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ARCHITECTURE OF PRODUCT RESEARCH AND DEVELOPMENT SYSTEM FOR COMPLICATED PRODUCTS ENGINEERING

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1 Introduction

The development and engineering process for complicated product, for example aero-engines, etc. follow the theory of system engineering. It conforms to the V-model of system engineering and the Hall logical model, and exhibits characteristics below.

The first characteristic is long development cycle. Complicated product development usually continues one or two decades. It begins by collecting and analyzing initial requirements from users, continues by product function, logical and physical analysis, product architecture designing, sub-systems and parts detailed designing and manufacturing, sub-systems and parts verification and validation, and ends with delivering product to users.

The second characteristic is covering varied business domains. Complicated product development such as aero-engines usually involves business domain such as design, manufacturing, test, materials application, purchasing, project management, etc. and disciplines such as gas dynamics, structure mechanics, thermal analysis, manufacturing process, etc. Multi-discipline analysis and balancing status is complicated.

The third characteristic is the complexity of product structure. A product typically consists of system, sub-system, assembly and parts. Each level above goes through the whole development and engineering activities according to the V-model. At the same time, the levels above interact with each other. For example, the requirement of system level should break into sub-system levels, and sub-system levels testify all requirements have been met for the system level.

The last characteristic is the use of processes, tools, methods, data bases and so on to finish the whole product development and engineering course in a standardized way.

And we consider processes, tools, methods, data bases, etc. as the elements of product research and development system.

As the process of complicated product research and development is complicated itself and behaves characteristics above, we think that it needs a team that operated efficiently and worked closed together with standardized processes using efficient IT platforms and tools. And the whole it needs, we considered as product research and development system (PRD system).

2 Discussion on the concept of product research and development system

The product research and development system, as is PRD system for short, is an artificial system to standardizing development process based on the methodology of system engineering.

PRD system is a complete solution for complex product research, development and engineering. It contains four sorts of elements, such as processes, technological element, organization (team for simplified) and IT. Therein, technological element contains methods, tools, standards; data bases and so on, which represent the best practices and experience of an enterprise. In these elements, the processes exhibit tractive effect. Engineers execute activities as processes stated, using methods, tools, data bases, etc. So the technological element plays a supporting role. The organization (research and development team other words) operates in integrated product development team mode resolving cross-regional, cross-professional collaboration across organizations, as is matrix management mode. Finally, the whole process operates in IT platforms to improve operational efficiency utilizing progress in International Technology.

So PRD system is confluence of industrial technology, international technology and engineering management technology. It standards and optimizes research and development process, improves research and development capabilities. It’s the core competitiveness of an enterprise.

3 Discussion on the Methodology of establishing architecture of PRD system

To establish architecture of PRD system, we refer mainly two methodologies. One is methodology of system architecture, and the other is methodology of enterprise

architecture.

The aim of system architecture is visualizing concept of product. It emphasizes to describing the elements that make up the product and the relationships between them in the operation condition. So there are three key points in this methodology, which are element, relationship and operation condition.

The use of enterprise architecture is clarifying business logic and IT environment in an enterprise. It reflects the organization relationship of process, technologies and personnel. So the key point of the methodology of enterprise architecture is the relationship between things, activities and personnel.

The process of product R&D is actually the conversion of concepts into physical product by enterprise. Therefore, when we think of architecture of PRD system, all the key points of system architecture and enterprise architecture are included.

4 Discussion on architecture of PRD system for complicated products engineering

As discussed above, the architecture of PRD system should clarify the elements PRD system contained, also the relationships between those elements. At the same time, the architecture of PRD system should show operation scenes meanwhile.

So the final architecture of PRD system presents as figure 1.

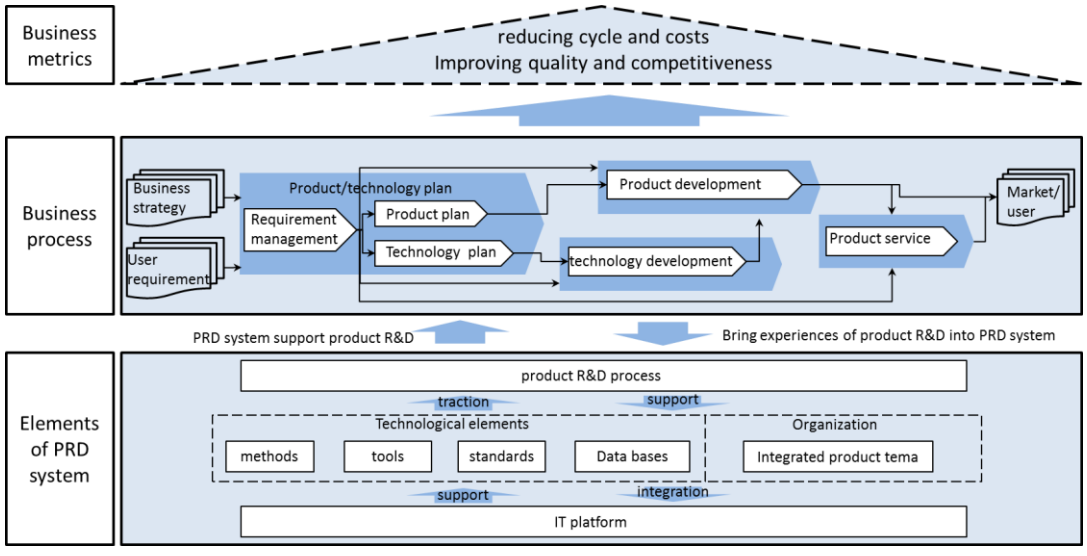

Fig. 1 Diagram of architecture of PRD system

In the architecture, there are three dimensionalities. The top part of figure 1 is the first dimensionality. It's not the actual part of architecture, but show function of PRD system, which is improving product quality, shortening the development cycle,

reducing development costs and improving core competitiveness. The middle section of figure 1 is the second dimensionality, which shows the business architecture in product research and development. This dimensionality accords to the V-model, and shows the operational state of PRD system. The bottom part of figure 1 is the last dimensionality, which is the actual and core part of architecture of PRD system. It shows the elements that make up PRD system, and the relationships between them. In this part, there is another architecture contained, which is architecture of IT, whose detailed description will be showing below.

The following sections are detailed depictions for all sub-architectures.

4.1 Business architecture

The business architecture presents as figure 2. It shows the generalized process for product research, development, engineering and service activities. The process begins from identifying and analysis initial requirements, going on with product and technology programming, product system definition and designing top-town, product integration, verification and validation bottom-up, delivering product and service, until products are out of market.

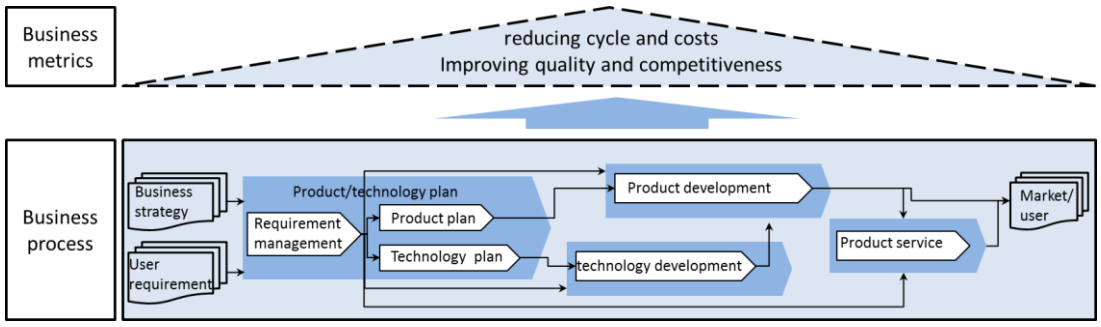

Fig. 2 Diagram of the business architecture of PRD system

4.2 The elements architecture of PRD system

As described above, there are four sorts of elements in PRD system, which are processes, technological element, organization and IT. The processes contain two categories, technological and managing process. The technological element contains methods, tools, standards, data bases and so on. The organization element mainly refers to integrated product engineering team. The IT element refers to using IT technology to increasing effectivity. The relationships between those elements show

in figure 3.

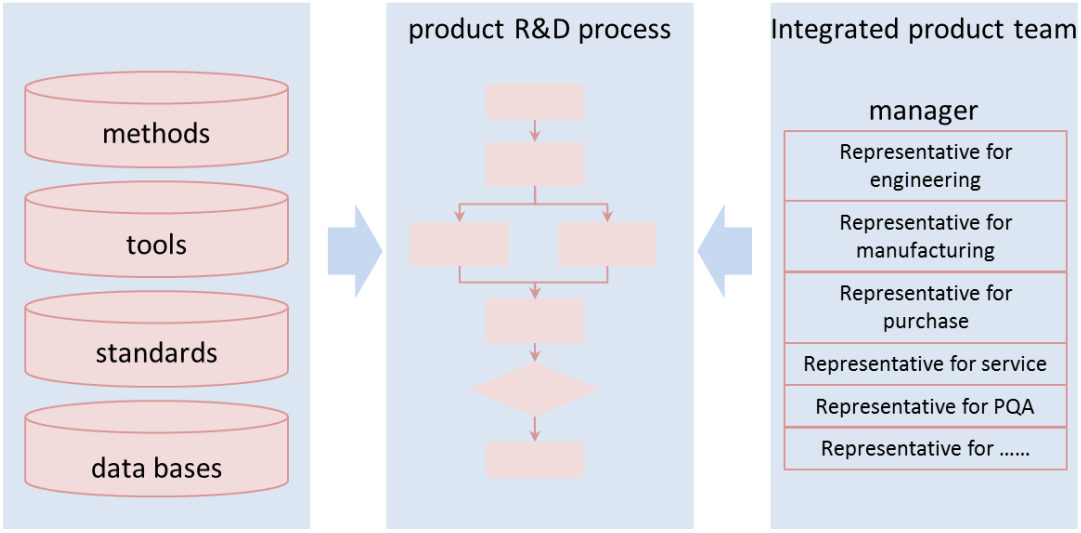

Fig. 3 Diagram of the relationships between the elements of PRD system

4.3 The IT architecture for product R&D

The IT architecture here mainly refers to application architecture. Through the analysis of business processes and business needs, the IT architecture should contain application groups mainly about requirement and planning management, innovation and technology research management, integrated product development and engineering management, product data management, program portfolio management, assembly and test management, basic recourse management, etc. So the IT application architecture is as shown in figure 4.

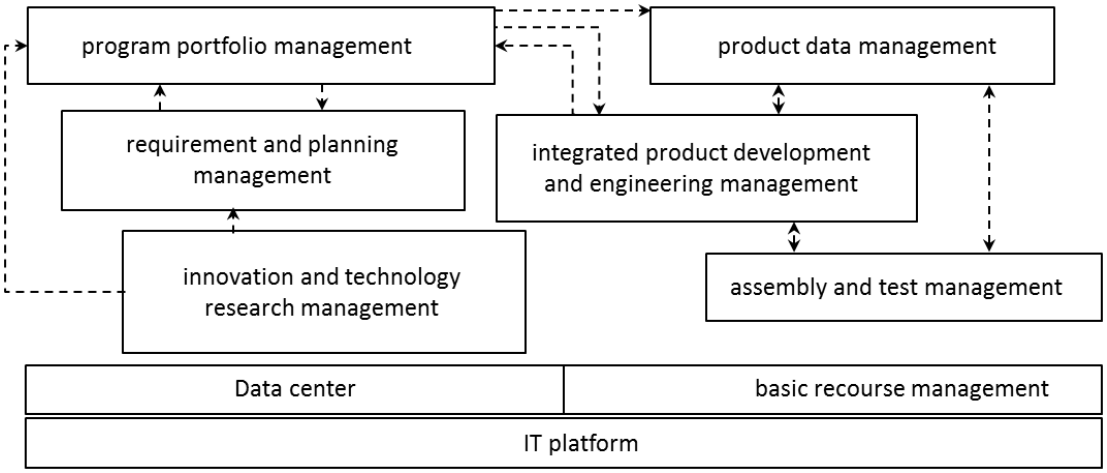

Fig. 4 Diagram of the IT application architecture

5 Conclusions

This paper outlines the complicated product research and development process and

definition of product research and development system. Then give architecture of PRD system based on discussing two methodologies. The architecture of PRD system contain business architecture, elements architecture and IT architecture. And the detail of three architectures above is given. Future work will concentrate on pilot application in order to verify and optimize the architecture of PRD system.

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