UDC 621 . 746 . 27 : 681. 3

Application of Open System Technology to the Continuous Casting Plant

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Abstract

In the renewal of old process computer system of the continuous casting plant, Nippon Steel Corporation has attained cost reduction by the introduction of general-purpose PC server and OS, and middleware (NS SEMI SYSTEM) originally developed in the activity of open system solution. Also the adopting general purpose RDB to the continuous casting plant has been realized in the first time. The reduction of cost and period in AP software development has been achieved by the program code generator tool originally developed.

1. Introduction

At the Hikari Works of NSSC, an upgrading of the old process computer system (hereinafter referred to as PC) for slab and bloom continuous casting (hereinafter referred to as VCC) that has been employed for the past 21 years since operations began was completed during a periodic revision period in August, 2001. The upgrading of the older VCC PC system was an attempt to reduce costs through the introduction of general-purpose PC servers, and OS (Windows 2000 Servers*(1)) and new Nippon Steel middle-ware (NS SEMI SYSTEM*(2)). Furthermore, this was the first attempt to adopt a general purpose RDB (SQL Server 2000*(1)) to a continuous casting plant.

The reduction of costs and shortening of system development periods in AP software development were achieved through new and originally developed program code generator tools. This paper introduces the general concepts involved in the upgrading of the VCC PC in view of these features.

2. The general concepts of the equipment and existing PC system

Fig. 1 is a conceptual view of the steel making process flow and VCC equipment of the Hikari Works. The facilities comprise 1 CC which is a slab continuous casting machine for single strands; and 2 CC which is a bloom continuous casting machine for a double strand configuration. Both are vertical type continuous casting equipment.

Urgent renewal of the old systems was necessary for the VCC PC because after 21 years of operation: 1. Spare parts had become exhausted through the aging of the process of the I/O apparatuses; and 2. Expansion of memory devices for expanded functions was not possible. The scale of the system calls for an approximately 80 k step, mid-sized PC.

3. Upgrading issues

In proceeding with this renewal project, one of the main issues was particularly to reduce costs by achieving the following two points.

(1) Reduced costs for purchasing of hardware and software

(2) Reduced application software development costs

In purchasing hardware, dedicated PCs of various manufacturers were compared to employ the general purpose products for lower costs in system introduction and operation based on engineering know-how at Nippon Steel Corporation to develop our systems. Furthermore, through a completely in-house software manufacturing organization, the establishment of software development engineering methodology for steel manufacturing controls and the develop-

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*(2) "NS SEMI SYSTEM" is a registered trademark in Japan of Nippon Steel Corporation.

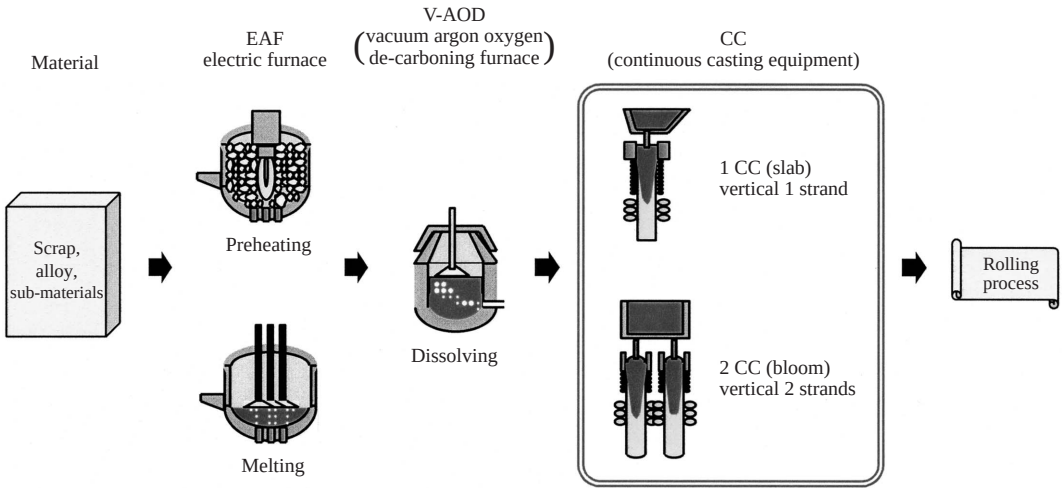

Fig. 1 Steel manufacturing processes and VCC equipment

ment of software development support systems improved the efficacy of application software (AP software). Recently, there has been a trend for a yearly increase in the introduction of open systems. An aim was to further improve AP software manufacturing ability through the development of software development and manufacturing improvement tools. These software development tools employ commercially available software packages that provide efficiency in development, through a visual approach.

With this project of renewal, it was the first time to apply a programmed automated generation tool for Nippon Steel Corporation as an application software development tool for continuous casting equipment.

4. System configuration

Fig. 2 shows the system configuration[1-3]. The general purpose PC server employed a duplicated configuration of disks to ensure the reliability of the system. Diskless WBT (Windows Based Terminals) were chosen for the terminal monitors in consideration of environment durability and maintainability. To reduce the processing load on the PC servers and to ensure response at the terminal monitors, a balancer type system was configured that separates each of the servers for functionality for screen control, list output control and data analysis. Furthermore, existing process computers and new PC servers were connected via a sequencer. A vertical startup was realized by improving test quality through a parallel run test and a shortened switching over period from the old to the new devices.

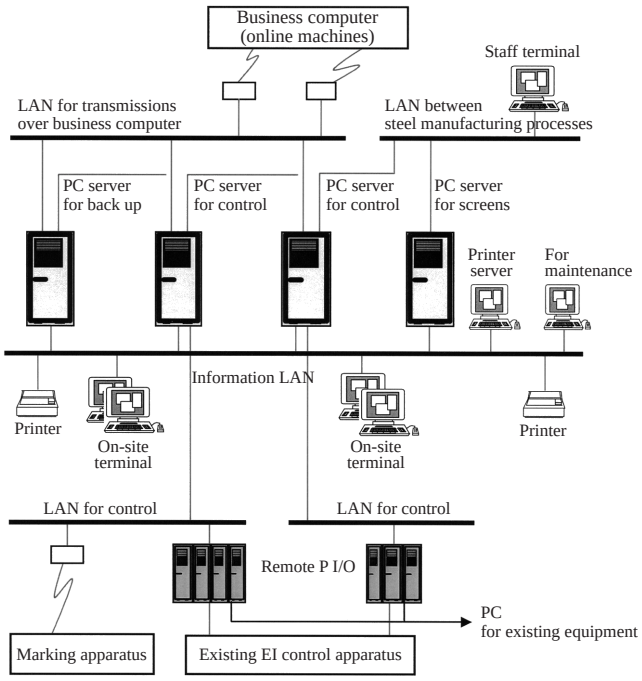

Fig. 2 Overall system configuration

5. Overall software configuration

Fig. 3 shows the overall software configuration[1-3]. Features of the system configuration are improved reliability and maintainability by deploying Nippon Steel Corporation's middle-ware on a general purpose OS (Windows 2000*(1)) environment and a general purpose RDB (SQL Server 2000*(1)), high processing speeds and to ensure transplant-ability (or reuse) of application software. Particularly, this was the first time for general purpose RDB to be applied to con-

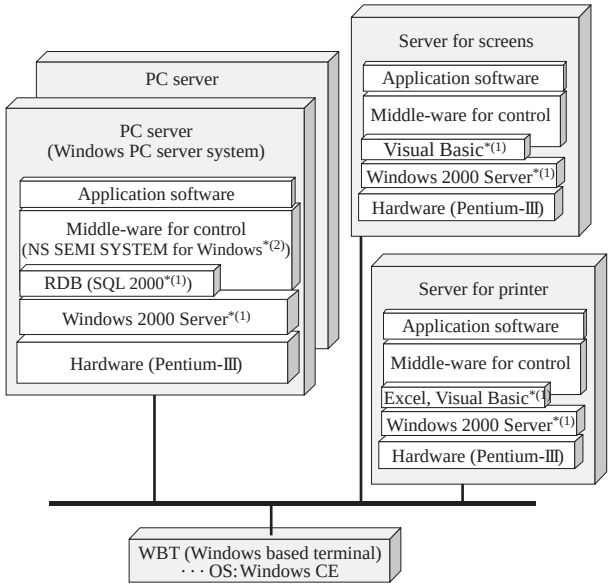

Fig. 3 Software configuration

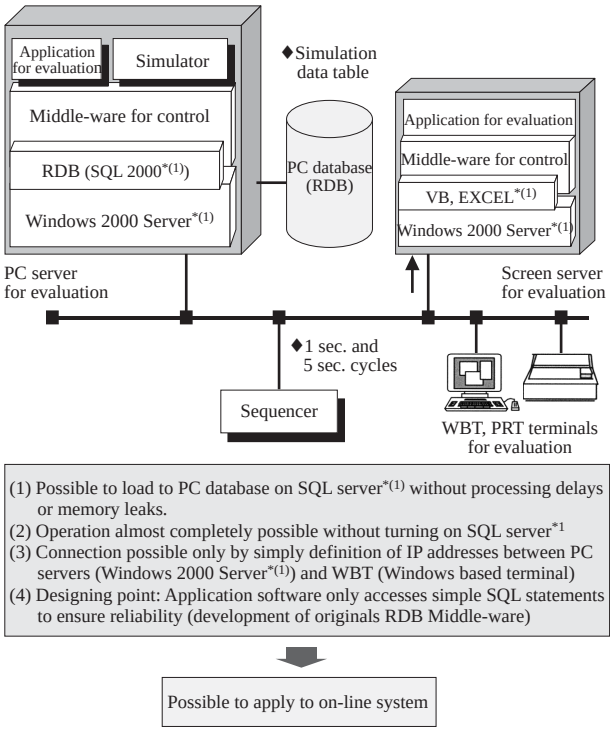

Fig. 4 Knowledge attained through the prior evaluation system

tinuous casting equipment which require high levels of reliability and real-time information response. For that reason, it was determined to apply the actual equipment after a thorough pre-evaluation of those issues (see **Fig. 4**[3]) had been conducted. Online data analysis servers employ web servers on a Linux*(3) system. By connecting OA terminals on each staff's desk, a low cost, yet highly convenient system was developed.

6. Features of application development

A feature of application software development is the application of a program development tool of Nippon Steel Corporation. This tool was developed using generally sold tools (Visual Basic, Excel*(1)) and general purpose RDB. The aim is to improve manufacturing[2,3] through automation of program processing designs, production and stand-alone tests (See **Fig. 5**).

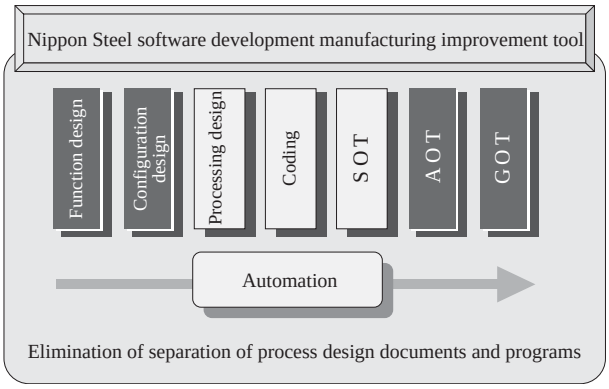

Fig. 5 Scope of program automatic generation

*(3) Linux is a trademark or registered trademark of Linux Trvalds in the United States of America and in other countries.

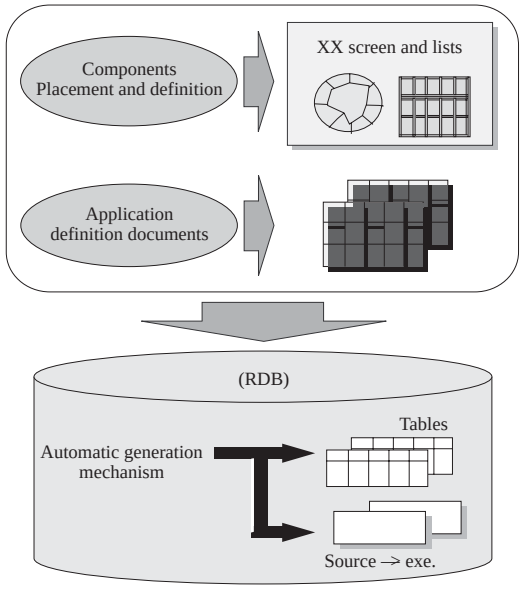

Fig. 6 General concept of program automatic generation tools

In conventional application software development, after creating the program processing design documents in the upstream design phase (function specifications, configuration designs), the software was developed in the process to code the program and to test it. In all cases, because of the human element, program processing designing and testing needed to be repeated a number of times due to human error. Also, separations between the program process design documents and program source occurred which caused an increase in the number of amendment mistakes was a cause of trouble in software development manufacturing improvements.

These problems were solved for the development tools by describing application process definition documents (the placement and definitions of development components for screens and lists) and converting to program source generation/execution formats via an automated generation mechanism and enabling uniformed development including installation on the actual machines[2, 3] (See **Fig. 6**). This has made it possible to quickly maintain good quality software maintenance for the maintenance divisions as well as for users on the manufacturing side.

7. Conversion of overall engineering techniques

Through these efforts, an overall conversion of engineering techniques was tested, not only to simply improve software manufacturing. In conventional waterfall-type techniques, it is easy to ensure software quality for each software manufacturing phase, but there are major demerits in that the quality of and changes in the required specifications cause many returns and that many human operating mistakes greatly affect the overall process[2, 3] (See **Fig. 7**).

A spiral type technique was used. This employs originally manufactured tools that eliminate human error and which do not affect any user department. To this use of that technique, the following changes of concept were tried[2, 3] (See **Fig. 8**).

(1) Required specifications cannot be 100% decided.
(2) Have users on the manufacturing side submit requested specifications gradually after they had been thoroughly studied, without applying any time restrictions to them
(3) Have submitted requests verified by the users on the manufacturing side as soon as is possible

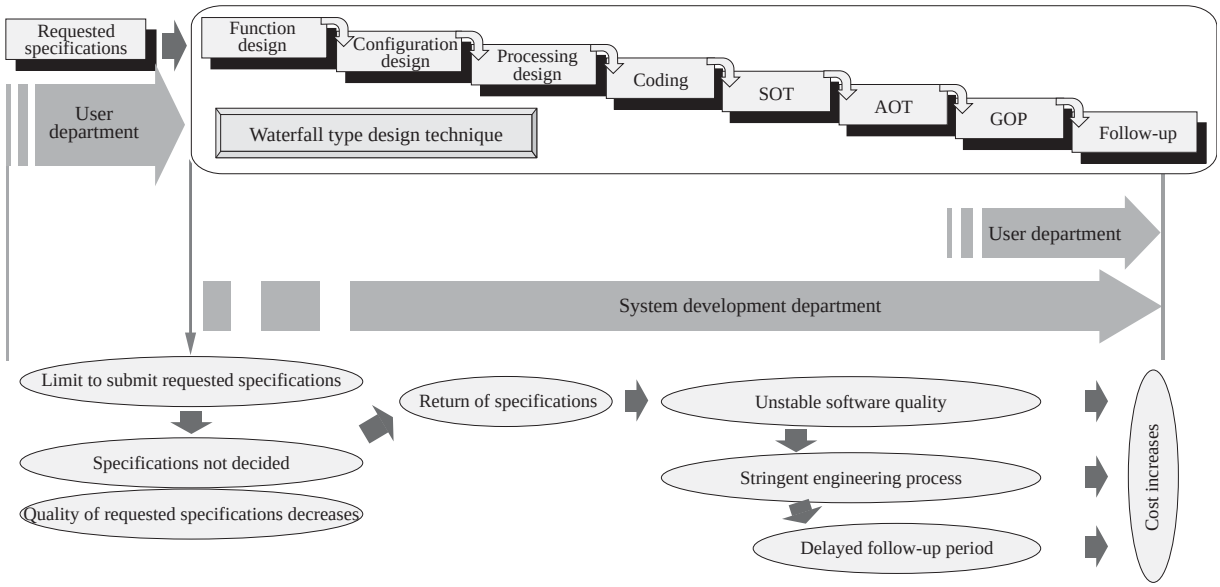

Fig. 7 Waterfall type design technique

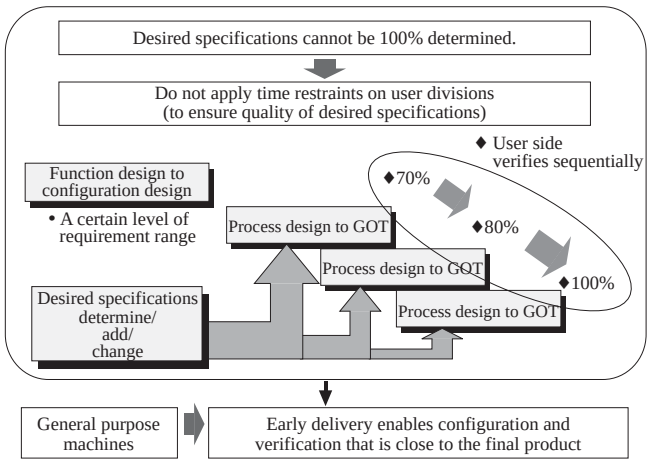

Fig. 8 Change of concept and spiral up type approach

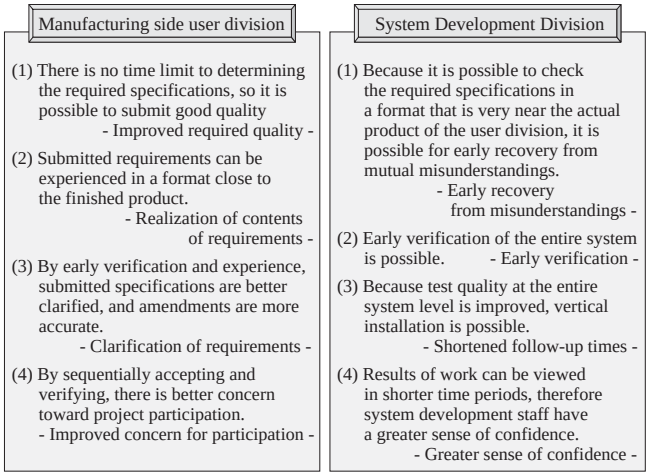

Fig. 9 Effects and knowledge from the application of spiral up type

(4) Sequentially amend, and change based on their verifications

Particularly, with regard to screen and list functions, it is easy for users departments on the manufacturing side to confirm the most requested specifications and to make further requests for changes or improvements thereto. For that reason, the system development department can propose screens and tables for those screens and lists (development using the originally manufactured tool makes it possible at this stage for the program source to already be generated), and to discuss those specifications with those user departments while developing and operating model operation data on a general purpose RDB. In this way, not only is it possible to confirm requested specifications, but also to experience actual operation such as the system's operability, response and visual impression. The application performed this time is the most effective.

Fig. 9 shows the main effects[2,3] of the spiral up type development technique obtained through its practical use.

8. Effects

Costs for purchasing new hardware were reduced approximately 2/3 (versus conventional costs), and application software development costs were reduced 50% by introducing general purpose components and applying our originally made application program tools. Also, as an overall engineering technique, a practical approach was taken from the waterfall type to a spiral-up type to enable shortened setup times and a vertical installation by early verification of the entire system.

9. Conclusions

A low cost, open type control system of good quality was developed. By achieving the first general purpose RDB application to continuous casting, the possible for application to other processes that require similar or better process performance and responsiveness was attained.

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