Integrating Design for Assembly and Manufacturing

Into ITT Industries' New Product Development Process

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May 2004

Key Terms: New Product Revenue, Total Product Cost, Product Assembly and Manufacturing Cost, New Product Development Business Process, Customer Value, Robust Engineering, Cycle Time, Reduced Time to Market

Executive Summary

ITT Industries has designed and deployed a new product development process which includes many methods and tools focused on maximizing new product revenue. This holistic business process engages all levels of management and employees in activities centered on creating unrivalled customer value.

This new product revenue generating business process integrates four "models". The first model creates a structured, data-driven business process, channeling executive management talent into (1) making project "go/kill" decisions at various points along the product development journey, and (2) providing substantial resources within a risk management framework. The second model creates a customer data generating engine with the objective of revealing customer needs (spoken as well as unspoken) and converting these to product system functions (main, supporting, and unwanted). The third model couples these identified functions with the engineering product development process to ensure that (1) the selected solution comes from many possibilities, and (2) provides the customer with a "robust" system capable of providing unrivalled customer value in the face of usage and environmental conditions. In addition, this "robust engineering" process optimizes the product system, both the product itself and its manufacturing process, while minimizing total cost. The output of this model freezes the product system cost range because 85% of cost is determined during the design phase. *It is within this "robust engineering" model that Design for Manufacturing and Assembly* (DFMA) is incorporated. The forth model, and ultimately perhaps the most important, creates a highly functional team and working environment to enable the success of the other models.

All of these models and embedded tools and processes come together for one purpose, to *decrease time to market while ensuring the development of the lowest cost, most robust product providing unrivalled customer value*. The following sections discuss several of these models, integrating them into ITT Industries' recently deployed new product development initiative called Value-Based Product Development (VBPD).

Introduction

ITT Industries is a premiere multi-industry company, providing products and services in four major markets: Defense Electronics and Services, Electronic Components, Fluid Technology, and Motion and Flow Control. ITT's 39,000 employees generated 2003 revenues exceeding $5.6B.

ITT has been focused on a consistent set of core strategies to ensure long term performance: **leadership**, **operational excellence**, and **growth**. All of these strategies seek to add *value* to ITT's stakeholders. *Value* is the key concept, so important in guiding decisions that this term is reflected in the name of each.

ITT's **leadership** strategy is called *Value-Based Leadership Development* (**VBLD**), and has at its core strategies to develop exceptional leaders who will create a strategic advantage because they make better and more effective business decisions. Exceptional leaders inspire and motivate their employees, unlocking their value-creating capabilities by creating the future, delivering results, inspiring commitment, building teamwork, and leading with character.

ITT's **operational excellence** strategy, called *Value-Based Six Sigma* (**VBSS**), is aimed at making the most meaningful impact on customers through commitment to continuous improvement in all processes. VBSS provides the infrastructure, tools, and discipline needed to make fact-based decisions, to solve complex problems, and find solutions in a systematic and measurable way. The VBSS objective is to change the way business is done in profound and enduring ways.

ITT's **growth** strategy is known as *Value-Based Product Development* (**VBPD**). This strategy is committed to achieving a robust pipeline of new products and services that provides unrivalled customer value, thereby increasing revenue growth. Paying close attention to customer needs and translating them into function, potential concepts, and finally, optimizing the winning solution is the essence of this product development process. The objective is to bring lower cost products with unrivalled customer value to market faster.

ITT's value-based strategies, VBLD, VBSS, and VBPD complement and build upon one another to drive continuously increasing stakeholder value. They are the foundation of ITT's corporate being, driving superior "premiere" performance through leadership, operational excellence, and revenue growth.

Scope

The purpose of the following sections is to (1) reveal how ITT has integrated DFMA into its new product development business process, and (2) show derived benefits. In order to paint a complete picture of ITT's journey towards increasing new product development revenues, the initial sections present a brief history of how this initiative came about, followed by sections dealing with key new product development success factors. The final sections present ITT's new product development business process flowchart complete with an integrated engineering process, wherein DFMA resides.

History

Conglomerate beginnings …… More than a decade ago, ITT Industries was a part of the $25B ITT Corporation which originated as the International Telephone and Telegraph Company. As with many older companies, revenue growth then was primarily achieved by acquisition and mergers. These ITT acquired companies became a conglomerate of many businesses, and in the 1950s through 1970s, ITT evolved into a "holding company", balancing a portfolio of businesses covering a diverse market spectrum. During these years, the financial and legal functions took the managerial lead, achieving revenue growth through an very effective acquisition strategy.

The "quality revolution" …… During the early to mid 1980s, ITT began embracing the new "quality revolution" ushered in by the US automotive industry attempting to compete against foreign companies, mainly Japan. At that time, ITT had a large business component supplying the automotive industry, and in order to comply with demand for improved supplier quality formed the Statistical Programs Group, later known as the Total Quality Management Group. The purpose of this corporate group was to train and deploy statistically based quality tools throughout ITT. It was the predecessor of today's Value-Based-Six Sigma corporate initiative.

Corporate Spin-offs …… In the early 1990s, ITT Corporation spun off its major management companies into separate business entities, forming ITT Industries which retained the industrial business components. ITT Industries, now commonly referred to as ITT, shifted from the "holding company" legal and accounting led business to a company focused on marketing industrial products, now led by marketing and engineering functions.

Re-emergence of statistical methods …… ITT continued its "quality revolution" despite the "spin-off" elimination of the TQM corporate group. Led by ITT's Defense and Electronics management company, statistical based methods and tools continued to be deployed, primarily focused within the Defense engineering arena. Later, this spread to the other management companies to a lesser degree. During the late 1990s, ITT began its Value-Based Six Sigma program deployment, increasing the breadth and width of statistical problem solving and project diagnostic training. Today, 10% of its 39,000 employees are trained as Six Sigma Champions, Master Black Belts, Black Belts, and Green Belts in a constantly rotating job assignment program, raising the bar for all employees.

Focus on a new product development processes …… It became evident, as a result of many value center level Six Sigma project diagnostic processes, that the "new product development" process needed to be fixed. It was also apparent that this task was very complex and involved just about all company functions, too broad in scope for a value center team to address. This issue was elevated to the senior executive level, interestingly enough, by a team of people originally part of the old ITT SPG and TQM groups who were seeking to "raise the bar" in the engineering community. Rather than just "finding and fixing" existing business systems, products, and processes, there was an urgent need to generate new product revenues, and not solely by acquisitions. VBPD was the result.

New Product Development Key Success Factors

There are many important factors associated with successfully making money from launching new products. The Product Development Institute has studied over 500 companies and developed a database from which they have extracted common characteristics of successful new product development efforts. The following list reveals some of the most important success factors.

- **Differentiated, Superior Products**
- **Up-front Homework**
- **Built-in Voice of the Customer**
- **Early Sharp, Stable Product Definition**
- **Early Planned and Resourced Market Launch**
- ***A* Go/Kill Decision Process for NPD Projects**
- **True Cross-functional Project Teams**
- **Leveraged (Aligned) Core Competencies**
  - **Marketing**
  - **Distribution**
  - **Selling**
  - **Technology**
  - **Operations**
- **International Market Orientation**
- **Top Management Support and Involvement**

The **Go/Kill Decision Process for New Product Development Projects** is the subject of the balance of this document. This does not mean that this Go/Kill business process is more important than any other key success factors shown above. This business process is necessary but not sufficient for successful new product development. Evidence indicates that of all the key success factors above, **Top Management Support and Involvement** is the enabler, and without it, the others will not be sufficient.

In addition to the key success factors shown above, a successful new product development business process must effectively allocate company resources in alignment with a product portfolio balanced with (1) stable, mature cash generating products and services, (2) recently launched products and services, and (3) newly emerging products with high profit potential. A poorly balanced product portfolio, like that of investment securities, increases risk during uncontrollable economic conditions, either resulting in conservative returns while competitors flourish or gambles on unrealistic "windfall" profits. All products within a portfolio compete for company resources. Selecting a balanced product portfolio and an associated "alignment" of company resources requires careful consideration to prevent a resource crisis[1].

(1) Allocating resources aligned with a balanced product portfolio and (2) selecting a winning new product and associated marketing strategy are the two most important tasks confronting today's management responsible for increasing organic revenue growth. Allocating too many resources to low value products robs needed resources for potentially high value product development. Recent research shows that resource allocation problems are the most pervasive barrier to successful new product development[2].

[1] Attempting to do too much with insufficient resources leads directly to poor product development performance. A resource capacity analysis can be effective in (1) determining where resources are currently allocated, and (2) developing a plan for shifting from maintenance to new product development. In addition, poorly designed products and processes create downstream resource drains, robbing needed resources for new product development in favor of "maintenance" activities.

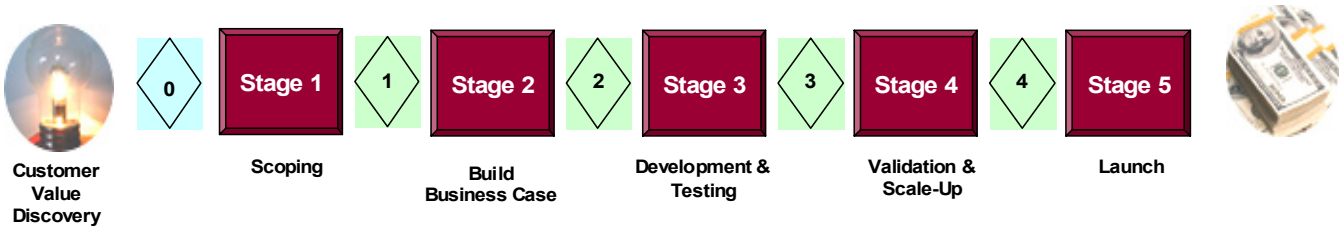
[2] Cooper, Robert; Edgett, Scott, "Overcoming the Current Crunch in New Product Development (NPD) Resources", Working Paper No. 17, 2004, Product Development Institute (www.prod-dev.com), Ancaster, Ontario. [pending publication in *Research-Technology Management*]

ITT's New Product Development Process

Late in the 1990s, a group of ITT executives gathered to address the issues of (1) generating more new product revenue through organic growth, and (2) ensuring that these products are designed to be "robust" deliverers of unrivalled customer value at the lowest possible cost.

The result was the creation of ITT's new product development process which has three major elements, (1) a Stage-Gate® business model and process, (2) a value model and process, and (3) a robust engineering model and process. A team was formed with the mission to develop and deploy ITT's new product development process to its value centers with the goal of increasing organic revenue from new products.

Stage-Gate® ..... The Product Development Institute figured prominently in the creation of ITT's new product development business model and process based on their Stage-Gate® model. ITT's model consists



of a series of activity "stages" and decision "gates" focused on ensuring that only new product development projects with the highest probability of financial success proceed to launch. Along the way, go/kill decisions are made to either allocate resources or stop the project, sending it back for possible recycling. This sequential decision making is analogous to changing the bet on horses as the outcome of the race becomes more apparent. This process increases the probability that the product will be a winner and that the resources spent to that point were used wisely.

This process, once introduced to a value center and training has been deployed, is led by a "process manager". This person ensures that the process is followed and that the necessary metrics are gathered, studied, and appropriate actions are taken. The process manager also guides the value center management, called "gate-keepers, through the activities and gates and assists with resource allocation balancing, as well as determining the number of projects in progress and their respective scheduling.

To facilitate this process, ITT uses an electronic document containing guidelines, templates, and procedures tailored to fit the nature of a value center's business.

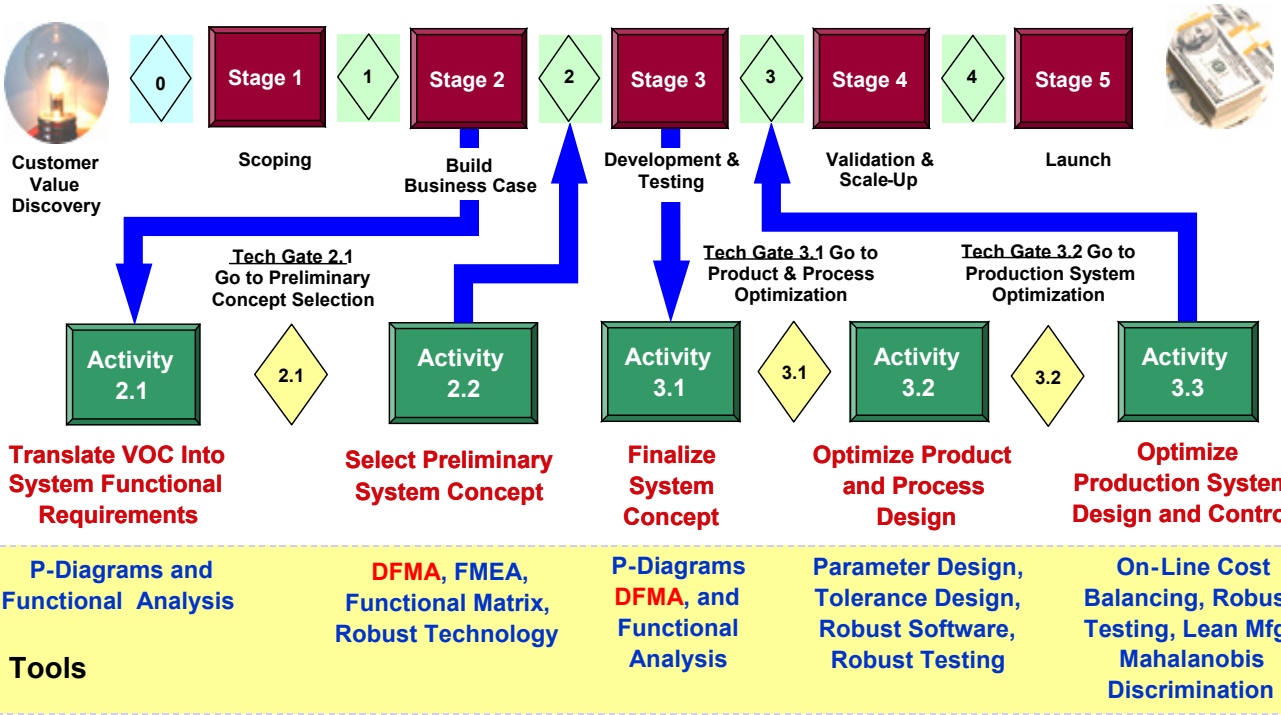
NIMBA Value Model ..... A key to product development success is offering unrivalled customer value as the solution to the customer's needs. This value theme runs from beginning to end of the Stage-Gate® process, focusing activities in the early stages on revealing these customer needs and generating product concepts that deliver a solution. Functional modeling ensures that the main function of the product system is maximized while unwanted and support functions are minimized. Early product definition via (1) a through knowledge of the voice of the customer and (2) functional analysis is key to product development success. The value model and process enhances capture of the VOC using well defined methods and guidelines.

The NIMBA[3] company provided ITT with this value model and training.

[3] http://www.nimba.com/

Robust Engineering ..... Selecting a product concept capable of providing unrivalled customer value is extremely important, but designing it and it's associated manufacturing process to ensure that needed functions maintain peak performance is just as important. ITT's new product development process has been integrated with a robust engineering process focused on creating "robust" products and processes, building upon best practices, methods, and tools in the engineering community. This process begins with a rigorous systems engineering approach aimed at identifying all system stakeholders and making sure all requirements are deployed through each product development step. The systems engineering framework structures the product system decision making, from customer needs capture, functional analysis, concept selection, detail design (where robust engineering takes place), verification, logistics, and finally to launch and customer support. *It is within this context that design for manufacturing and assembly* (**DFMA**) is used.

The robust engineering process takes advantage of the benefits of DFMA in two places within the systems engineering structure. The first occurs during finalization of product concept selection, taking advantage of part count reduction and comparative cost estimating for competing concepts. The second occurs during detail design where trade-offs are made between product design, manufacturing methods, and cost. This is



followed by optimization of function using parameter and tolerance design methods. The later two are often referred to as Taguchi's methods, a useful set of procedures and tools focused on achieving product robustness in the face of uncontrollable influences.

Deployment of the New Product Development Initiative ..... ITT's aggressive revenue growth targets triggered the need for rapid and successful deployment of its new business model and associated components- Stage-Gate®, the NIMBA Value Model, Systems Engineering, and Robust Engineering.

Located within the systems and robust engineering deployment plan, **DFMA deployment** involved first educating the VBPD team and senior executives. This was accomplished using Internet based presentations conducted by Boothroyd-Dewhurst, Inc. (BDI).[4] Following this event, 2-day workshops were used to train the engineering community and expose them to the benefits of using DFMA early in product development

[4] http://www.dfma.com/

projects. The workshop format required project teams using BDI's software to generate the product parts breakdown and associated costs, and then merge these with their respective manufacturing processes and costs. The result: team synergy, innovation, and creativity came together to generate alternate product solution concepts consisting of fewer parts manufactured using cheaper processes.

As a result, several benefit themes quickly emerged. These demonstrated the importance of this tool and increased the urgency of incorporating it into the early product design stages of ITT's new product development business process, targeting the engineering community.

Benefit themes that emerged:

- **DFMA enhances transition from functional analysis to concept** …… Early, effective voice of the customer translation into product functional requirements speeds the product definition phase, followed by developing possible product system solutions that best deliver those functions. The DFMA tool is an excellent fit for this task, cycling among the concepts, generating ideas for modifications, and then providing cost estimates for comparison, including supplier costs for parts and subsystems.

- **DFMA enables direct cost comparison of product solutions** …… Early in the concept selection phase, cost is a major criteria for comparison among possible solution concepts and then for final selection. DFMA enables relative cost assessments in a very short time period, including those of suppliers.

- **DFMA enables cost targeting for suppliers** …… Obtaining relatively accurate cost estimates for purchased components directly from the DFMA software shortens the development cycle time by eliminating the need for obtaining these from suppliers. In addition, these estimates establish a "reasonable and customary" cost target for use later during the procurement activities.

- **DFMA reduces product design complexity** …… By reducing the number of parts, product and assembly complexity decreases, eliminating the associated "hidden" cost of dealing with those eliminated parts. In addition, fewer parts and decreased complexity reduces the probability of the product experiencing problems in the hands of the customer, increasing reliability and decreasing potential warranty costs.

- **DFMA increases team performance and product design completeness** …… Working through the DFMA process early in the product design stages improves team synergy and performance, ensuring that design details do not go unaddressed until later when they are extremely difficult and costly to correct.

- **DFMA improves outsourced product designs** …… The DFMA process and associated software provides a common format for multi-located product design efforts, especially those that are outsourced. DFMA becomes the framework and structure within which otherwise challengingly different engineering management approaches can be managed.

The following table presents a sampling of ITT's DFMA benefits, including cost reductions and part eliminations, as a result of a few of the workshops held at various value centers.

Business Category	Part Reduction		Cost Savings
	From	To	
Fluid Technology	48	19	$174,000
	177	85	
	27	19	$37,000
Defense and Services	72	17	
	76	29	
Motion and Flow Control	58	42	$1,835,000
	9	4	$247,000
Electronic Components			$350,000
Total	**467**	**215**	**$2,643,000**

Summary

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