

Chapter 93

Research on the Project Hierarchy Scheduling for Domestic Automobile Industry

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Abstract To improve the accuracy and performability of the vehicle R&D project scheduling of domestic automobile enterprises, a “4 + 1” hierarchy process system of domestic automobile enterprises is analyzed and summarized. A corresponding four levels scheduling management mode of the vehicle R&D project is presented based on the hierarchy process system, and a planning approach of three-month rolling schedule for the fourth level is proposed. Schedule minor adjustment and modification are given to solve the different extent change of rolling schedule.

Keywords Hierarchy process · Hierarchy scheduling · Rolling schedule · Schedule minor adjustment · Schedule modification

93.1 Introduction

The research and development (R&D) of automobile products is complicated system engineering. The automobile R&D has a long cycle, and involves wide range of knowledge. At present, the R&D of a new model on a new platform

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generally requires 36–48 months, even on an existing platform it still requires 18–32 months (Wang 2009). The R&D process involves lots of knowledge and technology, such as mechanics, aerodynamics, structural mechanics, aesthetics, electrotechnics, electronics, cybernetics, computer science, etc. (Lin 2008). Therefore, professionals from different functional departments and different subject areas need to collaborate with each other to complete the R&D work.

For such a complicated huge system engineering, how to develop automobile products which meet the market and customer demands in limited time? This puts forward higher request to R&D process and R&D project management of new products. In recent years, Chinese automobile enterprises continue to learn from international leading enterprises, and many management tools and management methods such as advanced product quality planning (APQP) (Chrysler Corporation, Ford Motor Company, and General Motors Corporation 1995; Chen 2008) and project management (Liu 2009; Ju 2008; Zhang 2008; Sun 2004) are introduced to local automobile R&D process. They build their own R&D process based on learning from the standard R&D process of foreign enterprises.

However, due to the shortage of time, data and experience, immaturity of management and many other reasons, the R&D process cannot be properly implemented in domestic automobile enterprises, and the advanced management theory of project management cannot be well applied in the automobile R&D process management. Therefore, this paper analyzes and summarizes the current product R&D process of domestic automobile enterprises, presents corresponding management mode of the vehicle R&D project scheduling, and gives the solution to schedule decomposition problem caused by the long cycle and wide range of products R&D.

93.2 The Hierarchy Process of Vehicle R&D

Most domestic automobile enterprises have adopted hierarchy process to manage the R&D process. The vehicle R&D flow is divided layer by layer following a coarse-to-fine sequence in order to facilitate the process management. According to the R&D process, the vehicle R&D flow is divided into four levels: company quality gates (Q-Gates) level (the first level flow), cross majors/fields level (the second level flow), cross departments level (the third level flow), department level (the fourth level flow). The enterprises usually define a level with foundational fixed flow to implement of the four levels of R&D flow smoothly. So the flow system of automobile enterprises is the four levels of R&D flow plus a level of foundational fixed flow.

- (1) Company Q-Gates level. Based on the quality requirements of APQP and the management theory of Stage-Gate, the vehicle R&D process is divided into several stages, and the R&D quality of products is ensured through setting up a

Q-Gate between two stages. These R&D stages and Q-Gates constitute the flow of company Q-Gates level.

- (2) Cross majors/fields level. On the basis of division of stages and Q-Gates, all the flow nodes of company Q-Gates level are subdivided according to majors or fields which are involved by automobile products, and the second level subflow of cross majors or fields is defined.
- (3) Cross departments level. The flow nodes of cross majors/fields level are subdivided to departments which are involved by all majors or fields, and the third level subflow of cross departments is defined.
- (4) Department level. The R&D flow is defined within the departments according to their business scope in the vehicle R&D process. The flow is also the subdivision of cross departments flow nodes, so it is the fourth level flow in the vehicle R&D process system.
- (5) Foundational fixed level. In order to improve the R&D efficiency, the enterprises establish many fixed flows for certain R&D activities, as the basic supporting of the vehicle R&D process system. The flows can realize the automatic transfer among different steps of flow activities, avoid repeated hand labor and reduce manual workload.

Figure 93.1 Shows the “4 + 1” process system of Q automobile Co., Ltd. which is established based on their new product R&D manual (<http://doc.mbalib.com/view/d9fd9a8d5538f64af4cfb3>; <http://www.docin.com/p-220283401.html>; <http://wenku.baidu.com/view/dd7f9633a32d7375a4178066.html>). In the first level, the vehicle R&D process is divided into eleven stages from P0 to P10, and eleven Q-Gates are set up, such as new project research instruction, project R&D instruction, engineering start instruction, digital prototype and so on. In the second, the stages are subdivided according to the involved majors or fields. Taking P2 sculpt design stage as an example, it's divided into many tasks belong to mechanical design, manufacturing process, marketing, and other majors. In the third level, the flow of cross majors or fields is subdivided to departments. Taking the first round structural design as an example, the flow is divided to platform technology department, battery system department, CAX design simulation department and others. In the fourth level, the R&D flow in every department is defined. Take the first round assembly design as an example, the flow defines four flow steps that are the definition of system function and performance, the design of system parts and components, the definition of parts and components function and performance and the summary of system data. Document approval flow is a foundational fixed flow, and the typical procedures include compile-proofread-audit-approve.

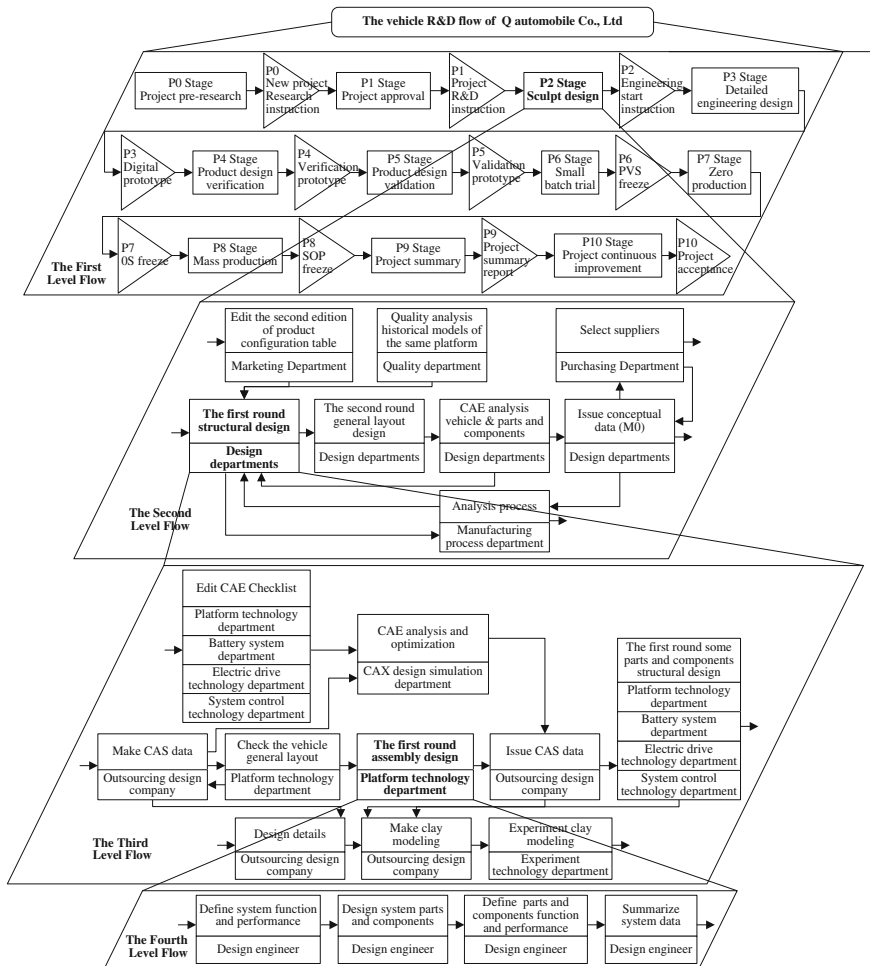


Fig. 93.1 “4 + 1” process system of Q automobile co., ltd

93.3 The Scheduling of Vehicle R&D Project

93.3.1 Hierarchy Schedule

In automobile enterprises, the thought of project management is introduced to manage the vehicle R&D process. The hierarchy schedule is developed for the vehicle R&D project corresponding to the hierarchy R&D flow model of automobile products to help enterprises implement the automobile R&D process more convenient. Based on the four-level R&D flow, the vehicle development project schedule can be decomposed into four levels: the first level schedule (big schedule), the second level schedule (cross majors/fields schedule), the third level

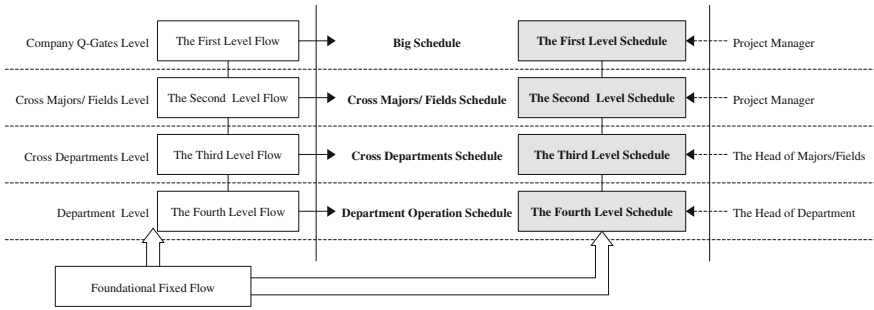


Fig. 93.2 Corresponding relationship between hierarchy R&D process and hierarchy schedule of automobile

schedule (cross departments schedule) and the fourth level schedule (department operation schedule). It is corresponding layer by layer between the four-level R&D flow and the four-level schedule, as shown in Fig. 93.2.

- (1) The first level schedule, also known as big schedule, is planned by project manager based on the vehicle R&D Q-Gates flow. The vehicle R&D stages correspondingly constitute the stage summary tasks in the first level schedule. The Q-Gates correspondingly constitute the milestones.
- (2) The second level schedule is cross majors/fields schedule. It is planned by project manager based on the vehicle R&D cross majors/fields flow. The flow nodes correspondingly constitute the tasks in the second level schedule, and are put under the phase tasks which correspond to the high level flow nodes of the second level flow nodes, so this level schedule is also the decomposition of the first level stage schedule. In addition, the second level schedule tasks will be assigned to the appropriate majors or fields.
- (3) The third level schedule is cross departments schedule in the project. These tasks of this level schedule are the decomposition of the majors or fields tasks by the head of majors or fields based on the cross departments flow, and the tasks will be assigned to departments. The third level flow nodes correspondingly constitute the tasks in the third level schedule.
- (4) The fourth level schedule is operation schedule within the departments. The head of departments decomposes the work of the third level schedule tasks based on the department flow and the functions and responsibilities of the department. The fourth level flow nodes correspondingly constitute the fourth level schedule tasks, and the tasks will be assigned to the project members.

There is no direct relationship between the foundational fixed flow and the decomposition of the project schedule, but the flow can support the implementation of the schedule tasks.

Figure 93.3 shows the four-level R&D project schedule of Q automobile Co., Ltd. which is planned based on the company’s four-level vehicle R&D flow.

	Task Name	Resource Name		
1	⊕ P0 Project pre-research stage		<div style="display: flex; flex-direction: column; align-items: center; justify-content: center;"> <div style="margin-bottom: 10px;">The first level schedule</div> <div style="margin-bottom: 10px;">The second level schedule</div> <div style="margin-bottom: 10px;">The third level schedule</div> <div style="margin-bottom: 10px;">The fourth level schedule</div> </div>	
21	P0 Issue new project research instruction			
22	⊕ P1 Project approval stage			
69	P1 Issue project R&D instruction			
90	⊕ P2 Sculpt design stage			
91	Edit the second edition of product configuration table	Marketing Department		
92	Quality analysis historical models of the same platform	Quality department		
93	⊖ The first round structural design	Design departments		
94	Edit CAE checklist	System control technology department, Electric drive technology department, Battery system department, Platform technology department		
95	⊕ CAE analysis and optimization	CAX design simulation department		
97	Make CAS data	Outsourcing design company		
98	Check the vehicle general layout	Platform technology department		
99	⊖ The first round assembly design	Platform technology department		
100	⊕ Define system function and performance	Wang Wei, Li Tao		
102	⊖ Design system parts and components	Li Tao, Wang Wei		
103	Design mounting system	Li Tao		
104	Design cooling system	Wang Wei		
105	⊕ Define parts and components function and performance	Li Tao, Wang Wei		
107	Summarize system data	Li Tao		
108	Issue CAS data	Outsourcing design company		
109	⊕ The first round some parts and components structural design	System control technology department, Electric drive technology department, Battery system department, Platform technology department		
115	Design details	System control technology department		
116	Make clay modeling	Outsourcing design company		
117	Experiment clay modeling	Experiment technology department		
118	⊕ The second round general layout design	Design departments		
127	⊕ CAE analysis vehicle & parts and components	Design departments		
129	⊕ Issue conceptual data (M0)	Design departments		
131	⊕ Analysis process	Manufacturing process department		
145	⊕ Select suppliers	Purchasing Department		
151	P2 Issue engineering start instruction			
152	⊕ P3 Detailed engineering design stage			

Fig. 93.3 Vehicle R&D project schedule of Q automobile co., ltd

93.3.2 Rolling Scheduling

The vehicle R&D project has long project cycle, involves wide majors and fields range, needs many coordinated interaction among departments, exists more uncertainty factors. Therefore, in the stage of project approval, the schedule cannot be decomposed exhaustively, only the first, the second and the third level schedule can be initially decomposed based on the standard R&D stages, the involved departments and overall R&D requirements. The detailed fourth level specific operation schedule within department is difficult to accurately plan.

The method of rolling scheduling (<http://baike.baidu.com/view/1359753.htm>) can effectively solve the above problem as it can regularly revise future schedule. The schedule is planned based on the principle of detailed recent and coarse forward. It means to plan detailed specific recent schedule and the coarse forward schedule at first, and then regularly make the necessary adjustments and revision to the schedule according the situation of implementation and the technical problems. The method combines recent scheduling and forward scheduling. On the one hand, it can plan the next R&D tasks in advance. On the other hand, it can solve the contradiction between the relative stability of schedule and the uncertainty of

actual situation better, and effectively improve the accuracy and performability of schedule.

The R&D cycle of domestic automobile products is usually 3–5 years, so the three-month rolling period for domestic automobile enterprises is reasonable and easy to manage and achieve. Therefore, it is needed to plan three-month rolling schedule in the period of vehicle R&D project. It means that the fourth level schedule of the next 3 months is planned in every month.

In the process of planning three-month rolling schedule, the schedule will be adjusted and revised according to the actual situation. It may lead to different extent change of the schedule. Two ways can be used to deal with different extent change.

- (1) Schedule minor adjustment. The project managers can adjust the project schedule for small change of schedule which does not affect the milestone tasks and the key tasks on the critical path.
- (2) Schedule modification. When the change affects the milestone tasks and the key tasks on the critical path, the project managers must modify the project schedule. The schedule modification will be achieved through implementing the change flow of project schedule, and then increase the version of the schedule.

93.4 Conclusion

Based on the management status of the vehicle R&D of domestic automobile enterprises, the paper analyzes and summarizes the “4 + 1” flow system of domestic automobile enterprises, which includes company quality gates(Q-Gates) flow, cross majors/fields flow, cross departments flow, department flow, and a level of basic foundational fixed flow. According to the four levels R&D process of vehicle, the paper presents corresponding four levels schedule management mode of the vehicle R&D project, which includes big schedule, cross majors/fields schedule, cross departments schedule, department operation schedule. The paper proposes a planning way of three-month rolling schedule as the fourth level schedule is difficult to detailly and accurately plan. Finally, the paper gives two ways, which are schedule minor adjustment modification to deal with different extent change of rolling schedule.

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References

- Chen G (2008) FA corporation's R&D process reengineering Based on APQP and project management (in Chinese), Xiamen University
- Chrysler Corporation, Ford Motor Company, and General Motors Corporation (1995) Advanced product quality planning (APQP) and control plan reference manual, in press
Information on <http://www.docin.com/p-220283401.html>, (in Chinese)
- Information on <http://baike.baidu.com/view/1359753.htm>, (in Chinese)
- Information on <http://wenku.baidu.com/view/dd7f9633a32d7375a4178066.html>, (in Chinese)
- Information on http://doc.mbalib.com/view/d9fd9a8d5538f64af4cfb3_b7593da32b.html, (in Chinese)
- Ju Y (2008) Research on application of the project management in R&D of CA 305 automobile self-determination-oriented products (in Chinese), Tianjin University
- Lin J (2008) Research on methods and application of project management to the new vehicle research & development Project (in Chinese), Tianjin University
- Liu S (2009) The application of project management on entire vehicle design (in Chinese), Shanghai Jiao Tong University
- Sun W (2004) Application of project management in automobile product development, (in Chinese). *Automob Sci Technol* 4:44–46
- Wang W (2009) Research of project management based on vehicle products R&D (in Chinese), HeFei University of Technology
- Zhang Q (2008) Application research of the project management based on lifecycle in automobile development (in Chinese). *Shanghai Auto* 8:24–27