Systems Engineering Management Plan for Korea Urban Maglev Program

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ABSTRACT: This study describes SEMP(Systems Engineering Management Plan) being applied for the successful promotion of a Korea national program of 'Urban Maglev Program'. The SEMP means a kind of fundamental document for total integrated managements of the program and of the systems engineering activities. Since the tasks and responsibilities of all participants of the program, involving the tasks to collaborate between them, can be clearly defined and described in the SEMP, all participants can share and clarify their role and responsibility. By the application of the systems engineering approach using SEMP, the successful result of the program is expected with the efficient process and this technology will be spread to the other related railroad projects.

1 GENERAL INSTRUCTIONS

Generally systems engineering(SE) is defined as <a synthetic approach way and tool considering various fields of engineering in order to develop the objective system successfully>. More concretely it can be defined as <the effective engineering activities with a proper analysis and control in doing the system development in the view point of considering system's usability and total life cycle (development, manufacturing, test & verification, distribution, operation, repair & support, training & disposal, and etc.)> (Min, S.K. 2007; Lee, H.W. at al. 2007). On the other hand, the management of SE is shown as the management activities in the SE processes, it is generally classified as following three categories (1) the activities of program's (or project's) plan/application/control, (2) SE processes themselves, and (3) specific engineering activities.

This study describes SEMP (Systems Engineering Management Plan) being applied for the successful promotion of a Korea national program of 'Urban Maglev Program'. The SEMP means a kind of fundamental document for total integrated managements of the program and of the SE activities. Since the tasks and responsibilities of all participants of the program, involving the tasks to collaborate between them, can be clearly defined and described in the SEMP, all participants can share and clarify their role and responsibility.

2 SEMP OF THE URBAN MAGLEV PROGRAM

The SEMP of the program is composed as follows. As the parts of program's plan/application/control, the program's final objective, total schedule, and organization of the program are described in the chapter 1 and 2 of the SEMP. The management of risk and TPM(Technical Performance Measure) are described in chapter 4 and 5, and the management of interfaces and documents are in the chapter of 8 and 9.

As the parts of SE processes themselves, the management of the system requirements/ specifications, design review and design change plans are defined in the chapter 3, 6 and 7. Furthermore the specific engineering activities such as RAMS (Reliability, Availability, Maintainability and Safety), LCC(Life Cycle Cost) and test evaluation/verification schemes are dealt in the appendix of the SEMP(Kim, D.S. et al. 2008).

2.1 Plan/Application/Contro1

2.1.1 Program's General/Schedule/Organization

The objective and schedule of the program are well known in the homepage of the program's organization (http://www.maglev.re.kr/). Table 1 shows the roles and responsibilities of each manager of the core and sub projects, and figure 1 shows the total SE schedule of the program.

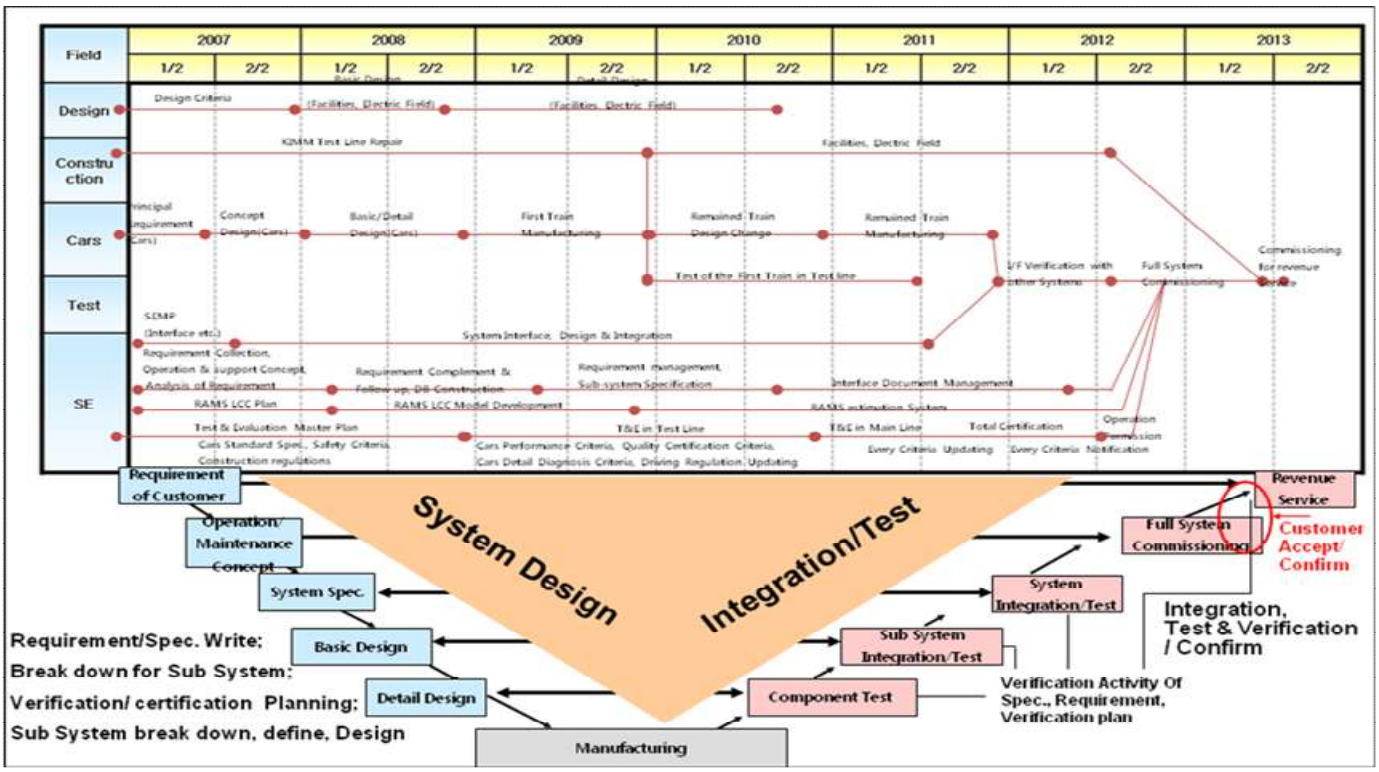

Figure 1. Schedule and SE Management Plan of the Program

Table 1. Roles and responsibilities of each project

Role	Responsibilities & Rights
Program manager	- Final Approval of SEMP - Approval & execution of each term written in this SEMP
1 Core project manager	- General management of SE - Drawing up SEMP and distribution - Updating SEMP - Mission execution of each term written in this SEMP
2 & 3 Core project managers	- Review & agreement of SEMP - Mission execution of each term written in this SEMP
Sub project managers	- Support to each core project - Mission execution of each term written in this SEMP

2.1.2 Management of Outputs & Documents

There representative outputs and documents of the program are as follows. <System Operation Service Scenario>, <System Requirements>, <System specification>, <Subsystem Specification (cars, signal & control communication, powers, guide rail, car base, station facilities)> are derived in chapter 3. From the design review & change management, <Design Review Reports(including Design Review Checklist)>, <Design Requirements & Specifications Follow-up Review>, <Design Change Order/Technical Review Report/Deliberation Report/Design Change Approval> are created.

From risk and TPM management, <Risk Management Plan>, <Risk Management Report>, <TPM Report> are derived. And <System RAM Management Plan/Report>, <Sub System RAM Management Plan/Report>, <System Safety Management Plan/Report>, <Test Evaluation Master Plan>, <Car Module Test Plan/Procedures>, <Car Test Plan/Procedure>, <Test Plan/Procedure in Test Track and Main Track>, <Principal Design of Integrated Measurement System> are derived from specific engineering activities.

2.1.3 Interface Management

Since the MAGLEV system is composed of cars, guide rail, signal & control communication, powers, car base, station facilities and other subsystems, the interface problems come from very important things. Within in the SEMP, the generation and solution procedure of the interface problems are defined, and

it's DB is collected and shared with all participants of the program.

2.1.4 TPM Management

As TPM (Technical Performance Measurement) is a way to measure the accomplishment of the technical goals by comparing the prediction and actual acquired value respect to key performance parameters which are built in the beginning point of program development schedule, it could be good criteria for the manager of the program to do his decision making.

By the TPM management, the program manager can control effectively the agreement of the acquired performance value with planed goals during the period of the program consistently. The effects of TPM management are come out as (1) derivation of early warning for technical problems, (2) level-up of management effectiveness (3) exclusion of a new danger factor which causing additional huge costs or time delay, (4) estimation of the effectiveness of the system performance change.

As the MOP (Measure of Performance) of this program, the key performance parameters are shown in Table 2.

Table 2. Key performance parameters for TPM

MOP	Goal value
Car length	28 m
Car weight (w/o passenger)	40 ton
Noise	65 dB (inside of car), 70 dB(A) (outside of car)
No. of passenger	93/car
Levitation gap	8 mm, (± 3mm deviation) at 110 km/h
Climbing ability	70 ‰
Acceleration ability	4.0 km/h/s
Braking ability	4.0 km/h/s (normal) 4.5 km/h/s (emergency)
Min. horizontal curve radius	50 mR
Min. vertical curve radius	1000 mR
Riding quality	UIC criteria 2.0 under
Deformation limit of guide rail	L/1500 – L/2000
Vertical gap of rail	1 mm under
Horizontal gap of rail	0.5 mm under

2.2 SE Process Management Plan

2.2.1 System Requirement (SR) Management Plan

The key of the SE activities is analysis and control of the objective system to be developed. Among the system analysis and control activities, the firstly required action is to set up and manage the customer's SR(system requirements).

In this program, through the organization of SR task force team, advisory committee of specialist, and review of operator, SR was set up and its change procedure was defined as figure 2.

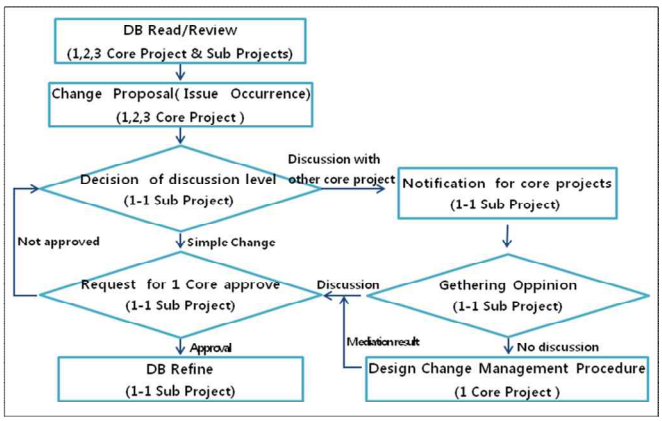

Figure 2. Management plan of SR

2.2.2 System Specification

The system specifications were derived for the total system itself as well as for the all sub-systems. Each design specification was set up considering the related items of system operation service scenario and system requirements, and it was reviewed by various parts of interest such as system operator, system developer, and the 3rd part of specialist.

Each design specification was prepared by 1-1 sub project named of "Development and Management of System Engineering of the Urban Maglev Program" and approved by the program's organization supported with all core projects.

2.2.3 *Design Review*

The purpose of design review is focused on satisfying the design requirements and checking the consistency between system specifications and design results which come out in each design step. In this program, the checklist which comes from the D/B of design requirements and specifications, supplies the design review criteria. The items of design review checklist have the serial number and the contents of specification corresponding to each design requirement.

On the other hand, the design review processes have the following steps;

○ System Requirements Review
- execution at the step of SR approval
- check of the consistency between system requirements and system specifications

○ Preliminary Design Review
- execution at the step of preliminary design completion
- review of preliminary design in the view of total system, all sub-systems, and component's level.

○ Critical Design Review
- execution at the step of critical design completion
- final review of all kinds of critical design results preparing for manufacturing

2.2.4 *Design Change Management*

In the management of design change, the design changes which affect the whole of the program are only concerned. These changes affect not only one direct project but other related projects. More concretely the following items of design change are concerned; (1) change of RFP, (2) change come from customer's requirement, (3) change of contract, and (4) change effecting the cost and time delay of the other projects.

Figure 3. Design change process

Figure 3 shows the design change process. When a major design change occurs, the program organization can approves and confirms the change via considering the opinion of the design change committee.

2.2.5 *Report for Design Consistency Pursuit*

Using the DB relationship between design requirement and specification pursuit, <Design Requirement & Specification follow-up Review> is created for any special components or specifications which are to be reviewed. Design review and system integration activities are supported by this consistency pursuit report.

This <Design Requirement & Specification follow-up Review > is created in the case that design review is performed at the various points of view, for example, when related laws or design criteria are changed or major design change is occurred.

2.3 *Specific Engineering Activities*

RAMS (Reliability, Availability, Maintainability and Safety), LCC(Life Cycle Cost) and test evaluation/verification schemes are dealt in this program as the specific engineering activities and these activities are practiced and managed as the form of sub projects of 1st core project (system integration project).

RAMS research is finally aimed to the analysis of reliability, availability, maintainability and safety of the system by using the practical prediction model based on real measured data.

LCC research is to develop the LCC model of the maglev system by using the data of inner and international similar projects for urban railroads or light electric railroads. It aims to construct highly complete LCC structures of maglev system by predicting the life cycle costs based on practical measured values.

Test evaluation/verification research has the following action items; (1) development of the system for the test evaluation and verification which aims to export market share respect to the system products, (2) development and standardization of test plan and procedure for the urban maglev system, (3) full system commissioning in main test line, (4) design and achievement of test measure equipment, (5) certification of authorization organization for test.

3 CONCLUSION

While it is emerging as very essential thing to apply SE technology in development of large complex systems, this maglev program is being practiced as one of national R&D programs. Since in this program, SE application is conducted by a mixed type with an existed national R&D propulsive system, it has some handicaps to apply SE management techniques consistently and powerfully. However as described in above, the SE technology is applied in this program by construction of synthetic management system for the program's plan/application/control, and by construction of SE processes for system requirement/ specification/design review/specific engineering activities. Furthermore by the application of the SE approach using SEMP, the successful result of the program is expected with the efficient process and this technology will be spread to the other related railroad projects.

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