Virtual System for Manufacture of Train using Project Data Management

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Abstract: Train has been developed to increase the operational speed of the trains on conventional lines which have many curves. This train is tilted at curves to compensate for unbalanced carbody centrifugal acceleration to a greater extent than compensation produced by the track cant, so that passengers do not feel centrifugal acceleration and thus trains can run at higher speed at curves. This paper developed PDM(Product Data Management) to make a system engineering of train with maximum operation speed 180 km/h.

Key-Words: virtual system, train, technology, curve, higher speed, PDM

1 Introduction
This study is about developing 180km/h train with train technology which overcomes the main problems of conventional train - derailment and the reduction of passenger's comfort on the curve due to centrifugal force.
The main issue of train development is to develop light train and optimize the arrangement of equipment in order to minimize the load on the track, and we need to design additionally train mechanism, train pantograph, and train electronic equipment which don't exist in the conventional train. Train technology can achieve its goal only when there is tight interface with car, car body, electronic equipment, and pantograph even in the train.
Therefore, in this study schedule management system, document management system, drawing management system, and part management system were developed based on system technology. These systems became the foundation for introducing system engineering technology to develop trains, and PDM was used and developed experimentally.
This system allows us to improve the reliability, safety, and economical efficiency of the developed train with efficient system engineering combination and optimization, and with design information sharing and systematic management this system is expected to be used in DMU(Digital Mock-Up) that checks problems in manufacturing lines beforehand by assembling each part in the virtual space, which will lead to short development period, and low cost.

<table>
<thead>
<tr>
<th>Bogie</th>
<th>Manufacture</th>
<th>angle</th>
<th>Speed (Km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETR 460</td>
<td>Fiat</td>
<td>8</td>
<td>250</td>
</tr>
<tr>
<td>X2000</td>
<td>ABB</td>
<td>8</td>
<td>240</td>
</tr>
<tr>
<td>Acela</td>
<td>Bombardie</td>
<td>6</td>
<td>210</td>
</tr>
<tr>
<td>VT611</td>
<td>Adtranz</td>
<td>6</td>
<td>160</td>
</tr>
<tr>
<td>ICT-VT</td>
<td>Siemens</td>
<td>8</td>
<td>220</td>
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<td>TGV-Pendu</td>
<td>Fiat- SIG</td>
<td>8</td>
<td>200</td>
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<tr>
<td>ICN</td>
<td>Alsthom</td>
<td>6</td>
<td>210</td>
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<tr>
<td>Virgin Rail</td>
<td>Fuzi</td>
<td>6</td>
<td>220</td>
</tr>
</tbody>
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Table 1 Major train system specifications of other countries

2 Train development in other countries
Train technology is to tilt the train on the curve in order to minimize centrifugal force to passengers and to improve the speed within the limits of passenger's comfort and safety. According to reports from other countries, there is 15~30% speed improvement compared to the conventional trains. In the case of Italy, as much investment has been done to train technology, there are 250km/h express trains just as good as TGV in France and ICE in Germany developed by Italian original technology trains in Italy. The efficiency of trains is relatively
much higher than constructing new express lines in the place where there are many mountains. Train technology is divided by two - forced train control system that controls the train with constant angle on the curve, and natural train control system that controls the train with natural angle created when the train runs on the curve. Now, most trains use the forced train system, and you can find major train system specifications of other countries in the table 1.

3 Train system engineering model
System engineering management model is designed for speed improvement on the conventional lines. Management plan model development followed the system engineering management plan guideline, and will be developed with three parts – document management system, drawing management system, and schedule management system. Fig. 1 is the system of train system engineering and shows each organization’s role, data sharing and interface concept.

3.1 System engineering requirement
3.1.1 Parts Management
It guarantees the conformity and the newest type of parts by managing all the information about part with part master management function, and provides part management, automatic part numbering according to part classification system. Also it integrate data centering part numbers and manages all general parts and standard parts by applying part management function and standard part management function.

3.1.2 Product Structure Management
It enables the intuitive management of part structure with CAD, the automatic E-BOM management according to product structure, and the E-BOM management by its version. It also enables the intuitive multi-layer product organization function with tree structure, and is the integrated management function that provides generation/search/modification of parts in product structure tree, CAD modeling and documentation.

3.1.3 Drawing management
It is connected with work process organically, and enables integrative/consistent drawing management. It also manages the history of drawing version, manages the attribution of drawings in relation with parts, and stores CAD data in its own file server. Also, CAD information is managed regardless of its categories.

3.1.4 Document Management
It manages documents by its categories. It enables the history management according to document version, and the management of document with related parts. It also enables users to search document quickly with various search conditions.

3.1.5 Process/Workflow Management
It includes electronic approval and electronic distribution. You can have multi-level approval, simultaneous approval and other various kinds of approval process with this function. Also you can monitor approval process and distribution status.

4 Train system engineering PDM setup
4.1 Train document management system
4.1.1 Document management system
The following document classification system is introduced to sort all the document produced in TTX project.
4.1.2 Code system
TTX○○-○○○○-○○○○- Rev ○ ○
Block 1  2  3  4

Block 1: Use the current code of TTX (Train technology R&D project/Speed improvement project of conventional lines) and rest two numbers show the phase and year of the current train technology development plan.

Block 2: Organization or department in charge
1st ~ 3rd number: ID of sub-project
3rd number: ID of detailed sub-project
4th number: ID of sub-contractor
5th number: Document management and sharing scope

Block 3: Type and serial number of document
1st place
P: Policy (Design specification, design standard plan, various rules and main document)
D: Design (Review, calculation, specification)
T: Test/evaluation (Test procedure, test result)
Rest three number is given to documents by its order. In order for consistency, each development organization should number in order and manage documents systematically.

4.1.3 Drawing management system
The drawing management system enables you to manage drawings, approved drawings, and reference drawings. You can also connect parts with drawings, manage multi drawings for one part and use various drawings and drawing tools. Fig. 3 is the drawing management system of TTX-PDM. TTX-PDM allows you to search drawings, and if you want drawing information from database, you can search drawings and check-out/check-in drawings.

4.1.4 Train project schedule management system
In TTX-PDM, we can control the life cycle of products with following the system. Project registers parts require by each product, defines the approval process, and manage products according to defined schedule. Also, you can easily handle project with template provide by basic information.

4.2 Train PDM construction
Since we started to develop system engineering technology for the speed improvement of conventional lines, we have used system engineering management methods to manage each development stage -- design, manufacture, and test. And system engineering methods are used to optimize the system. If we use this kind of methods, we have to manage all the huge design records. This means you can manage all the information with consistency from requirements to sub-systems required to meet such requirements and components. Also, it provides schedule management, risk prevention management, document management, and configuration management built according to system engineering methods as well as engineering management.

4.2.1 Standards for drawings
In developing train, the layout and the scale of drawings must be defined to prevent errors in drawings. Especially, since drawings downloaded from TTX-PDM are automatically viewed, drawing must be managed according to the consistent principle. For there are many kinds of CAD, AutoCad, Catia V4, and R10 are decided as standard tools, considering data compatibility.

When developing technology for conventional lines, it is very important to decide efficient 3D-CAD system in order to remove design errors in the early stage. Also, it is critical to achieve higher developing goals. PBS(Product Breakdown Structure) for each parts in TTX-PDM have two levels, and standards must be able to be applied with BOM(Bill of Materials).

4.2.2 Authorization
User management function decides PDM user management and program users’ role, so that it is useful for security control and can be used to control development teams with each member’s information.

User search function can provide user information from database, and user information is controlled by
admin (system manager). General users can change password. It can control user’s read/modification/print under the TTX-PDM, and monitor all the status of connected users and printing.

5 Conclusion
This study introduced how to set up the system engineering management system in order to develop trains for the speed improvement of conventional lines. Since it is very important to manage various parts, data in train technology, the management system like this study is necessary to secure reliability and safety of the system. After this, we will keep upgrading PDM built with system engineering technology and carry out studies on design/manufacturing, test and evaluation of parts and train. Through this study, we will study on how to improve speed of conventional lines. Also, we can construct the system for efficient management of development cost, weight and part unit prices, if we can successful finish train technology development project for the first time with PDM (Product data management). We can expect the drastic train technology improvement by sharing information on the network with CAD Viewer.

References: