New Product Introduction in the Electronics Industry

Tiina M Apilo
VTT Industrial Systems
Finland

ABSTRACT
This paper shows a new method for minimizing the New Product Introduction (NPI) time of electronics manufacturing. The Fast Ramp-Up project defines the constructed and tested framework used for controlling the process from R&D to the production ramp-up process in the electronics industry. The suggested construct is based on tailored simulation games and change management measures. Thus, the Original Equipment Manufacturers (OEMs) and the Contract Electronics Manufacturers (CEMs) practiced the NPI process by using simulation games. The characteristics of a successful NPI process are also described.

Keywords: New product introduction, ramp-up, electronics industry, simulation games.

1. INTRODUCTION

Today, high tech industries have shifted their focus from minimizing time-to-market to minimizing time-to-volume [1]. Moreover, the custom-oriented electronics industry includes economic aspects by formulating their NPI target to minimizing time-to profit. Indeed, companies in the electronics industry face new challenges and trends; short product cycles, due to market demand, cause constant ramp-ups and ramp-downs. Furthermore, strong outsourcing makes these product changes really challenging.

The Original Equipment Manufacturer (OEM) focuses more and more on R&D, brand and marketing; the Contract Electronics Manufacturer (CEM) undertakes production and logistics. In addition, the role of CEMs is increasingly carrying out manufacturability design, testability design and R&D as a whole.

The starting point of the research was to find ways to accelerate ramp-up and increase co-operative effectiveness and the efficiency of OEMs and CEMs. Due to the short history of using contract manufacturing on a large scale, not many studies expand on ramp-up processes in a supply chain context.

Terwiesh, Chea and Bohn defined production ramp-up as a period during which a manufacturing process makes the transition from zero to full-scale production at targeted levels of cost and quality. [1] They concentrate on determining components that cause losses in ramp-up phase production: yield, rework and breakdown losses etc. Haller, Peikert and Thoma have emphasised the importance of short and stable cycle times during ramp-up [2].

2. BACKROUND

The preliminary pragmatic objective of this project was to radically improve the performance of ramp-up processes in the case enterprises in terms of quality, time and costs. Simultaneously, the research objective was to produce new, tested and applicable knowledge concerning New Product Introduction (NPI) and particularly development of ramp-ups in the electronics industry.

Obviously, doing the right things in the right way in the R&D phase ensures, or at least enables, fast production ramp-up. Based on these findings we have broadened our research scope from production ramp-up to the NPI process. We can now define NPI as follows: New product introduction is the co-operative process of combining and integrating the needed organizations, functions and activities cost-efficiently in order to bring the new product from R&D to full-scale manufacturing in a supply chain environment. Figure 1 illustrates the definitions of ramp-up, production ramp-up and NPI showing the cost curves of an OEM and a CEM during a product development and a launching phase.

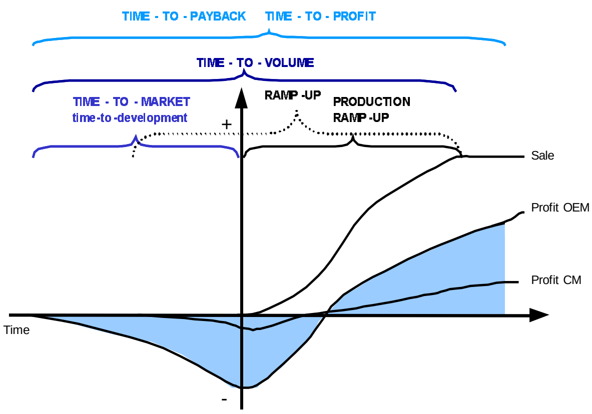

Figure 1. Focus minimizing from time-to-market to time-to-profit.

Kieran, Reed and Bourdeau [3] have listed the top ten NPI challenges as follows:

- synchronization of build schedule dates with changes in board CAD exit dates,
- communication among groups at each hand-off step in the process,
- communication of changing priorities between OEM and CEM,
- managing engineering change order (ECO) activity and last-minute design changes,
- tooling procurement in short lead times,
- synchronization of software availability for builds and the impact of code availability on test development,
- sizing of process and test capacity and ensuring test process readiness for pilot and production builds,
- managing high-quantity ramp-rates from prototype through production and
- maintaining BOM and documentation accuracy from prototype through production,
- material availability to line up with build schedules.

Loch and Terwiesch also state the importance of communication in reducing rework [4]. According to Paasivaara, the main communication problems in networked R&D are a lack of common communication and information exchange mechanisms, an over-reliance on key individuals, a lack of understanding of information needs of partners and information generation, and a lack of direct contacts and non-working network level document management [5].

3. METHODS

In the Fast Ramp-Up project adapted and tested the change measure management system and simulation-game-based change process framework in an NPI environment, which Taskinen [6] initially constructed for the radical development of production processes. Using information obtained from five companies from the electronics industry, the project was conducted as a case study.

3.1 Simulation–game-based change process

Using a tailored simulation game has many examples both in manufacturing process development and the administrative process [7, 8, 9, 10]. Equally, the OEMs and the CEMs in all five companies practiced the NPI process using tailored simulation games. In two cases an OEM and a CEM practiced co-operation together, and in the third case a concern company had its own manufacturing units. All three cases used in Figure 2 illustrated a development process of 15 steps. On the whole, each case lasted from 8 to 12 months.

3.2 NPI simulation came

During the study three main uses were recognized for a tailored NPI simulation came. The first is the above-described simulation game applied to develop the NPI process. The main targets of this kind of game are to collect a large number of development ideas and obtain commitments to change from participants in the development process.

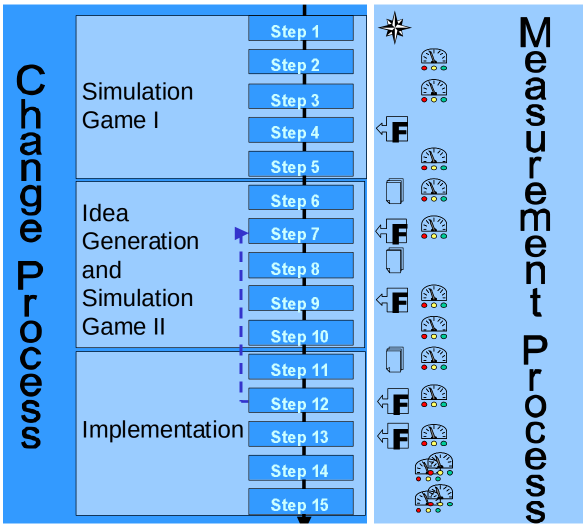

Figure 2. Steps of the simulation-game-based change management process. (Modified from Taskinen, [6])

The main target of the second type of game is to implement new processes and furthermore search for development ideas as a continual improvement task. Incidentally, this type of game can be used to implement a new process developed in a pilot unit to other units in the enterprise or with another CEM etc.

Finally, the third application is a training game. A new product program can be practiced in the planning phase with a simulation game. The training game functions as risk estimation and an evaluation tool of the project plan in a kick-off phase. In the same way, the training game can add to the training of new employees. A detailed process flowchart that is defined and used in a simulation game process is also later suitable for training new employees.

The NPI simulation game used here looks more like a structural discussion workshop than a simulation game used to simulate a production process with tact times etc. In fact, the tact time and time cycles are radically longer in the NPI environment than in normal production processes; they are measured in days rather than seconds. In addition, generally the collection of initial data for a tailored NPI simulation game requires more work and time than for a manufacturing process simulation game.

In the NPI simulation game a discussion between cross-functional teams and over company borders is a matter of consequence. In the game situation, a flowchart is projected on the wall showing the NPI process constructed earlier by a project group in the game construction workshop. During the game, the cross-functional teams, in which one can be a CEM, participate in a structural discussion with real documents. Indeed, the participants get a considerable illustration of the whole NPI process and can better understand their own role in terms of both significance and interdependence of separate tasks in the NPI process.

3.3 Change measurement systems

Taskinen classifies the simulation-game-based change measurement system into two types: measurement of change projects and measurement of process, which will be changed [6]. Both of these metrics have three dimensions: human resources, processes and technology. Furthermore, both of these dimensions have been reviewed from effectiveness and efficiency perspectives. The particular measurement framework has been tried and tested in the NPI environment. Nevertheless, the change project measurement was mainly used to direct the attention of project groups to doing the right things in each project phase and noticing the essentials. Thus, the change project measurement queries gave fast feedback regarding both the progress of the project and the readiness for, and commitment to, change.

4. NEW PRODUCT INTRODUCTION PROCESS

4.1 Developing the NPI process

An OEM can claim to succeed in the competition of fast changing markets only by managing the right time launching. Here, right timing involves both the timing of the original design plan and the right timing in the given market situation. Above all, an OEM has to launch a product with the right volume, quality and cost. Based on this target an OEM will develop efficient R&D processes and methods. In any event, in today's complicated and fast changing markets, going it alone has become inadequate. An OEM needs to develop efficient NPI processes and methods together with their key supply chain partners.

The main targets in cutting NPI time in these three case studies were to decrease the through-put time of R&D, minimize the number of prototype iterations, and avoid communication difficulties and the resultant non-value-adding work. As noted earlier, the case OEMs and the CEMs used the simulation game to develop their NPI process. The game process, including game construction meetings, management meetings, simulation games and idea workshops, offers the chance to share the learning process. First of all, during the simulation game, the partners could concentrate on developing their co-operative NPI process without daily business problems.

The most important result of the development work between the partners proved to increase an understanding of each other's processes. Also, in the same way, they learned from the processes of their own cross-functional teams. During the simulation game process the partners communicated what information was needed in a specific phase, and why. Accordingly, one significant factor in the study was the co-operation agreement on methods and terms for communication between OEMs and CEMs. By using the same terms for information exchange, partners avoid unnecessary misunderstandings.

Moreover, a need to formalize routine information exchange has emerged for the same reason: avoiding misunderstandings. In addition to formalizing routine information, the partners became aware of the significance of informal information exchange in the concept phase of development. In the concept phase, where the product structure is not yet defined, CEMs in many cases increasingly bear the responsibility for manufacturability design, and in the circumstances need earlier and much more detailed information from OEMs than before. Likewise, the transfer from a prototype series to volume production will be easier and faster if the products have been designed according to the requirements of the manufacturing facilities of the CEM. Similarly, CEMs need early information about production methods, components and time schedules. In the new processes of the case companies, the CEMs are involved in a product program one to two phases earlier than before. Further, an informal information exchange regarding a new upcoming program is not the only way to improve co-operation; CEMs also participate in product design meetings.

The results and comments from the case companies were encouraging. Above all, the OEMs and the CEMs learned to understand their own processes and co-processes. In addition, participants in each development case project discovered a substantial number of development ideas. According to the questionnaire, the participants strongly committed themselves to these needed changes after the simulation game. Moreover, in one case, the OEM used the NPI simulation games as a tool for planning and rating risk in a virtual NPI by exercising the new product program beforehand in the product definition phase.

4.2 NPI process

Here we look at the topics of particular interest that emerged during a successful NPI. Evidently, a formal and well understood gate model of R&D, in which the NPI function is observed, helps a firm to manage a product program to volume production and thereby to profit. Companies with a fully implemented gate model use stages and gates as points on a common map. Thus, a model understood the same way by everyone helps communication between cross-functional teams. The teams do not have to explain what has been done so far and what follows next; they merely state at what stage of the product program they are.

The second success factor of the NPI process besides the formal and implemented gate model seems to be extensive review meetings at every gate. Specifically, in the early stages of the product program representatives of many teams are needed, not forgetting manufacturing and logistics. Figure 3 illustrates an example of an NPI process has taken into account the exigencies posed by the electronic industry.

Concept

Many firms have a lot of improvement potential in the management of a concept stage. Namely, the concept stage will be the next one needing to be formalized and developed. Because of the need for big volume and fast ramp-up, in a concept stage the same attention has to be drawn to the feasibility of manufacturing technology as to the feasibility of design. OEMs are increasingly transferring the task of follow-up and checking the manufacturing technology to CEMs. Also, using a CEM for manufacturing, an OEM will avoid piloting a new manufacturing technology itself every time. In other words, an OEM will share the technology risk and cost of development work with other OEMs. In addition, a selection of components and suppliers is ready after the feasibility study already at the concept stage.

Planning

To ensure a successful NPI process at the planning stage, proficiency of co-ordination of technical and industrial design is essential further to the manufacturing and testing requirements. To take cognisance of manufacturability, a CEM participates in the specification work and project planning. A project plan is completed including a ramp-up ending criterion definition at this stage.

Specification

At the specification stage, after implementation specification, a CEM participates in a new and critical component check and capacity planning of a ramp-up.

Development

At the development stage, an OEM informs as early as possible a preliminary BOM (bill of materials). Therefore, a CEM has too short a time to prepare for manufacturing and especially for source materials and components, if an OEM waits until all documents are ready and the quantity and date of an order are fixed. A systematic version numbering minimizes the risk of confusion at this early informal phase of information exchange. At the same time, with product design the test process is defined, and a CEM participates in the defining work.

Testing

A successful testing stage is composed of quick feedback of proto manufacturability and management of product change. Because virtual design systems have not yet replaced protos, minimizing of the proto series is one substantial task in cutting the NPI process time.

The decision concerning the place of proto manufacturing is linked to an OEM's rating of fastness, nearness and learning possibilities. OEMs who manufacture proto series give several reasons for doing so, like having it near the R&D in the same building or same company, or they deem proto manufacturing to be a confidential phase. In addition, by manufacturing

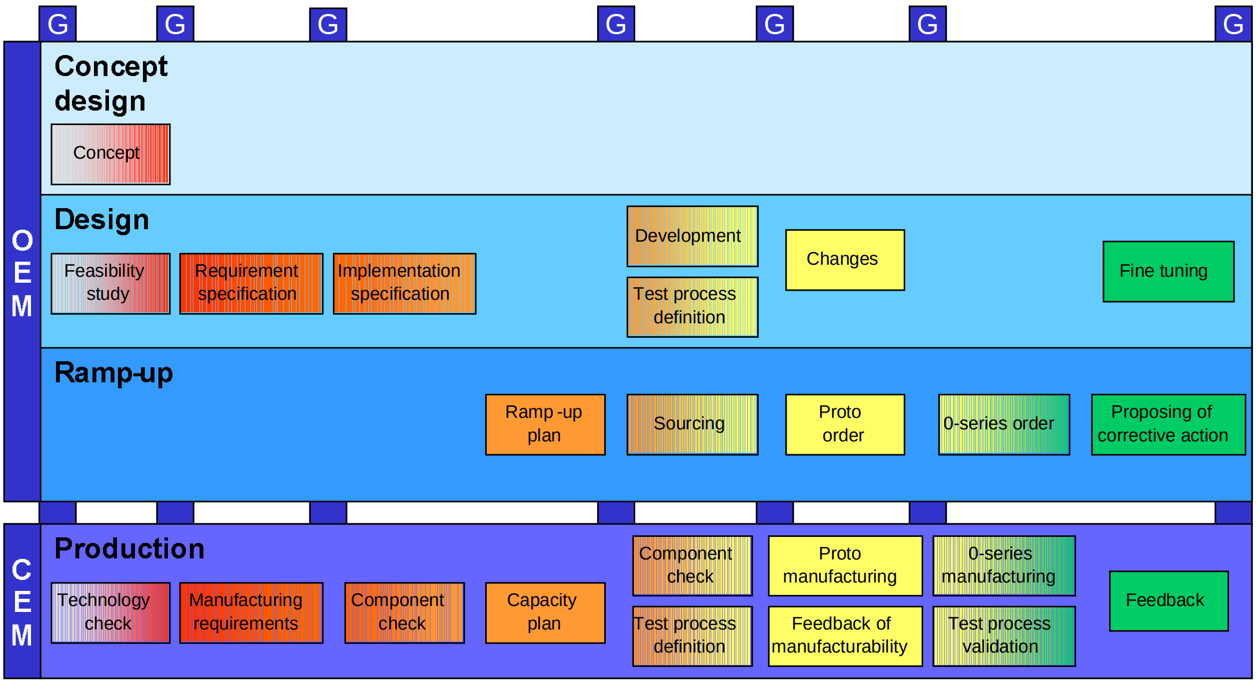

Figure 3. Example of NPI process.

proto series in specific proto lines, the proto manufacturing capability of an OEM increases and mass production will not be interrupted. Otherwise, a CEM could better prepare for mass production, if it manufactured proto series also and protos were designed, made and tested in mass production lines. Furthermore, the decision on the manufacturing place of proto series depends on the distance between an OEM and a CEM. If partners are located on different continents, close co-operation between R&D and proto manufacturing is difficult to organize.

Fine tuning

In a production ramp-up stage, mass production is improved by fine-tuning: software is debugged, testers are developed for volume production and product changes are managed. In addition, one significant task to provide is feedback. Collecting lessons learned is a means of continued improvement. In co-operative manufacturing an OEM strongly needs manufacturability feedback from a CEM.

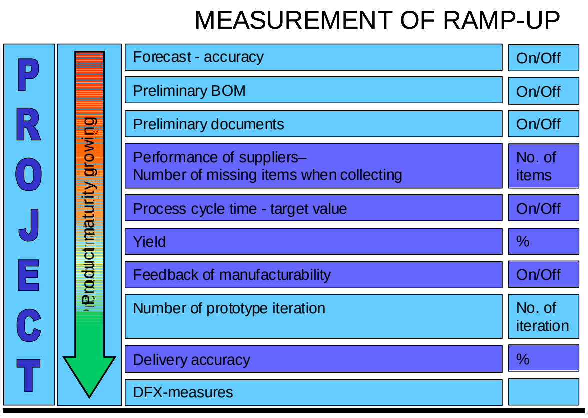

Figure 4. Example of NPI metrics.

4.3 Metrics of the NPI process

Consequent to existing measurement systems, defining the metrics of NPI in the case companies was a complicated task. Besides, companies are more willing to decrease than increase the amount of metrics. They measure their R&D process on the one hand and their production processes on the other. In fact, in many firms NPI organizations have only been established and formalized in the last few years.

Figure 4 shows an example of NPI metrics. Part of it includes checklist-type metrics whereas another part has target numerical values. The on-off metrics measure the growth of product maturity. In particular, most companies trace especially the development of yield percent as the main metrics of the NPI process, as it illustrates the maturity of a product from the manufacturability point of view. Thus, when the yield percent achieves a target value, a NPI organization transfers the responsibility for the program to a production organization. Besides, product development teams use a price estimate of a product as important, emphatic metrics. Companies in the big volume electronics industry follow the price estimate of the product throughout its development program.

5. DISCUSSION

A need has been recognized to define and study more about the NPI process. Many firms have not established NPI practices, because NPI organizations are young or not structured at all. Cross-functional teams do not have clearly defined responsibilities.

Measurement questionnaires used to collect immediate feedback of development progression should be as simple as possible and should be tailored for every development phase. Further, the metrics of the NPI process must be studied more.

Testing of new NPI processes in the case companies is still incomplete. The final results will emerge once the new product programs pass through new processes and are measured.

In some cases, where formalization of NPI processes has been done carefully, it has become clearer from knowing the process more intensely which actions are essential. These firms drop unnecessary tasks or documents. Undoubtedly, leaving out some tasks is assumed to be calculated risk evaluation and should be done only in a product program with a light update.

6. CONCLUSION

The research reported in this paper concerns the New Product Introduction (NPI) process in a supply chain environment. The main problems with NPI from the viewpoint of OEMs are discerning the right timing for launching the product according to the original design plan with the right volume and quality, not to mention cost. To reach this target, the OEM must develop efficient R&D processes and methods.

The main objectives of the CEM, however, seem to be early information about production methods, components and time schedule. By formalizing routine information exchange, partners are able to increase informal, but important early phase information. In fact, mere information on targeting high level performance is not enough. The participation of the CEM in product specification and project planning ensures manufacturability and fast ramp-up.

The NPI simulation game fits the enhancement of our understanding of supply chain environment. The game enabled the partners to develop their process without the distraction of urgent business problems.

7. REFERENCES

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