Lean Six Sigma Approach to New Product Development

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Abstract
In this rapidly moving electronics market, fast to market with new products is what separates top performing companies from average companies. A survey conducted by Arthur D. Little (ADL)[1] revealed that "New-Product Development (NPD) productivity in a top performing company is five times what it is in the average company. The top performer gets five times as much new product output for the same investment." What do they know that the rest of us don't? One winning factor is the use of Robert Cooper's Stage Gate process.

Since its introduction in the early 1980's, it has gone through many modifications to make it more lean and effective for today's business climate. Many larger organizations already practice this method. However for small to medium size organizations, a dedicated New Product Development (NPD) process may appear to be a daunting task. This is due to the perception of the complexity of the Stage Gate process.

This paper will present a Lean Six Sigma approach to "right sizing" the Stage Gate process to be efficient, practical, and easy to manage. Various tools of Stage Gate along with proven best practice will be covered. In addition, a reduced Stage Gate model will be discussed for simple, low risk projects.

Introduction
The term "New Product Development (NPD)" may have different meanings to different organizations. In its simplest form, NPD is the process of designing, building and marketing a product or service that adds revenue to an organization while solving a customer's problem. NPD can fall into several categories; such as, technology development, product/process feature enhancement, incremental improvement of existing product, customer or market segment specific product development, etc. Among the categories mentioned above, one category, technology development, needs to be managed somewhat differently than standard NPD process due to its end objective. In general, technology development deals with fundamental research over a relatively long period of time (2-5 years). Technology development usually leads to a breakthrough product/service or platform development. A detailed discussion of technology management can be found in Robert Cooper's article "Optimizing the Stage-Gate Process"[2], therefore it will not be discussed here. However, the other categories, which comprise over 80% of all NPD projects, will be the focus of this discussion.

New product development and introduction is a critical factor in organizations striving to succeed. As product lifecycles are getting shorter (more so in the electronics industry than any other industries) and global competition is becoming stronger, winning organizations must take a smart approach to organic growth that fits their organization structure. Since the mid 80's the most commonly used method has been Robert Copper's "Stage-Gate®" process. Many different flavors of the original Stage Gate have immerged over the last 30 years. However, organizations are still struggling to find the right program that meets their needs. Some recent studies show that many organizations are questioning the traditional Stage-Gate method to a point where they are employing different tools such as product lifecycle management (PLM), new product development and introduction (NPDI), lean manufacturing, Six Sigma, and total quality management (TQM). Each of these methods has its own strength and a specific outcome. For example, TQM is designed to improve quality while lean is designed to remove waste from the development process. However, Stage Gate still remains the most suitable tool for new product development model when followed properly. Over the last thirty years, Stage Gate has gone through many metamorphosis to suit different industries, processes and products. However, the basic premise of a structured, disciplined approach to product development still remains the core of the Stage Gate process.

Stage Gate Overview
Stage Gate can be defined as[3] "a conceptual and operational map for moving new product/projects from idea to launch and beyond". This process can be viewed as a step by step recipe, not unlike a cookbook, to move an idea from conception to commercialization. Stage Gate provides a framework for arranging new product development into distinct stages. Each stage is separated by a gate which serves as a decision making point. Stage Gate can incorporate anywhere between 5 to 9 stages as shown in Figures 1 and 2. . Each stage plays a specific role in the whole development process, similar to a recipe. As seen from figures 1 and 2, the entire process can be viewed as a sequential process between stages. In this sequential process, stages are located where specific tasks are performed and gates are where decisions are made (go/kill/hold). Within a specific stage many tasks can run in parallel. However in general, traditional Stage Gate process doesn't allow two stages to run in parallel. As an

example, in traditional stage gate process, no stage 2 tasks can be performed until gate 2 is closed. Even though this model has some advantage, it does adds additional time and resources to the product development process. This was adequate decade back when product life cycles were relatively long and competition was less prevalent in certain market segments. In today's dynamic market place, especially in the electronics industry, first to market is the key to success. One way to speed up this process is to take a lean approach to Stage Gate process for new product development.

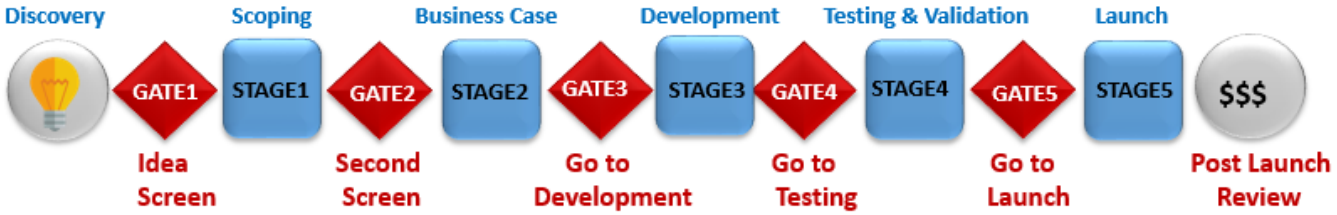


Figure 1-Typical schematic diagram for 5 stage Stage Gate[4]

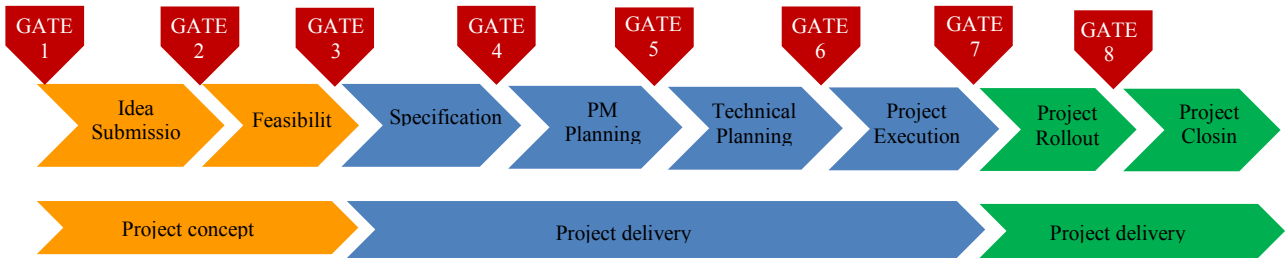


Figure 2-Typical schematic diagram for 8 stage Stage Gate[5]

New Approach to Product Development

As mentioned earlier, electronics industry is one of the fastest moving industries in the marketplace. Traditional product development cycle time, which used to be 15-24 months must be reduced now by half to remain competitive. In order to meet these new demands, we must fully understand and categorize each idea/concept to apply the correct product development model. The approach of traditional Stage Gate model of "one size fits all" is no longer applicable. In addition, to devising the right model, we must make the model, simple, flexible and user friendly for people to adopt in their daily activities rather than practice in "paper only".

Many organizations today faces two types of product development. One is the traditional new product development where a new or significantly modified product is worked on. The second type is smaller, more time sensitive project with lower risks, where little to no discovery takes place. People have come to realize the traditional 5 to 9 stage model is too rigid and complex to be applicable to all types' of projects. Hence many organizations used the approach of "just do it" for smaller, low risk projects. This means bypassing the Stage Gate process all together for smaller projects. The end result is draining of precious resources from new product development projects without accountability. Larger, more valuable projects suffer from both timeline and quality prospective. In addition to bypassing the system for smaller projects, many organizations use the "gates" to rubber stamp the stage/phase activities just to move over to the next stage. This is entirely counterproductive and undermines the Stage Gate process. The primary reason for deviation from Stage Gate is the perception of its complexity.

One way to overcome these issues is to take the lean approach of "simplify and standardize" while keeping the process flexible for today's business climate. Below we describe two models to manage product development that has been developed over several years by considering 'best practice" by some of the most successful organizations. The new approach is presented in schematic form in Figure 3. As figure 3 shows, two types of Stage Gate models are proposed here to handle short-term (simple projects) and long-term (NPD projects). A full Stage Gate process (NPD model) is recommended for new product development while a reduced model (CPD, Custom Product Development) is proposed for "just do it" type of projects. Tools necessary to run both type of models are described in the following sections.

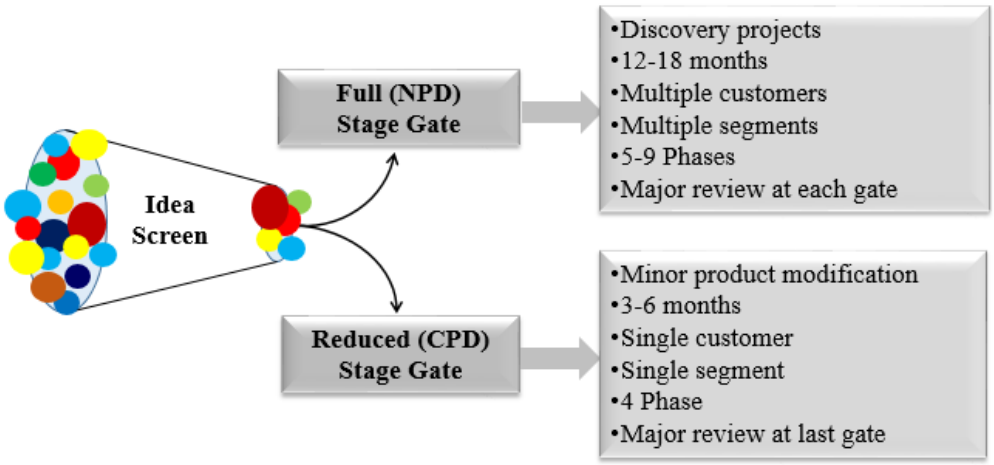


Figure 3-Schematic of new product development model

NPD Process Model

The lean six sigma approach to product development includes two critical elements: 1. Focus on "fuzzy front end" (Stage 1), 2. Both parallel and serial activities between stages. Figure 4 graphically represents the new lean NPD model.

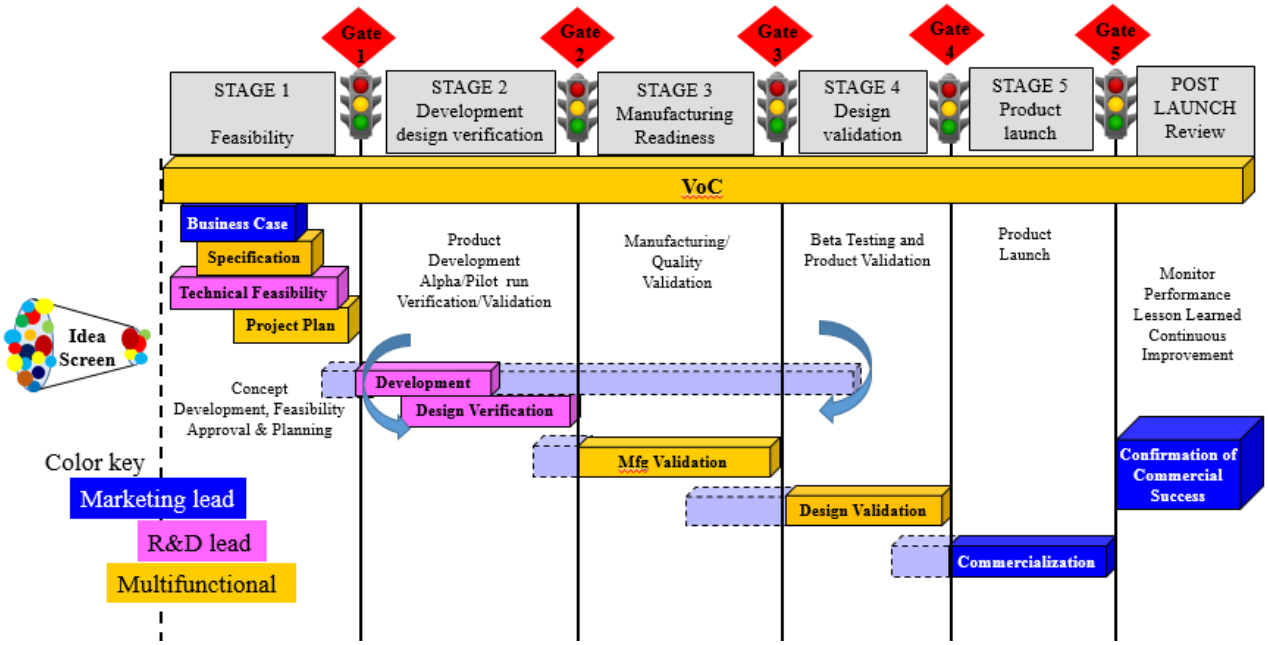


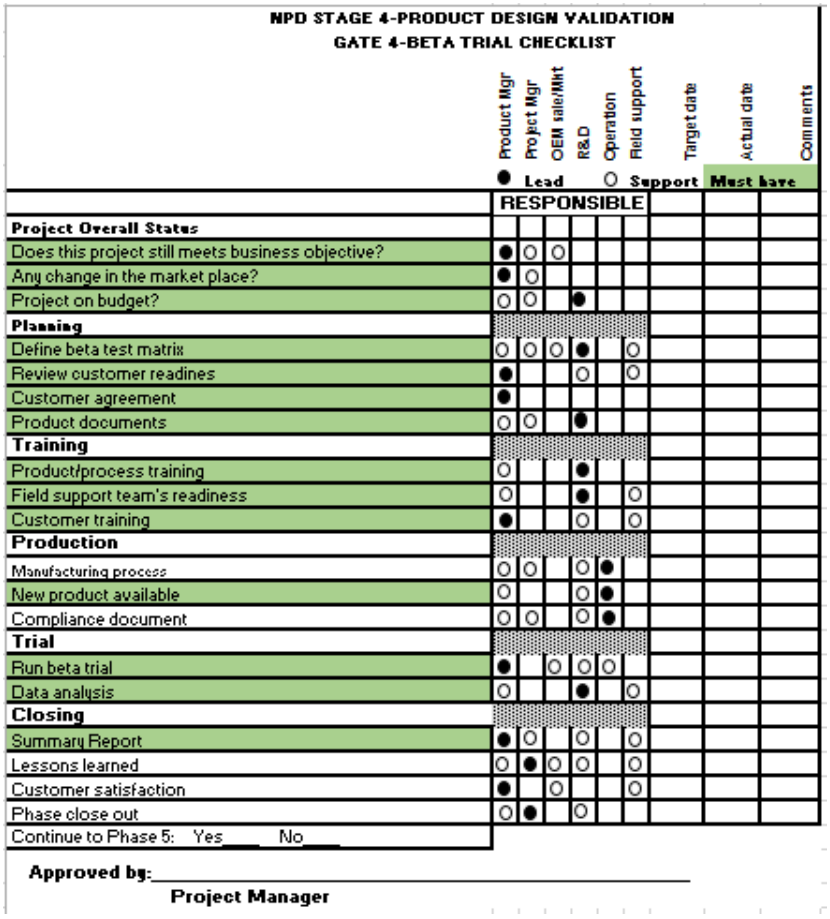
Figure 4-Full Stage Gate Model for new product development

The "fuzzy front end" is defined as "the period between when an opportunity for new product is considered, and when the product idea is judged ready to enter "formal" development"[6]. There are many factors that contribute to the success of fuzzy front end. Among them, Voice of Customer (VoC) is probably one of the most important factors. VoC is the driver behind any new product development. However, many organizations fail to recognize this. Frequently, people will use VoC as a onetime activity where in reality, it is a continuous process which goes beyond product launch. In addition fuzzy front end includes a clearly defined business case with Net Present Value (NPV) analysis, technical specification, technical feasibility and project planning. Many world class organization have recognized time spent up front has tremendous impact on the success of new products. Hence, this has become an integral part of Lean Stage Gate process.

We see from figure 4 certain tasks within the NPD process is continuous, such as VoC. Some are iterative, such as development to product validation (stage 2 to stage 4). While others could be run in parallel or overlap such as manufacturing validation and beta trial. Even though some stage/task can overlap, each stage has a specific set of deliverables within a specified time period. Among the deliverables, some are categorized as "must complete" while others are categorized as 'should complete". The lean approach allows you to move on to the next stage as long as the "must complete" tasks are complete. "Should complete" talks can be run in parallel with the next stage without impacting the project negatively. In addition, to categorizing

the tasks, the lean approach also clearly defines the responsible team having the lead role in completing certain tasks. This removes confusion and duplication of efforts.

At the end of each stage, a gate review is held to ensure all necessary tasks have been completed and the project still meets the business objectives to proceed. In other word, this is where the go/kill/hold decision is made. Typically a checklist is used to gage the readiness of each stage before closing the gate. Figure 5 shows an example of a check list. The example here refers to gate 4, closing of design validation stage (beta test). In addition to the stage task completion question, each gate asks the most important and common questions as listed under "Project Overall Status" heading in the checklist.



NPD STAGE 4-PRODUCT DESIGN VALIDATION
GATE 4-BETA TRIAL CHECKLIST

● Lead ○ Support Must have

	Product Mgr	Project Mgr	OEM sale/Mkt	R&D	Operation	Field support	Target date	Actual date	Comments
	RESPONSIBLE								
Project Overall Status									
Does this project still meets business objective?	●	○	○						
Any change in the market place?	●	○							
Project on budget?	○	○		●					
Planning									
Define beta test matrix	○	○	○	●		○			
Review customer readines	●			○		○			
Customer agreement	●								
Product documents	○	○		●					
Training									
Product/process training	○			●					
Field support team's readiness	○			●		○			
Customer training	●			○		○			
Production									
Manufacturing process	○	○		○	●				
New product available	○			○	●				
Compliance document	○	○		○	●				
Trial									
Run beta trial	●		○	○	○				
Data analysis	○			●		○			
Closing									
Summary Report	●	○		○		○			
Lessons learned	○	●	○	○		○			
Customer satisfaction	●		○			○			
Phase close out	○	●		○					
Continue to Phase 5: Yes___ No___									

Approved by:_____
Project Manager

Figure 5. Typical checklist for Gate 4 review

Tools of Lean Stage Gate

Table 1 describes the tools used in each stage and its role in the new Lean approach. Some tools are common to all types of product development while others can be customized to meet specific project/product needs. As described earlier, a typical example of common tools are VoC, Business case and product specification.

Table 1-Tools of NPD Stage Gate Process

Stage	Tools	Purpose
Stage 1	VoC	Capture customer pain point and agreed upon product requirement
	Business case	Capture commercial opportunity and strategic fit
	Technical specification	Capture product design criteria and rank them
	Technical feasibility	Assess technical probability of success
	NPV analysis	Understand economic benefit
	Project plan	Specify resource and timeline
Stage 2	Product FMEA	Capture product design failure mode
	Product design protocol	Standard method to communicate design method

	Design verification	Capture Alpha test criteria
	Product test matrix	Document test matrix
	Technical data sheet	Preliminary TDS to communicate internally
Stage 3	Product scale-up protocol	To standardize product transfer from lab to production
	Process FMEA	Critical to build a robust manufacturing process
	QC test matrix	Standardize to eliminate customization
	Compliance documents	Ensure health and safety issues are integral part of development
Stage 4	Beta contract	Clarify customer/supplier liability
	Beta test matrix	Clarify what are the key attributes needed to be validated
	Roles and responsibility	Clarify customer/supplier roles and responsibilities
	Success criteria	Indicates end point of beta testing
	Beta report	Share the outcome of beta trial
Stage 5	Product launch package	Standardize product introduction
	Product introduction plan	Eliminate market place confusion
	Testimonials	Product promotion
	Sales tracking tool	Track product/project commercial success
Post launch review	Lesson learned Post mortem	Improve the process by applying lesson learned

CPD Process Model

One of the newest and effective developments in the Stage Gate process is the implementation of a reduced model to handle simple, "one off", projects. Usually these projects are customer requests, minor product modifications, extension of working window, or cost reduction to name a few. The time line for these type of projects are typically aggressive and risks are low. Hence a less rigorous review and management is employed. Figure 6 shows the work flow for CPD model. Similar to NPD model, each stage has a set of deliverables and check list to ensure appropriate review has taken place to meet project objectives. However the gate review is considered to be "soft" and usually doesn't involved senior management. Table 2 shows typical tools employed in a CPD model.

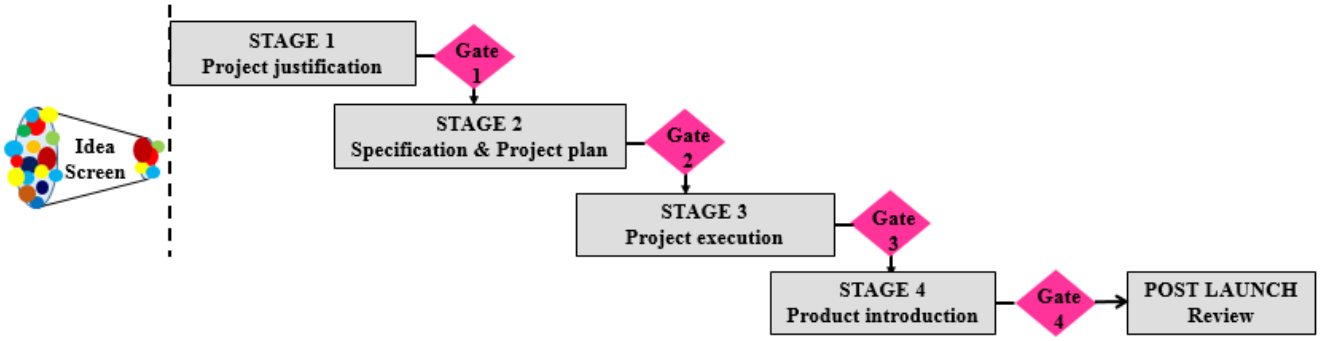


Figure 6-Typical 4 stage CPD model

Table 2-Tools of CPD Stage Gate Process

Stage	Tools	Purpose
Stage 1	VoC	Capture customer pain point and agreed upon product requirement
	Business justification	Capture commercial opportunity and strategic fit
	NPV analysis	Understand economic benefit
	Project plan	Specify resource and timeline
Stage 2	Customer requirements	Capture product design criteria and rank them

	Historical data review	Standard method to communicate design method
	Project plan	Specify resource and timeline
	Product test matrix	Document test matrix
Stage 3	Technical plan execution	
	Product verification	Critical to build a robust manufacturing process
	QC test matrix	Standardize to eliminate customization
	Compliance documents	Ensure health and safety issues are integral part of development
Stage 4	Product introduction package	Clarify customer/supplier liability
	Compliance documents	Ensure health and safety issues are integral part of development
Post launch review	Lesson learned Post mortem	Improve the process by applying lesson learned

Summary
Research shows most failures in new product development occur at the end of development[1,6]. The fundamental cause of failure is in the way organizations set up and run their Stage Gate process. Many organizations have morphed their Stage Gate process to be a Project Management (PM) tool to control product development, rather than facilitate a structured approach to new product development. When organizations use Stage Gate as their project management tool (which many world class organizations do), the focus shifts to the "development stage" rather than the full process of "Idea to Launch". People start micro managing the development phase while neglecting both front and back end of the full project. In doing so, fancy (and expensive) project management software are employed to further micromanage the process. At the end, Stage Gate is abandoned thus further deteriorating the organizations ability to stay competitive.

The lean approach to Stage Gate presented here provides a practical solution to new product development by focusing on fuzzy front end and making Stage Gate more flexible. The two types of models described here (NPD &CPD) gives a simple but structured way to approach new product development based on its complexity and timeline.

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