the SAP R/3 system for example. LinkforSap can retain the backup result data for up to 30 days. The user can issue the start, stop, and other instructions to each interface adapter address via a configurator window. LinkforSap is designed to allow continuous operations



**Figure 8** A Configurator Window for CS Batch Interface Adapter

to be carried out without losing any data during a short-term shutdown such as an instantaneous power failure. Historical data such as the error log and system log can be saved to a file to allow analyses of transient error, thus assuring high maintainability. In addition, LinkforSap can support the redundant batch database structure of the CS Batch package.

**FUTURE IMPROVEMENTS**

One of the main features of the current version of LinkforSap is that it supports connection to a Yokogawa DCS. We will expand the connections as necessary to cover factory automation systems (i.e., discrete control systems) and various production support systems such as schedule management, quality management, and facility management. This will enable us to pursue true information unification.

**REFERENCES**

- (1) Miura, S. and Adachi, K. "Open and Flexible Process Data Acquisition Package Exaview." Keiso(Instrumentation and Control Engineering) in Japanese, vol. 39, no. 9, pp. 47-52, 1996
- (2) Shimada, C., et. al. "'CS Batch Recipe Management, Process Management Package' for CENTUM CS." Yokogawa Technical Report, no. 21, pp. 13-17, 1996

**Trademarks**

- Microsoft, Windows, and DDE, are trademarks or registered trademarks of Microsoft Corporation, USA.
- SAP and SAP/R3 are registered trademarks of SAP Akiengesellschaft, Germany.
- LinkforSap is a registered trademark of Yokogawa Electric Corporation and a product approved as a complimentary software product (CSP) by of SAP Akiengesellschaft, Germany.
- CENTUM, CS Batch, and Exaview are registered trademarks of Yokogawa Electric Corporation.