Design of Underwater Vehicle Assembly and Debugging Management Information System Based on Process Node

Shuaishuai Yang*[a], Minhui Ding[a], Shuang Liu[a]
[a]Kunming Shipbuilding Equipment Research and Test Center, Kunming, China
* Corresponding author: yss930819@163.com

ABSTRACT

Along with the deepening of human exploration of the sea, the demand for underwater vehicle is increasing day by day, and the quality of underwater vehicle needs to be further improved. In this paper, we propose a management model based on process nodes and carry out information system design based on this model to realize system function design, system architecture design, hardware design and software design, and provide a basis for the development of the whole process management system for underwater vehicle assembly and commissioning.

Keywords: information system, assembly and commissioning, management, process node, software design

1. INTRODUCTION

With the rapid development of computer technology, network and communication technology in recent years, information technology has been commonly used in various fields of industry and society [1-4]. Information technology development is leading new changes in social production, creating new space for human life, expanding new areas of national governance, and greatly improving the ability of human beings to understand and transform the world [5-6]. The transformation of enterprises to information technology has become a major trend [7-8].

Along with the deepening of human exploration of the sea the demand for underwater vehicle is increasing day by day, and the quality of underwater vehicle needs to be further improved. As the most important part of assembly and commissioning, the quality of the execution process is directly related to the quality of the product. Traditional underwater vehicle product assembly and commissioning are manually recorded and checked by people, when the product problems cannot be timely investigation and positioning problems, resulting in product quality and production efficiency cannot be improved.

The purpose of this paper is to discuss a design of an information system for underwater vehicle assembly and commissioning management to solve the management problems of underwater vehicle assembly and commissioning, and effectively improve the quality of underwater vehicle, as well as enhance the production efficiency of the product.

2. PROCESS NODE MODELING

2.1 Assembly and commissioning process analysis

The assembly and commissioning process of the underwater vehicle is shown in Fig. 1. It can be roughly divided into six parts: product parts unpacking, subsystem commissioning, product assembly, full system commissioning, product quality inspection and product packing. The management of the assembly and commissioning of the underwater vehicle needs to cover the whole process cycle.

Product components into the factory to open the box: After the product components into the factory, the assembly and transfer personnel remove the product components packaging, and check the key items such as components accessories, components appearance and components supporting documents.

Sub-system debugging: After the product parts are checked and passed, the assemblers will debug each sub-system separately, and debug the sub-system hardware and software separately through special debugging equipment.

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Product assembly: After all subsystem debugging is completed, the assemblers assemble all product parts into complete products according to the process requirements.

Whole system debugging: After the product assembly is completed, the assemblers use the whole product debugging equipment to debug the whole system to ensure the normal operation of the whole product.

Product quality inspection: After the completion of the whole system debugging, the inspection personnel will review and re-commission the debugging data of the product.

Product boxing for delivery: After the product quality check is completed, the assembling and adjusting personnel will load the complete product into the shipping box and finish packing, and deliver it to the shipping department.

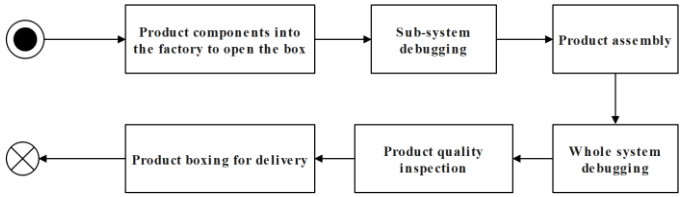

Figure 1. Assembly and Commissioning Process.

2.2 Management Model Design

In this paper, each node above is defined as process node *N*, as in (1). According to the characteristics of the process node, this paper defines the process node as a set of 3 elements as follows, and the three elements can be divided into three stages of the process node.

$$N = \{start, steps, end\} \tag{1}$$

where

start is the start stage of the process node;

steps is the execution phase of the process node, which is a set of steps consisting of a specific step.

end is the end stage of the process node.

A process node *N* must be a complete set of start, execution and end phases, with no missing elements.

The management model for a process node *N* is shown in Fig. 2, which includes four parts: process management, human, machine, material, law and environment management, data management and quality management.

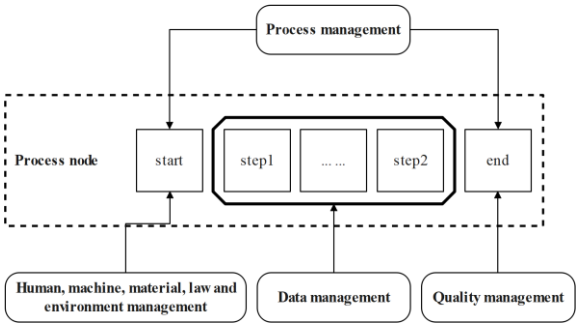

Figure 2. Management Model.

Process management includes two parts managing the flow between nodes and nodes and managing the execution of the process nodes themselves. The management of node-to-node flow needs to focus on the complete and efficient flow of information data from one node to the next. The execution management for the process node itself needs to focus on the start and end status of the node, while managing the status of the node itself including four cases of not started, in progress, completed (success), and completed (failure).

The management of human, machine, material, law and environment is the pre-condition management before the start of the process node, through which it is checked whether the corresponding job skills personnel, necessary assembly equipment, consumable materials, assembly process and site environment are available before the start of the process.

Data management needs to record the product supporting information, key step data and detailed operation process in the assembly and commissioning process, including the management of data such as product data, image data and assembly data.

Quality management is the monitoring of quality through automatic or semi-automatic judgment of quantifiable and detectable quality indicators in the process. The goal is to eliminate factors that cause non-conformity or unsatisfactory results at all stages of the quality loop by monitoring the quality formation process.

3. SYSTEM DESIGN

3.1 System function

As shown in Fig. 3, the main functional features of the underwater vehicle assembly and commissioning whole process management information system include six functional points: basic components, process management, data management, quality management, human, machine, material, law and environment management, data visualization, etc.

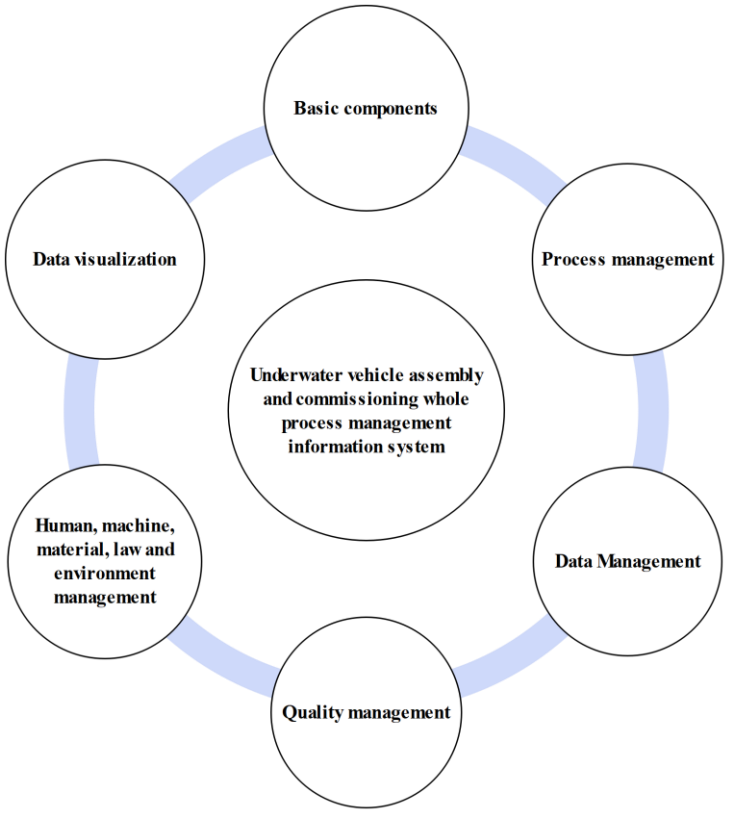

Figure 3. System function.

Basic components: A collection of basic functions that ensure the system can run stably.

Process management: Management functions that ensure the process node model can flow normally and the process node status is accurate.

Data management: Ensures that product data, image data, and mounting data can be reliably stored.

Quality management: Automatic or semi-automatic quality audit of collected data to ensure the integrity of each process execution quality.

Human, machine, material, law and environment management: Management components for resources such as assembly and transfer personnel situation, equipment situation, material situation and process documentation

Data visualization: Data statistics display component to visualize the data in the form of charts.

3.2 System architecture

Underwater vehicle assembly and commissioning whole process management information system to solve the problem of assembly and commissioning whole process management, its target involves the crowd consists of assembly personnel and manager, the system provides services for these two types of personnel the general framework shown in Fig. 4.

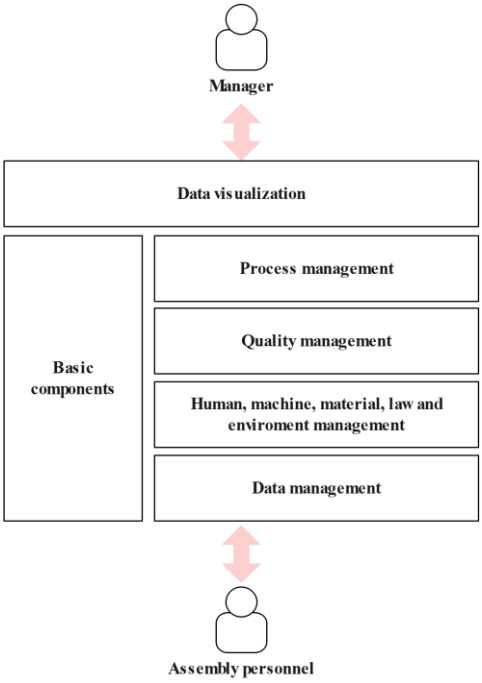

Figure 4. System architecture.

The assembly personnel fill in the data information such as assembly progress and product status into the system through the data management function of the system. The system controls the automated flow of the entire assembly process based on the process node model and the process management, quality management and uman, machine, material, law and environment management components through the acquired data information. Through the visualization component of the system, managers can view the current product assembly progress and understand the product quality in real time, so that they can reasonably allocate the product assembly tasks and improve the production efficiency of product assembly.

4. HARDWARE DESIGN

The hardware interconnection relationship of underwater vehicle assembly and commissioning whole process management information system is shown in Fig. 5. It includes four parts: user terminal, assembly terminal, network switch and server. The user terminal and server are interconnected with the network switch through Ethernet, and the assembly terminal is interconnected with the network switch through wireless network. The four devices form an internal local area network which is not connected to the Internet. This network can ensure the convenience of the system operation, and at the same time realize the physical isolation of the assembly information network from the Internet to ensure the security of assembly information and generation of information to a certain extent.

The user terminal is a desktop host placed in a fixed position, mainly used by the management staff to assign tasks and monitor the assembly progress. When not in use, the assembly terminal is kept in a designated location, and when in use, it can be taken away by the assembly personnel to the vicinity of the assembly station to facilitate the process data recording.

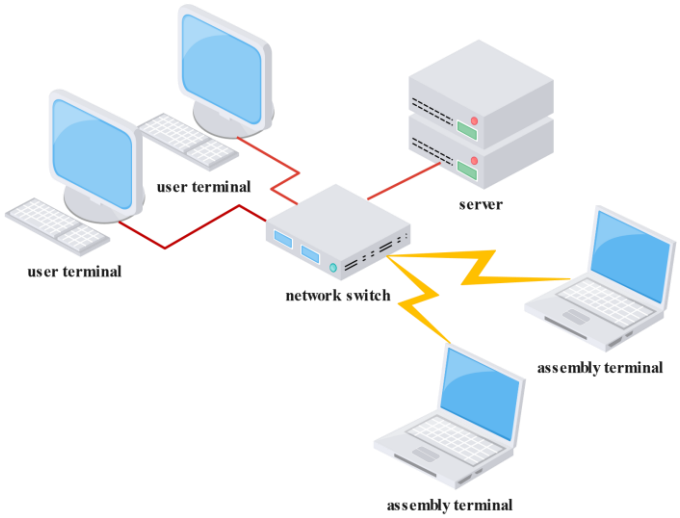

Figure 5. Hardware architecture.

5. SOFTWARE DESIGN

The system software can be divided into three layers: business presentation, business processing and basic platform, as shown in Fig. 6.

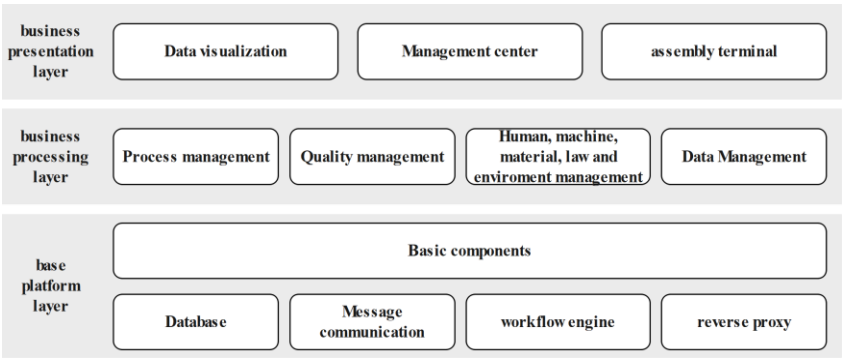

Figure 6. Software architecture.

The business presentation layer is a user-oriented human-computer interaction application that runs in user terminals and installation terminals. The data visualization and management center provides managers with the assembly and commissioning process management. The assembly terminal provides a set of step-by-step process guidance system for the assembly personnel, which facilitates the assembly personnel to execute the assembly process according to the steps and facilitates the entry of key data in the assembly into the system.

The business processing layer is responsible for handling the control logic in the business, such as the transmission of information flow, control of accessible resources, control of process nodes, etc., exposing interfaces for use by the business presentation layer and running in the server. Its main implementation components are process management, quality management, human, machine, material, law and environment management and data management to cover all the elements in the process node management model and to provide functional implementation.

The base platform layer is the basic functional components and necessary third-party runtime resources that support the system to run properly, running in the server. Among them, database, message communication, workflow engine and reverse proxy are third-party runtime resources. The basic components provide basic functions such as users, roles, permissions, logs, file management, etc.

6. CONCLUSION

This paper is oriented to the problem of information transformation of the whole process management of underwater vehicle assembly and commissioning, and proposes a management model based on process nodes and carries out information system design work based on this model to realize system function design, system architecture design, hardware design and software design, which provides a basis for the development of the whole process management system of underwater vehicle assembly and commissioning. The analysis and mining of assembly and commissioning data can be carried out based on this study.

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