# Design of R&D Management Platform for Rail Transit Signal Equipment Based on PLM

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**Abstract.** The rail transit signal system and PLM system are briefly introduced. The framework of R & D management platform is built based on the features of signal R&D project. The product data management, project management and RAMS management of the R&D management platform are introduced in detail, which are implemented in the entire series of products in the company's Signal system R&D department. Practice has proved that the time for R&D approval is greatly shortened. The traceability of the product development process has been achieved, and the production efficiency and customer satisfaction are improved.

**Key words:** PLM, Signal system, R&D management

## 1. Overview

### 1.1. Signal System Overview

The urban rail transit signal system is usually composed of two parts: a train operation automatic control system and a depot signal control system. It is used for train access control, train interval control, dispatch command, information management, equipment condition monitoring and maintenance management, thus forming an efficient integrated automation system.

The signal system is the key system equipment that guarantees the safety of train operations, modernization of train command and train operations, and enhancement of transport efficiency. It is a safety system that should meet the SSIL safety level requirements and its development must meet the requirements of the railway applications of Standards EN50126/EN50128/EN50129. In view of the complexity and high security of its products, an innovative R&D management platform is urgently needed to realize product design standardization, serialization, and modularization, and to realize product demand management, process management, configuration management, and change management in the entire life cycle.

### 1.2. Product Lifecycle Management(PLM) System Overview

PLM is the generic term of information technology related to product innovation in the field of technology informatization [1-3], and is a concept of product data information management throughout the life cycle from product development to engineering application, and to scrapping. It is based on collaborative PDM, and can realize the collaborative application of product data between the internal R&D department and related departments, and even between enterprises. PLM software is a set of system application software composed of interrelated software modules. It uses information technology to realize the management of the entire product life cycle. These modules have a unified source of data (product data), which can support the

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company's internal and external product-related personnel to work collaboratively with the help of the system.

## 2. Design of the R&D Management Platform

To support the R&D business of signal systems and their respective R&D processes, the signal system R&D management platform is divided into 3 areas and 21 function modules based on PLM native software modules. The logical architecture diagram is shown in Figure 1 below:
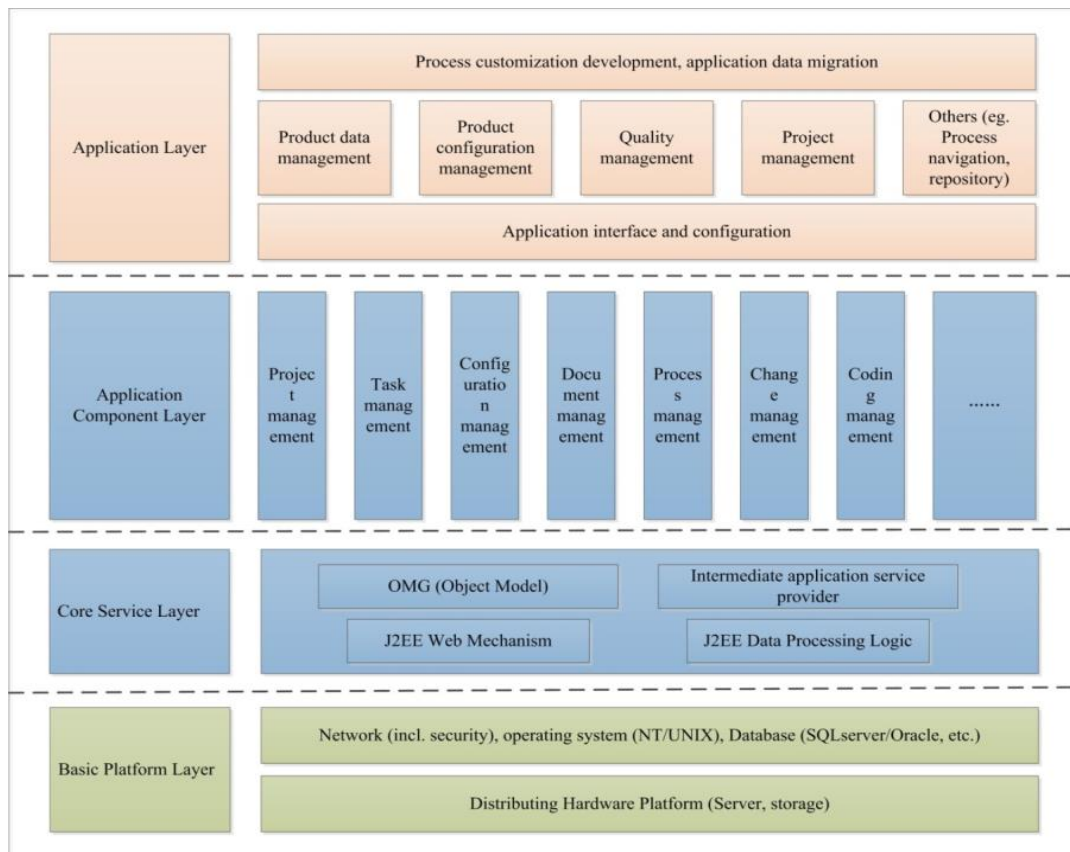


Fig. 1: R&D management platform architecture diagram

### 2.1. Product Data Management

Product data management is the core of the PLM R&D management platform. It defines product data models, pinpoints the scope and granularity of product data objects, and realizes unified management of product data in the product life cycle, including the following features:

1) Drawings and documents management

Drawings and documents is an important part of product data, the product data management of which centers on parts, and the parts management and BOM management are enhanced from the business perspective. PLM manages security sharing of drawings and documents through centralized management of rights and use code categories, manages reviews change management by defining design approval change process; it implements multiple levels of change management modes and processes from simple to complete and implements permission settings for change process personnel. PLM can generate statistical reports based on design changes that have already occurred and objectively present "accident-prone areas" to help the main designers and managers to formulate correct corrective and preventive measures in a timely manner, avoiding the frequent occurrence of more and more faults after correction in new product design and development in the manual mode.

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2) BOM management

The product model contains product information at various stages of design, manufacture, assembly, use, maintenance, recycling, etc. The basic view of the product structure model includes the design view, manufacturing view, assembly view, use view, maintenance view, recycling view, etc. BOM management is achieved by reconstructing a product structure tree based on product configuration, and a variety of product parts library, including the management of standard parts, device selection and upgrade, material automatic coding, support for DBOM, MBOM management, and the seamless transition among DBOM, EBOM and EBOM.

3) Product management

A product is assembled with multiple parts and components according to a certain assembly relationship. Product objects are described by related data and technical documents. There is a certain link between the definition data of these product objects. Each data change will affect other related product data. PLM establishes a framework for product data structure, organizes a large number of product data according to certain relationships and rules to achieve effective management of product data, including hierarchical relationship management of product structure, product and document relationship management, and version management.

4) Product configuration management

On the basis of product structure management, the product structure is managed and described with various methods of division. Each view is configured as a management object, and the view objects can transfer the component information and the structure information according to certain rules, so that the product data can be managed horizontally according to the product structure, the version number and other information.

5) Process design management

It includes the process route sorting, processing methods selection and process processing policy paper preparation, approval and change management, and provides process and design integration function, seamlessly viewing design content, timely transferring design changes, and automatically receiving quality feedback information to ensure the implementation of a complete quality management system. PLM can be extended from process management to equipment management, tooling management, etc., with the reconstruction function of the process model, which can meet needs of various ERP on process information.

6) Engineering change management

It records the person responsible for the change request, the reason for the change, and the opinions on the handling of changes in details. A sound review mechanism and process control can automatically handle multiple changes in transit, parent version conflicts, shorten change implementation time, and monitor the change activities.

7) Application system integration:

It provides data integration and interfaces with ERP, EDA, Office, CAD.

## 2.2. R&D Project Management

The R&D management layered plan and centralized control make the management of large-scale and complex projects easy and controllable. The temporary assignment of data access according to project tasks can control data security and sharing problems flexibly and effectively. The support for ongoing project monitoring helps managers manage project schedules, costs, and quality in a timely and effective manner to ensure the quality and efficiency of project completion.

In accordance with the requirements of EN50126/EN50128/EN50129 for railway applications, the R&D project of the signal system is divided into three decision-making review points and four technical review points in ten stages, as shown in Figure 2 below:
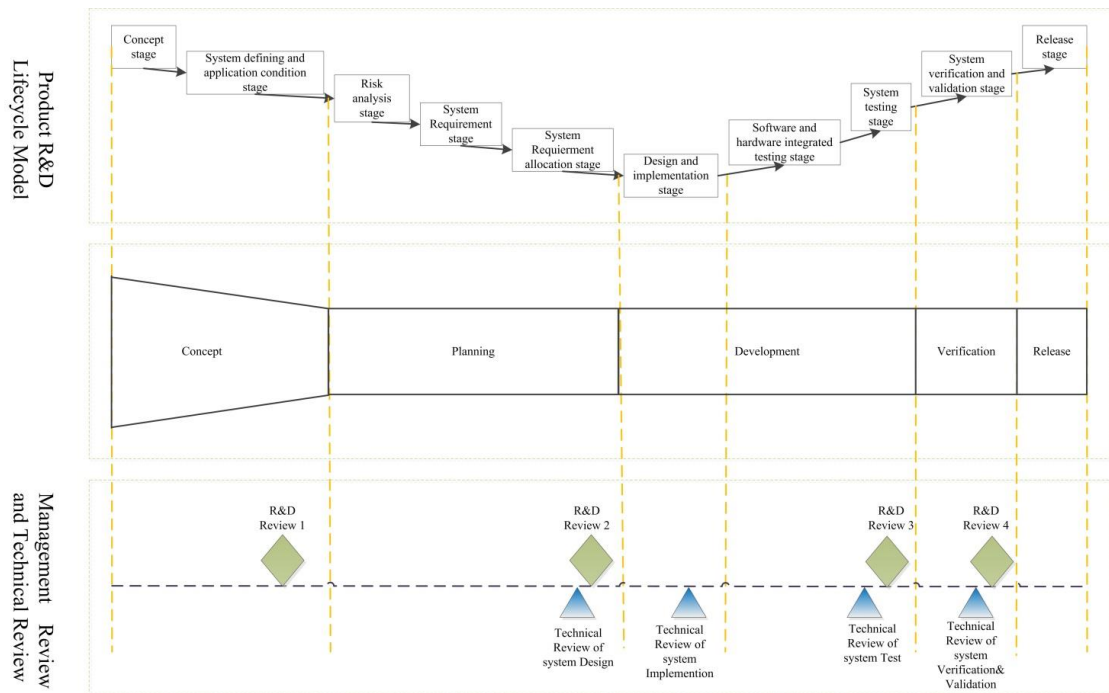
Fig. 2: Signal system R&D project stage division

Including the following parts:

1) Plan management

Covering multi-dimensional, hierarchical project planning, tracking, monitoring, and risk management.

2) Quality management

PLM provides project establishment, project closure, subproject derivation functions. It can customize the product development lifecycle model according to the requirements of EN50126/EN50128/EN50129, and formulate key technical review points for the product lifecycle. It ensures that the project follows the processes and methods defined in the quality plan by defining the process auditing, process evaluation, and other process means, and also ensures that deliverables meet the quality objectives through technical change control, process change control, defect prevention, quality metrics analysis, quality thematic analysis, quality traceability, review of deliverables, launch assessment and other activities.

3) Demand management

Product demand comes from outside the company (customers) and other departments within the company (eg. marketing department, business department, supply chain, and R&D of product optimization and improvement). Defining the demand acceptance process supports the collection and analysis of product requirements, version planning and implementation verificationof demands, as well as demand changes and traceability.

4) Test management

It provides correlation of demand and test cases, test results and defect information, and can automatically export test reports. Statistics and export of test scale, test severity levels, and defect closure trends mainly achieve the demand end-to-end traceability and test defect management. The implementation of demand end-to-end verification provides a reliable basis for the final delivery of the product.

5) Configuration management

It provides configuration item identification, baseline, release and configuration change control, configuration library authority management. By defining process, it carries out configuration management planning, configuration library management, configuration change control, configuration release, configuration status release, and baseline release. The management with an R&D project as a unit ensures the integrity and consistency of the product during its life cycle.

6) Authority management

It provides role-based/post-based access control authority management function that allows users to access only their authorized resources. Authority management supports two methods: setting permissions for roles and setting permissions for groups. The access authority for different roles and groups can be configured. The types of permissions for an object are: search, read, write, change, delete, move in, move out, transfer, copy, submit, and schedule. The types of permissions for a process are: create relationships, expand relationships and delete relationships.

7) Expense management

It includes the budgeting, management and control of R&D project costs, the customization of management-related template support formats, and the integration with the current financial software.

8) Cost target management

It emphasizes on the realization of product target cost, keeps an eye on the cost of product installation, service, operation and maintenance in its full life cycle, correctly recognizes the hidden cost of the whole process, and take it into the consideration of front-end design and development.

9) Project dashboards:

PLM uses the back-end data collection and configurable logic calculations to display project status graphically from a variety of dimensions, such as workload, schedule, cost, purchasing and manpower.

10) Communication management

Identify stakeholders of R&D projects, ascertain their information requirements and communication methods, formulate communication plans, maintain communication environment for development, manage relationships with project stakeholders, and generate, release, and store project information in a timely manner to ensure timely and efficient project communication.

11) Project portfolio management

By defining project portfolio and project approval, project portfolio planning and monitoring, PLM can uniformly and dynamically manage resources and risks, share information easily, coordinate project dependencies, resolve manpower and resource conflicts, co-share external communication channels and reduce the risk of single project management, so as to achieve collaborative development and resource allocation of multiple R&D projects to ensure the maximum performance of the entire project group, rather than the optimal performance of individual projects.

12) Human resource management

It defines the list of R&D activities of the employees at each stage, and supports the project team members to fill out and submit the daily log, so as to clarify the daily tasks, durations, activity classification, attributed project and other information. It provides the measurement of project workload and the calculation of labor costs, and regularly generates the employee's working hour return form, which is to be reviewed and confirmed by the project manager. Employee hourly costs are included in management as part of the project costs.

## 2.3. RAMS Management

Theparticularity of signal system safety requirements: PLM customizes RAMS management functions according to the requirements of EN50126 Standard, which supports the safety requirement management of different stagesin the life cycle of R&D projects.

1) Safety management

With one project as an unit, it provides safety analysis and safety auditing functions, and enables data entering/importing, updating and other editing functions in the safety analysis process. It also provides traceability among analysis tables at different stages, traceability between analysis tables and demand or framework, relationship between analysis tables and hazard logs, relationship between hazard logs and test cases, traceability of analysis results, export of safety analysis process data and automatic generation of documents, hazard logs management, safety application condition management and safety auditing.

2) Reliability management

According to the established RAM strategy and RAM guarantee plan, the integration of processes and the reliability software Isograph is defined to implement the RAM activities and reliability, availability, and

maintainability objectives that must be implemented in each life cycle, and at the same time, the calculation and analysis activities required to prove that the system RAM target is met are provided.

# 3. PLM R&D Management Platform Application

UniTTEC Co., Ltd. has been designing and implementing the PLM R&D management platform since 2015. It has implemented the database construction based on materials and documents with 21 functional modules in 3 fields. The 46 custom process-driven data operation rail signal R&D management platforms and the R&D functional processes are shown in the following Table 1:

Table 1: R&D Management Custom Processes

| No. | Functional Module | Name of Electronic Process |
|---|---|---|
| 1 | Demand Management | Demand receiving electronic process |
| 2 | Quality Management | Review electronic process |
| 3 | Quality Management | Verification electronic process |
| 4 | Quality Management | Standard problem list |
| 5 | Quality Management | Simple problem list |
| 6 | Quality Management | Project implementation problem list |
| 7 | Quality Management | Quality improvement electronic process |
| 8 | Quality Management | Quality backtracking electronic process |
| 9 | Quality Management | Approval of issuance electronic process |
| 10 | Quality Management | Multi-level auditing electronic process |
| 11 | Quality Management | Project implementation problem list tracking electronic process |
| 12 | Quality Management | Project multi-level auditing electronic process |
| 13 | Configuration Management | Version transferred for test electronic process |
| 14 | Configuration Management | General product/application release electronic process |
| 15 | Configuration Management | Specific application release electronic process |
| 16 | Configuration Management | Authority request electronic process |
| 17 | Configuration Management | Design change request electronic process |
| 18 | Configuration Management | Version release electronic process |
| 19 | Project Management | Project establishment and approval electronic process |
| 20 | Project Management | Field development project status tracking electronic process |
| 21 | Project Management | Life cycle critical stage point technical review electronic process |
| 22 | Project Management | Task tracking electronic process |
| 23 | Project Management | Risk management electronic process |
| 24 | Project Management | Experience case release electronic process |
| 25 | Project Management | CBB release electronic process |
| 26 | Resource Management | Work log submission electronic process |
| 27 | Resource Management | Asset outbound electronic process |
| 28 | Resource Management | Asset maintenanceelectronic process |
| 29 | Resource Management | Asset transfer electronic process |
| 30 | Resource Management | Asset inventory electronic process |
| 31 | Resource Management | Asset cancelling stocks electronic process |
| 32 | Resource Management | Asset retirement electronic process |
| 33 | Performance Management | Performance appraisal electronic process |
| 34 | Product Data Management | New material model selection electronic process |
| 35 | Product Data Management | Parts upgrading request electronic process |
| 36 | Product Data Management | Mechanicalparts and cable trial-manufacture request electronic process |
| 37 | Product Data Management | Engineering change requestECR |
| 38 | Product Data Management | Engineering change order ECO |
| 39 | Product Data Management | Manufacturer change order MCO |
| 40 | Product Data Management | Components trial-manufacture |
| 41 | Product Data Management | Single-board trail–manufacture request electronic process |
| 42 | Product Data Management | PCB trail-manufacture request electronic process |
| 43 | Product Data Management | R&D procurement request electronic process |
| 44 | Product Data Management | Packaging feedback request electronic process |
| 45 | Product Data Management | Material status transition electronic process |
| 46 | Product Data Management | Manufacturer & brand request electronic process |

In 2016, the functions began to be applied gradually. The implementation of the R&D processes before and after application of the PLM R&D management platform was compared as shown in Figure 3 below:
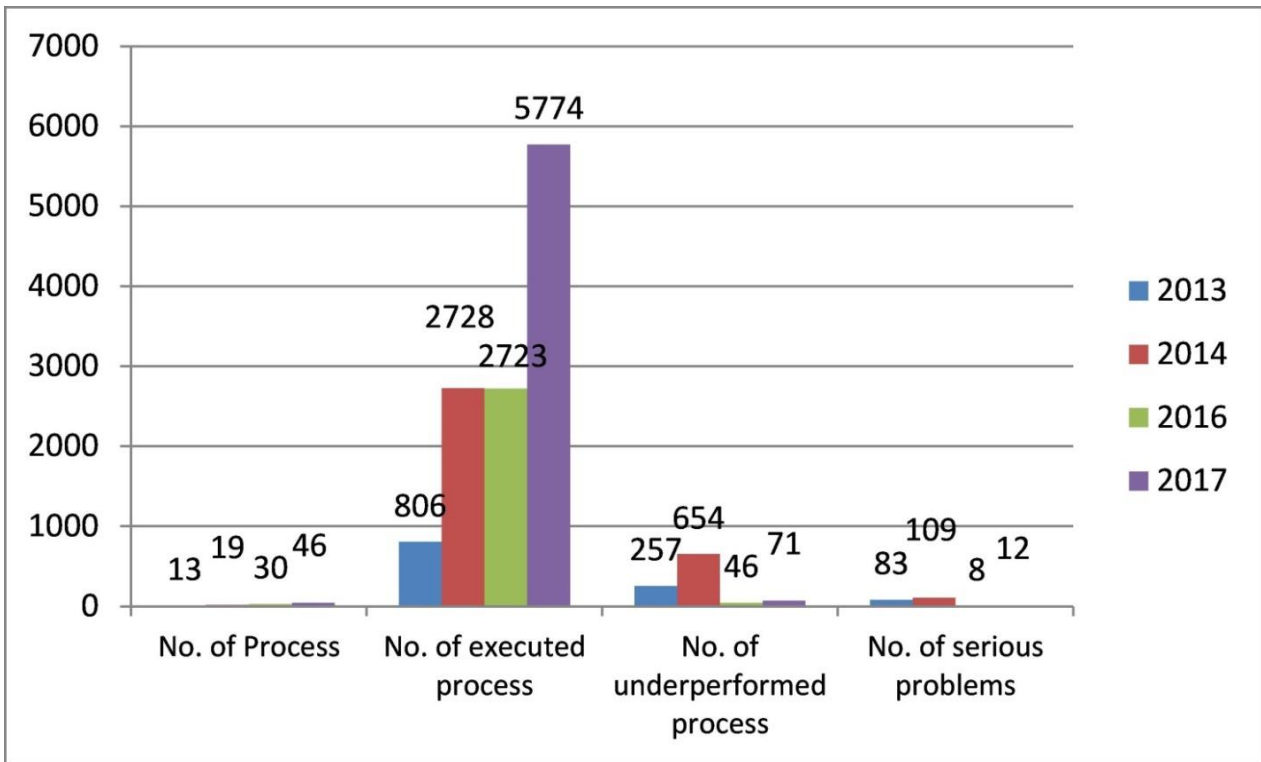
Fig. 1: Signal system R&D processes implementation condition

The improvement of process implementation condition is more intuitively reflected in the improvement of the quality and costs of product R&D and production, as shown in Figure 4 below:
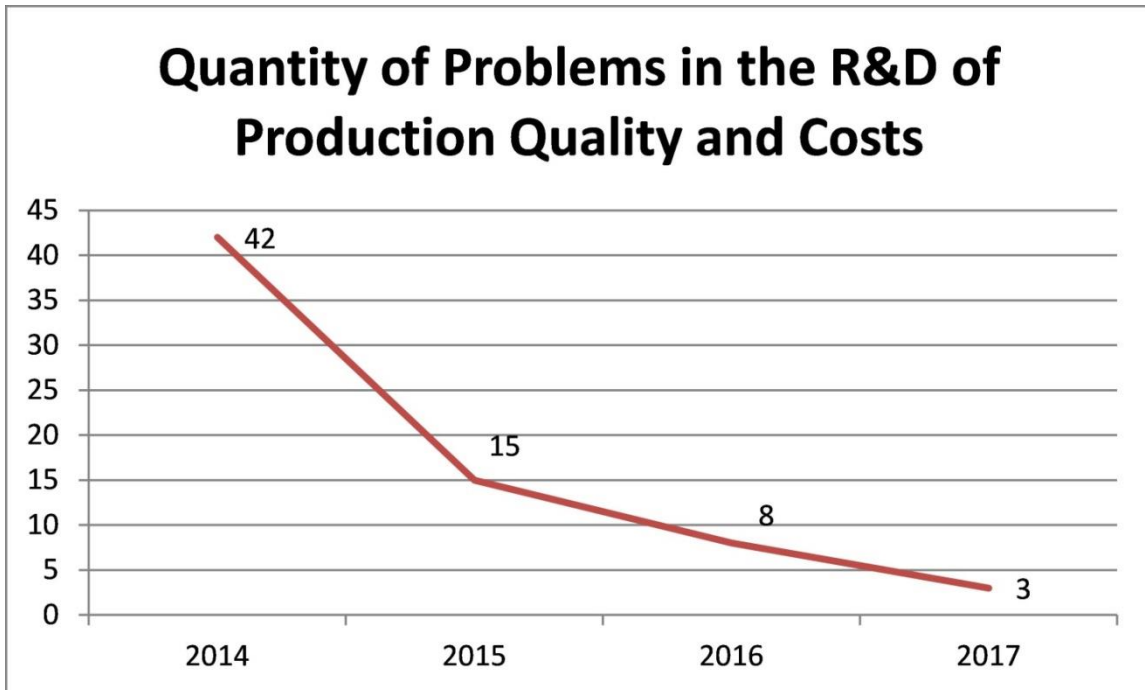


Fig. 4: Quantity of problems in the R&D of production quality and costs

## 4. Summary

The PLM R&D management platform has solidified the processes that meet the requirements of the EN50126/EN50128/EN50129 industrial standard and met the special requirements of rail transit signal equipment design. It adopts full electronic processes instead of the original paper processes, which greatly saves product R&D time and improve product traceability. High-quality, high-efficiency delivery of safe signal products is supported, and product delivery capability and R&D management level are enhanced.

## 5. Acknowledgement

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