Application of Systems Engineering in Shipbuilding Industry in Korea

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Abstract : Modern naval ships are large complex systems with the number of requirements ranges from thousands to tens of thousands. To build a quality ship, the satisfaction of the requirements should be traced. In most shipbuilding projects it is almost impossible to manage all the requirements without a proper CASE (computer aided systems engineering) tool. And for effective management of the shipbuilding project, the integrated database for technical data is very important. This paper describes how the requirements are managed, and the integrated database is built in the naval shipbuilding industry in Korea.

Key Words : Shipbuilding Systems Engineering, Requirements Management, Integrated Database, Requirements Traceability

1. INTRODUCTION

Modern naval ships are large and complex system, so to build a successful ship, the management of requirements is very important. These requirements come from ROC, TLR, TLS, ship design bases and stakeholder requirements which range from thousands to tens of thousands or more. Managing these requirements using word processor or spread sheet is very hard and error prone. So the CASE tool is essential for the management of the requirements in the shipbuilding projects. To manage requirements management we should customize the CASE tool, input requirements, establish traceability. We describved each step of re-

quirements management process in following chapter.

And the other important point in shipbuilding project is the integrated database which contains all the technical data of the project. Keeping the integrated database, all the participants of the project can work using the same data, and can save time for find data. The contents of the integrated database can be requirements document, risk management data, technical measurement data, design report, issue, reference documents etc. It is important to keep relationships between these data in the integrated database. The integrated database also can be reused

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in the following projects or similar projects.

2. Requirements Management

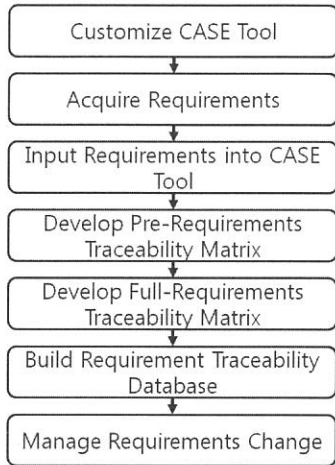The requirements management process is as follow.

Fig.1. Requirements Management Process

2.1 Customize CASE Tool

To customize CASE (Computer Aides Systems Engineering) tool, we should analyze the work process, and decide the schema. Through the analysis of the work process, we can identify what kind of data is used in the work, and design the scahema and the user interface of the CASE tool.

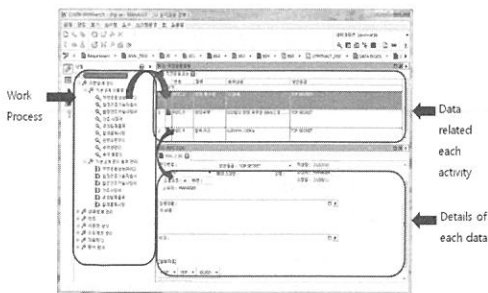The work process is related with in Cradle® CASE tool as follow.

Fig 2. CASE tool representing work process

In Fig.2, the left side of the pane shows the work process. This is to help the user find data easily. Right upper pane shows data related with each work, the user selected, and right lower pane shows details of each data.

Typical schema for naval ship requirements management is as follow.

ROC : Required Operational Capability
TLR : Top Level Requirements
TLS : Top Level Specification
BS : Building Specification
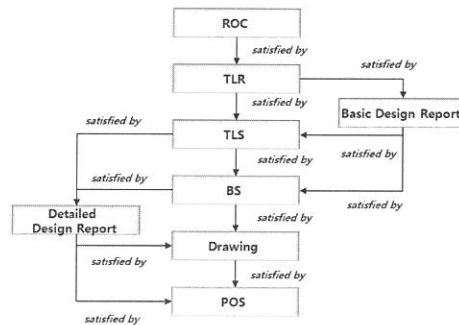POS : Procurement Order Specification

Fig 3. Requirements Management Schema

2.2 Acquire Requirements

The requirements specified in the contract document. But the sometimes it is needed to capture stakeholder requirements not specified in the contract document.

2.3 Input Requirements into CASE Tool

According to the schema as in Fig.3, requirements are input to CASE tool. It is important to input requirements by each sentence. Because the traceability of each requirements are managed for each sentence

in the requirement documents .

2.4 Develop Pre-Requirements Traceability Matrix

Pre-Requirements traceability matrix contains the requirements that each design report should satisfy. Main job of design engineers is to write design reports which analyze speed, weight and other performance of the ship. So the systems engineer distributed the pre-requirements traceability matrix for each report before the writing the design report begins. With this matrix, the designer can know which requirements should be satisfied in the design report. Finally all the requirements are distributed to each design report and there is no missing requirement.

Fig 4. Requirements Traceability Matrix

2.5 Develop Full Requirements Traceability Matrix

Fig.4 shows the full range requirements traceability matrix. The requirements traceability matrix is completed by each design engineer in charge of the report. Design engineers fill the column "report section", "satisfied?" and write comments if the requirement is not satisfied in the design report. The full requirements traceability matrices collected by systems engineer to build requirements traceability database.

2.6 Build Requirement Traceability Database

Systems engineer set traceability between requirements and the contents of the design report.

Using the Cradle®, the traceability can be set by drag & drop as in Fig.5

Fig 5. Requirements traceability setting

The requirements traceability can be shown in many ways. Using the Cradle, the traceability can be set by drag & drop.

Fig 6,7,8 shows various kind of requirement traceability representation, matrix, hierarchy diagram and tree type. Once the traceability is set, these figures can be generated automatically in CASE tool.

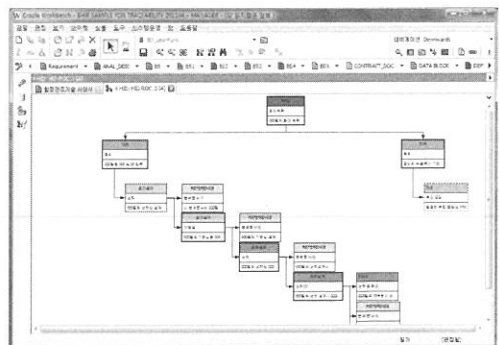Fig 6. Requirements traceability matrix

Fig 7. Requirements traceability matrix

The requirements traceability can be shown in many ways as follow.

The traceability of requirements goes on until the requirements are flowsn down to the POS(Procurement Order Specification) or drawing. This means that the requirements are implemented in the equipments or in the building procedures or facilities etc.
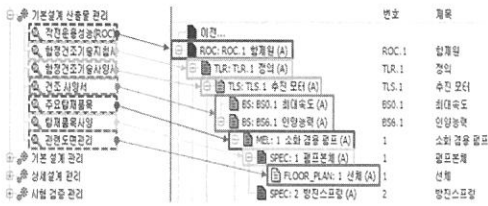

Fig 8. Requirements traceability tree

2.7 Requirements Change Management

One of the important merits of the use of CASE tool is removal of human error. Especially the management of the change of the requirement is very complex and error prone. Using the CASE tool, the changes of the requirements are automatically recorded in the database as in Fig. 9.

As in Fig.9, the details of the change of the requirements – date, comments, person, changed contents comparison – can be followed.
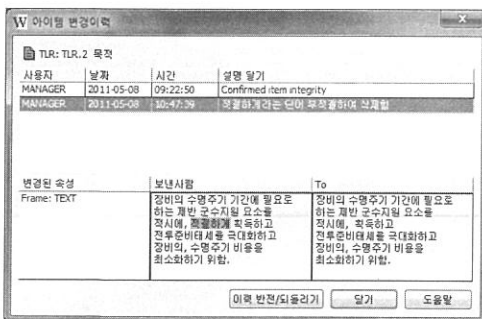

Fig 9. Requirements change history

Using the requirement traceability, the impact of the change of the requirements can be easily identified. As in Fig.9, the details of the change of the requirements.

4. Integrated Database

Integrated databases means that all the data are stored in one database and the relationships between the data are maintained. Typical contents of the integrated database are requirements document, risk management data, technical measurement data, design report, issue, action item, reference documents etc.

The risk can be related to a requirement, and the TPM can be related to requirements. So the integrated database can provide various information easily.

One of the merits of Cradle® is that, it can contain and drive all the application data like micro soft office, PDF etc., as in Fig. 10.
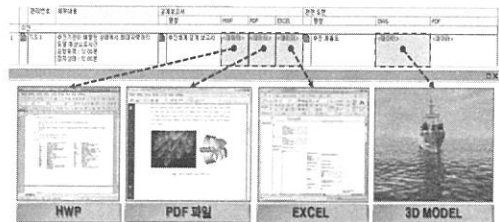

Fig 10. Application file save

The risk can be related to a requirement, and the TPM can be related to requirements. So the integrated data can provide various information.

Although the CASE tool is designed to support systems engineering, it can contain project management data too.

5. CONCLUSIONS

In this paper, we described how requirements are managed, and integrated database are build in the naval shipbuilding industry in Korea.

To manage requirements traceability, we customized the CASE tool, and develop requirement traceability matrix for requirements flowdown and build requirements traceability database.

Integrated database is also import for effective management of the shipbuilding project and for the reuse of the data in later projects. Using CASE tool we could build integrated database containing various technical data.

REFERENCES

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