Cranfield University

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# New Product Introduction Process Improvements in an Automotive Company

School of Applied Sciences

MRes Thesis

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New Product Introduction Process Improvements in an Automotive Company

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# Abstract

**Keywords:** Product Development Process; New Product Introduction; Product Development.

New product development is an important strategic decision for an automotive company. The need for a structured method of early project planning is herein enforced due to competitive advantage and global market expansion. Client satisfaction constitutes a major challenge that requires the employment of a structured process for turning around a product within a short lead time. To maintain a recognisable and respected position in the market, early and accurate planning and allocation of adequate relevant resources for a successful project is required. A well defined New Product Introduction (NPI) Process will support this concept.

It is imperative to ensure that an improved process is aligned to varied project portfolios consistently and integrates seamlessly into the NPI process. Therefore the aim of this study is to enhance the current NPI process within an automotive company and to cover state of the art practice of automotive product development, by accomplishing the following set of objectives:

1. Capture automotive NPI best practice through intensive literature review and industrial applications;
2. Carry out performance measurement survey to identify opportunities of improvement within the current practice of NPI;
3. Propose enhanced NPI process model (addressing the key opportunities for improvement) adapting principles of NPI process best practice;
4. Propose a standardised list of criteria to measure the success of NPI projects;
5. Validate the proposed NPI through expert judgment opinions**.**

The approach adopted in this research is exploratory due to the “how” and “why” questions raised. Supported by comprehensive literature review and supervision, the current NPI process was examined by conducting out a qualitative and quantitative research following a three stage plan. With the use of performance measurement

questionnaire and semi-structured interviews, this thesis sought to respond to three core questions:

1. How applicable is the NPI process?
2. How does Project Management impact the NPI process?
3. What are the areas of opportunities for improvement?

The key areas identified, were limited formal procedures, supported by inefficient communication. As a result, this study identified the areas of opportunities for improvement, thereby facilitating the possibility for drivers to successfully implement, adopt and adapt the process.

# Acknowledgements

I would like to take the opportunity to thank all who have contributed and supported me over the year of my program.

First and foremost, I want to thank my loving children (Namde and Symchay) for being so understanding and responsible while away from them. Their outstanding reports from school, sacrifices, constructive criticism and support have been the rock that stabilised and determined the completion of this thesis. This achievement is because of them and I therefore dedicate this thesis to them. It will be remiss of me not to mention my mum and brother, Tunde for their support also throughout the year.

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In light of the subject area of study undertaken, I am extremely fortunate to have worked with my academic supervisors, who pragmatically goaded me towards a successful completion. Dr Ahmed has been a major influence, helping me in developing conceptual clarity in data evaluation. It was a privilege to work with my supervisors and I will treasure my time with them.

Sahr Kainbanja, a great emotional anchor, was also a major influence during the course of this project, a great advisor with supporting ideas; Lynnette and her family were great in supporting me in moments of despair; and Natalie provided a shoulder to cry on whilst also suggesting routes that led to progress.

I would like to thank Dr Festus Cole, for his contribution to this thesis, responding to calls at odd hours to serve as an invaluable proof reader. Finally but not least, I wish to

extend to my newly acquired friends and cohorts at Cranfield, especially Obi and Emeka. I was fortunate to have them around me.

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# Table of Abbreviations

| Acronyms | Description |
|---|---|
| APQP | Advanced Product Quality Planning |
| BoM | Bill of Materials |
| CAD/CAM | Computer Aided Design and Manufacturing |
| CE | Concurrent Engineering |
| DFA | Design for Assembly |
| DFMA | Design for Manufacture/Assembly |
| DFSS | Design for Six Sigma |
| DFV | Design for Variety |
| ECO | Engineering Change Order |
| Engr | Engineers |
| ETO | Engineer-to-Order |
| FMEA | Failure Mode Error Analysis |
| FPDS | Ford Product Development System |
| HoQ | House of Quality |
| IRR | Internal Rate of Return |
| Mgt | Management |
| MRes | Master of Research |
| NPD | New Product Development |
| NPI | New Product Introduction |
| NPV | Net Present Value |
| PCO | Product Change Order |
| PD | Product Development |
| PDP | Product Development Process |
| PLR | Post Launch Review |
| PM | Project Manager |
| QA | Quality Assurance |
| QFD | Quality Function Deployment |
| RAG | Red, Amber and Green |
| REP | Representative process management & quality assurance tools |
| ROI | Return on Investment |
| RP | Rapid Prototyping |
| SEP | Strategic Engineering Partner |
| SOP | Start of Production |
| SQA | Supply Quality Assurance |
| TPDS | Toyota Product Development System |
| TTM | Time to Market |
| UOM | Unit of Measure |
| VA/VE | Value Analysis/Value Engineering |
| VOC | Voice of the Customer |

# 1 Introduction

## 1.1 Background

The introduction of New Products is a vital determinant in positioning an organisation. It contributes and underpins the growth and sustainability of an organisation within the rapidly expanding global competitive playing field. Contributory factors such as technological evolvement; market trends; mergers and business strategies are continually increasing and impact on an organisation's bottom line – revenue and profit. The successful introduction of a new product relies on a solid foundation of an aligned organisation and team structure, as well as the services and technology employed.

New Product Introduction (NPI) can be described as the entire business process through which new products could be introduced to the market. It covers the entire product life-cycle from customer requirement, business strategy or technological improvement (initial identification) through to production, market launch, support, enhancement and retirement (IFM - NPI, 2008).

NPI within the automotive industry has rapidly evolved beyond comprehension in the last decade and this can be attributed to the complex customer requirements, as well as environmental and changing regional legislative conditions. Although the ever advancing technologies employed constitute the leading edge and of the state-of-the-art in this process; its features and functionalities cannot solely be relied upon to guarantee customer requirement satisfaction in terms of the quality of the product, costs, service and delivery time (to name a few). There is the need to communicate, collaborate and integrate with other systems in order to fulfil product requirements.

NPI is the key towards sustaining and improving market share for manufacturing companies. Therefore there is a need to have a customer-oriented approach of the NPI process model. In addition, such model needs to be reviewed and enhanced regularly to capture the state-of-the-art and best practice in product development (PD). This MRes thesis examines an NPI process model to identify opportunities for improvements.

## 1.2 Research motivation

New product introduction is an important strategic activity for any business. One of the most important challenges faced by manufacturers is time to market for new products. Collaboration and communication are the basic elements of product development as customers are becoming more and more demanding and their requirements are changing all the time. In these circumstances, product development stages need to be harmonised to reduce time. To maintain market position, the basic attributes of quality, features and functionality need to be continually enhanced. In order to achieve market success and satisfy customer requirements, the right products in terms of quality and features, at the right time at minimum costs require adequate planning. Planning is one of the determinants required to satisfy project quality, reduce financial and schedule risks and help in the success of a project. Subsequently a systematic approach for product development and evaluation is needed.

## 1.3 Problem Statement

One of the impediments to the successful implementation of the NPI process at the automotive company faced by all relevant stakeholders is the inability to successfully align the process to the varied projects undertaken. These projects cover individual customer requirements; partners and third party projects. The existing process is considered by both management and engineers as not being flexible or scalable to the varied type of projects managed by an automotive company. As a result, a study of the NPI process stages and activities and their relation to the different types of projects is required. This will help identify critical issues and provide the required information to construct a framework for improvement.

## 1.4 Industry Sponsor

The sponsoring company is an internationally recognised automotive engineering consultancy based in the UK. Their global facilities include those in Michigan (USA), Kuala Lumpur (Malaysia), China and offices in Germany and Japan, with rapid expansion in new territories such as South East Asia and the Gulf States.

The automotive company provides comprehensive and versatile consultancy services to many of the world's OEMs and Tier 1 suppliers, offering full engineering services from initial concept and project design through the development and integration of the complete vehicle to me*et al*l worldwide markets specifications and customer requirements through to full production. This includes third party 'niche vehicle' engineering and manufacture worldwide.

## 1.5 Aim and Objectives

The aim of this research study is to enhance the current New Product Introduction process within an automotive company to cover state of the art practice of automotive product development.

The specific objectives to achieve the project deliverables were identified to:

1. Capture automotive NPI best practice through intensive literature review and industrial applications;
2. Carry out performance measurement survey to identify opportunities of improvement within the current practice of NPI;
3. Propose enhanced NPI process model while (addressing the key opportunities for improvement) adapting principles of NPI process best practice;
4. Propose a standardised list of criteria to measure the success of NPI projects;
5. Validate the proposed NPI through expert judgment opinions**.**

## 1.6 Scope of the study

The elements within the scope of the study have been outlined under the aim and objectives. The output of the project will be validated by key stakeholders of the NPI Process (expert judgement) of the automotive company. What are not included are improvements in the manufacturing process; knowledge management and NPI costing.

## 1.7 Thesis Layout

The remainder of the thesis comprises of six chapters as illustrated in Figure 1-1. Chapter 2 undertakes an extensive review of the extant literature and existing work done by other researchers which discuss the NPI process and concludes by highlighting the

major gaps and limitations of previous research work including the scope of the actual thesis.

Chapter 3 describes the approach, methodology and techniques employed to achieve the outcome of the project. Chapter 4 describes the NPI process of an automotive company. Chapter 5 analyses the results from the performance measurement survey carried out within the automotive company. This takes into consideration the opinions of both management and engineers alike. As a result, Chapter 6 utilises the results from Chapter 5 to detail the opportunities for improvement in line with state-of-the-art best practice obtained from the literature review. Chapter 6 discusses the results further. Finally, in Chapter 7, conclusions are drawn and the potential for future work is presented.

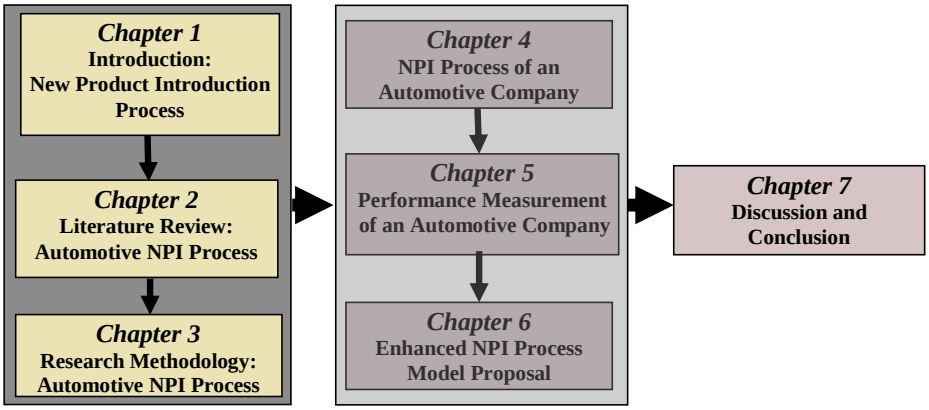



**Figure 1-1: Thesis Structure**

## 1.8 Summary

This chapter undertakes a brief description of the background to the project in order to provide a context for the study. It also identifies its rationale, highlighting the main aim and objectives of the project. Chapter 2 presents an extensive literature review of NPI process. The review of supporting literature on new product introduction (development) process designed to gain provide an understanding of the subject and identify areas and opportunities for further improvement.

# 2 Literature Review on Automotive NPI Process

## 2.1 Introduction

This chapter reviews the literature from studies carried out on New Product Introduction (NPI) process, with a view to providing the background to this study. There is extensive literature coverage on NPI and what is considered the process in achieving successful Product Development (PD). However most of the literature has been focused on New Product Development (NPD), a concept used interchangeably with NPI.

The state-of-the-art of NPI process and synthesis of best practice will constitute the foundation for improving NPI process and creating an organisational framework for the effective use of the NPI process. It is hoped that this review will help to identify and identify gaps in the research on PD as well as map out some best practices for NPI process.

Further, this review discusses the NPI process against the background of the work undertaken by other researchers by examining its structure, to provide models that are considered best practice, discuss drivers of the process as well as challenges to the system. The chapter concludes by highlighting the gaps of previous research work. The review of supporting literature on new product introduction (development) process aims to provide and an insight into the subject thereby helping to identifying areas and opportunities for improvement. The structure of this chapter is illustrated in Figure 2.1.

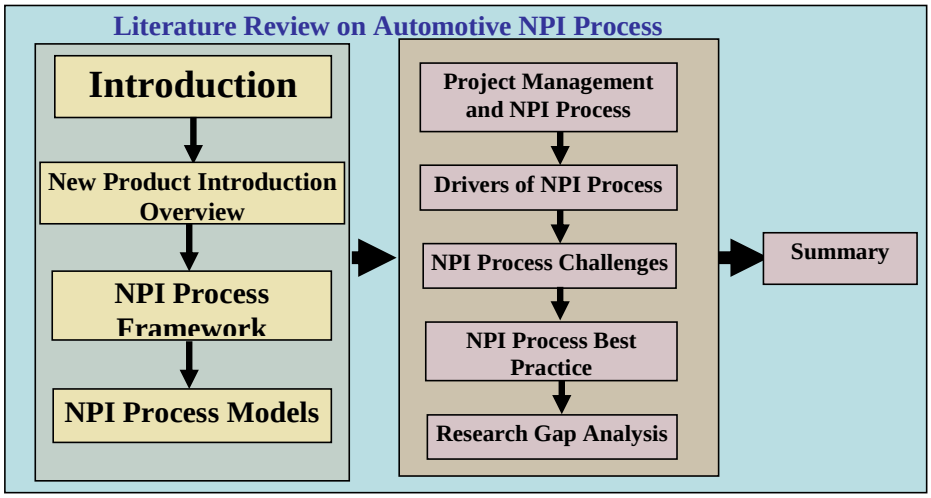



**Figure 2-1: Literature Review Structure**

## 2.2 New Product Introduction Overview

New Product Introduction within an automotive industry is pressured and tasked with the delivery of products that demand ever increasing levels of performance improvements. The evidence shows that over the years, NPI has become the driver in many automobile industries, due to dynamic economic growth, buyouts, mergers and competitiveness.

This area of study is well researched and documented, focusing on the successes and failures of the process, and at the same time identifying the factors that contribute to new product success (Cooper, 2001). There are a number of ways of categorising a product as "new" such as new concepts, upgrade to existing models, improvements, repositioning or cost effectiveness, (Ulrich *et al*, 2004).

In the current competitive climate, the task of developing and introducing new products in themselves are proving quite challenging. This must be complemented by the constant management of product introductions having regard to the time required to market the product, cost reduction and conformity to the increasingly stringent environmental and regulatory requirements.

NPD and PDP terms can be and are used interchangeably with NPI process. The exact meanings of these terms tend to vary from organisation to organisation, including the level of integration across different departments. (IFM - NPI, 2008).

NPD is the process by which an organisation uses its resources and capabilities to create a new product or to improve an existing one (Skold *et al*, 2007). NPD process involves a set of activities starting with an idea, a business plan or customer demands which then result in the production of the product, the creation of market opportunities, sale and delivery of the product (Barclay, 2002; Ulrich *et al*, 2004). NPD can also be explained as a gradual process of transformation of specified product requirements to developed product stage (Nanda 2005).

## 2.3 NPI Process Framework

Numerous studies have been undertaken and published with regards to the NPI process model. This work focused on a model that is supported by actual industrial field studies, the vast majorities of companies and in particular the sponsoring company. This is aimed at identifying the essential elements that should comprise the criteria for the NPI process review and the analysis presented in this study. NPI process model is essentially the master plan that guides the company's product introduction and development, (Atkinson *et al*, 2008).

The models that have been researched over the past decades are:

- Concurrent Engineering (CE) model, based on Toyota Product Development System (TPDS);
- Stage-gate model;
- Phase gate;
- Response model;
- Platform model;
- Front-end loading model.

The word “Engineering” in CE is generic. For the purpose of this study, the following sub-sections are based on the concept of the two most common models, CE and Stage-gate.

### *2.3.1 Stage-Gate*

Cooper (2001) developed the stage gate process, an approach formulating the introduction of a new product to market. This approach processes the initiation of ideas, if approved, to final production, it’s launching and progress with the necessary controls (gate keepers) whilst also providing checkpoints for decisions on “Go/No” for the project. As defined by Cooper (2008), “A Stage-Gate process is a conceptual and operational roadmap for moving a new-product project from idea to launch. Stage-Gate divides the effort into distinct stages separated by management decision gates. Cross-functional teams must successfully complete a prescribed set of related cross-functional tasks in each stage prior to obtaining management approval to proceed to the next stage of PD” (Cooper, 2008).

The process is controlled, time managed and streamlined when resources are allocated to PD as shown in Figure 2.2. The process of stage-gate can only be utilised in reality if the deliverables are well defined, simple and clearly understood. It is claimed that about 60% of the world’s companies use this structure as it is or adapt it in such a way as to ensure that they are aligned with business strategies (Cooper, 2008).

The key to successful implementation and utilisation of a gated process is proper clarification of business case requirements and product specifications. The extensive literature review shows that there are limited tools and activities to interface engineering and marketing functional units. Putting a hold on product specifications such as market changes is not generally warmly embraced; however the challenge is whether the specifications and engineering work can be carried out simultaneously and a hold only should take place if and when it is critical.

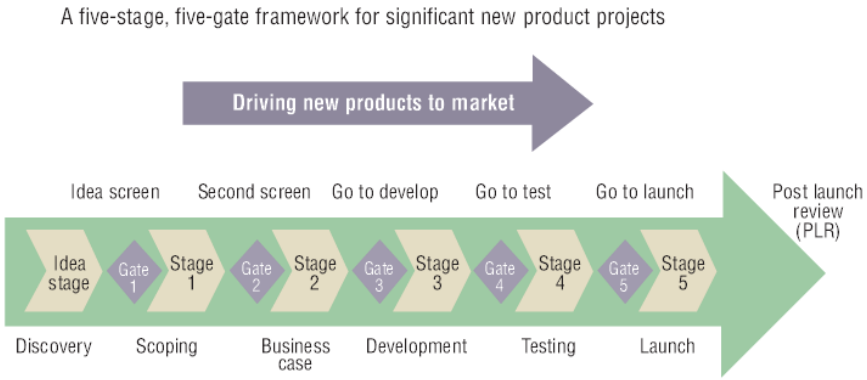



**Figure 2-2: An overview of NexGen Stage-Gate (Adopted Cooper,2008)**

### *2.3.2 Team Structure*

There is no known process that has actually been implemented and utilised in its entirety without a leader. Cooper (2001) argues that, "there has never been a successful installation of a stage-gate process without a process manager or facilitator in place". There is a requirement for a full time facilitator to ensure alignment to business operations and for continuous improvement. To support the process the team should comprise of:

- A process manager empowered to lead and manage the process; review the process on a project by project basis; maintain an understanding of the process and deliverables; provide guidance and participate in required training; maintain process matrix; ensure the appropriate tools and techniques are in place (Cooper, 2001; Ernst, 2002)
- A gate keeper (chair person) whose remit is to ensure adherence to the process and any improvements, being directly responsible for the process deliverables and the supporting tasks, and managing changes (resources, finance and technical) that impact the progress of PD (Cooper, 2001; Ernst, 2002).
- A gate review board that comprise of stakeholders and representation from relevant business functional units with the required knowledge and expertise. Its remit is to authorise the "go/no" decision based on the assessment of risk, investment impact, business case alignment to the company strategy and

objectives of the projects. To minimise delay in the process, an allowance should be made for the provision of a deputy in the event of a board member being unavailable (Cooper, 2001; Ernst, 2002).

- Selection criteria to make an assertive and definitive decision on whether to go ahead or not with a project. According to Cooper (2001) and Ernst, (2002), with the use of a checklist and scoring method, the following factors require proof at the point of decision:
    - Feasibility of the project outcome;
    - Availability of adequate and related resources for the project;
    - Business case and company strategy alignment;
    - Return on Investment, Internal rate of Return and risk assessment;
    - Market share and competitive advantage.

### *2.3.3 Activities within NPI Process*

Most of the activities within NPI process have to do with the engineering and development of entirely new concepts. The "skeleton" representation of activities detailed in Table 2.1 provides a guide as to what generally occurs during NPD/NPI:

**Table 2-1: NPI Process Activities (adapted Cooper *et al*, 2003; Chao, 2005; Nanda, 2005)**

| Activity | Description |
|---|---|
| Business Strategy, Market influence, Technology impact, Business Case | The initial go/no go: Point at which decision for funds allocation to the proposed new product idea is made |
| Preliminary market analysis | An initial, preliminary, but non-scientific, market assessment; a first and quick look at the market |
| Preliminary technical assessment | An initial, preliminary appraisal of the technical merits and difficulties of the project. |
| Detailed market study/market research | Marketing research, involving a reasonable sample of respondents, a formal design, and a consistent data collection procedure. |
| Business/financial analysis | A financial or business analysis leading to a go/no go decision prior to PD. |
| PD | The actual design and development of the product, resulting in, e.g., a prototype or sample product. |
| In-house product testing | Testing the product in-house: in the lab or |

| | |
|---|---|
| | under controlled conditions (as opposed to in the field or with customers). |
| Customer tests of product | Testing the product under real life conditions, e.g., with customers and/or in the field. |
| Test market/trial sales | A test market or trial sales of the product-- trying to sell the product but to a limited or test set of customers. |
| Trial production | A trial production runs to test the production facilities. |
| Pre-commercialisation business analysis | A financial or business analysis, following PD but prior to full-scale launch. |
| Start of Production. | The start-up of full-scale or commercial production. |
| Market launch | The launch of the product, on a full-scale and/or commercial basis: an identifiable set of marketing activities specific to this product. |

## 2.4 NPI Process Models

There are a number of processes that have been studied within the automotive industry. The deployment of NPI process is quite necessary to ensure efficient PD with minimal error occurrence. The time invested in deploying effective NPI process impacts greatly on costs quality and time to market (Krishnan *et al*, 2001).

Many companies employ some form of gated process as a guide to their PD (Table 2.2). Each process investigated has identical functions to fulfil however unique they may be in their implementation. NPI process models constitute a disciplined framework to provide a common set of guidelines and practices for PD ensuring time to market is achieved at minimal cost and on time, with the end result of satisfying customer requirements. The use of a model also promotes standardisation across an organisation. NPI process backed by effective management decisions and efficient management of risks is highly valued. This section provides examples of NPI process models implemented by automotive and supporting companies.

**Table 2-2: NPI Process Activities (adapted Cooper *et al*, 2003; Chao, 2005; Nanda, 2005)**

| Company | Process Title | Number of Stages |
|---|---|---|
| ABB | PD process | 6 |
| BMW | Gateway in new product development | 7 |
| Chrysler | New Product Development strategy | 4 |
| Ford | World class timing milestones | 11 |
| GE | NPI | 9 |
| Honda | Programme milestone philosophy | 8 |
| The automotive company | NPI | 6 |
| Lucas | Product Introduction Management | 5 |
| Lucent | NPI | 4 |
| Renault | Project Management System | 6 |
| Rover | Project Management Guidelines | 8 |
| Toyota | Generic development process (TPDS) | 9 |

### *2.4.1 Renishaw NPI/NPD process model*

For over 30 years, Renishaw has been an innovator in metrology, the science of measurement, enabling measurements to be brought into line with international standards. The company's first product, the touch-trigger, was designed to solve a specific inspection requirement for the Olympus engines used on Concorde. The first Renishaw Company was established in 1973. This innovative product went on to revolutionise post-process inspection of machined components.

Renishaw's portfolio of products is vast and is continually growing, consequently necessitating the employment of an NPI process. Renishaw's NPD process provides the structure of their process, which depicts a focus on documented control of innovation as illustrated in Figure 2.3. From their mission statement, Renishaw fundamentally believes that success is derived from: "innovative products and processes, high quality manufacturing, and the ability to provide local customer support in all our markets" (Renishaw, 2003).

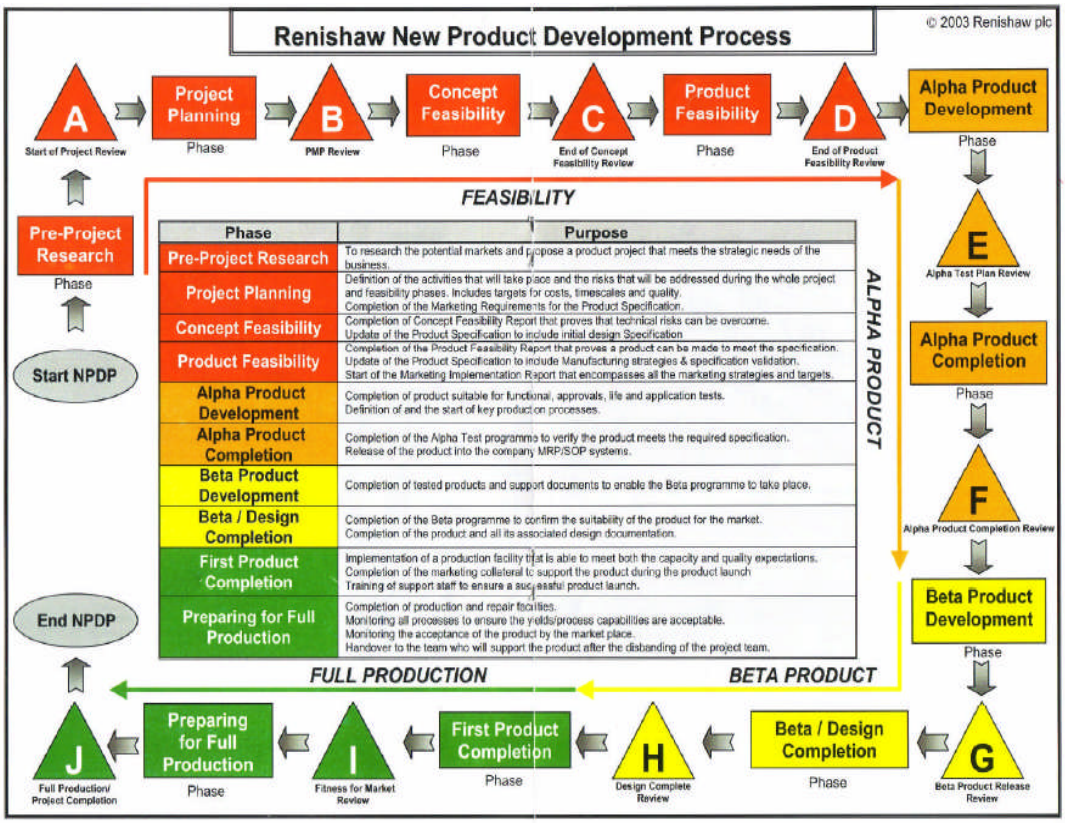



**Figure 2-3: Renishaw NPD process (Adopted from Renishaw, 2008)**

### *2.4.2 Ford*

Ford Motor Company is concerned with the manufacture of cars, trucks, SUVs and other vehicles. Ford's generation and implementation of the Advanced Product Quality Planning (APQP) process flow is aimed at supporting its core businesses. As a result, the process is designed to "facilitate communication between all persons and activities involved in a program and ensure that all required steps are completed on time, with a **high quality-of-event,** at acceptable cost and quality levels" (Ford Ltd, 2003).

The APQP process chart depicted in Figure 2.4, illustrates the status reporting guidelines for 23 key APQP disciplines, identified as Ford's elements. These elements

of quality and process controls communicate the status of different levels of a program, during PD.

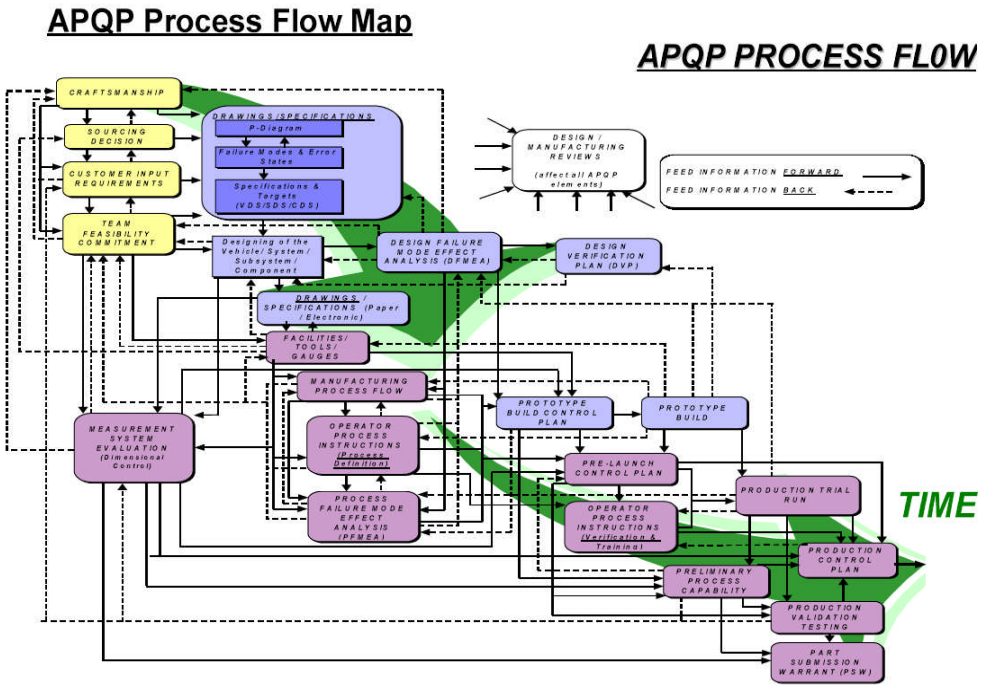



**Figure 2-4: Ford APQP process (Adopted Ford, 2003)**

### *2.4.3 Asea Brown Boveri (ABB)*

ABB is an acronym made up of the first letters from the names of our two parent companies - ASEA AB of Sweden, and BBC Brown Boveri Ltd., of Switzerland. These two companies merged in 1988 to create Asea Brown Boveri, better known as ABB. Today, ABB employs 111,000 employees in around 100 countries, (www.abb.hu, 2008)

The ABB gated process is structured in three different layers: business decision, PM and Execution (Figure 2.5). A business decision point to determine the project continuance or not is done at each gate process. The decision takes into account benefits, status, risks, resource and supporting technology. All the required tasks are completed prior to the next stage. Active involvement of management is ensured.

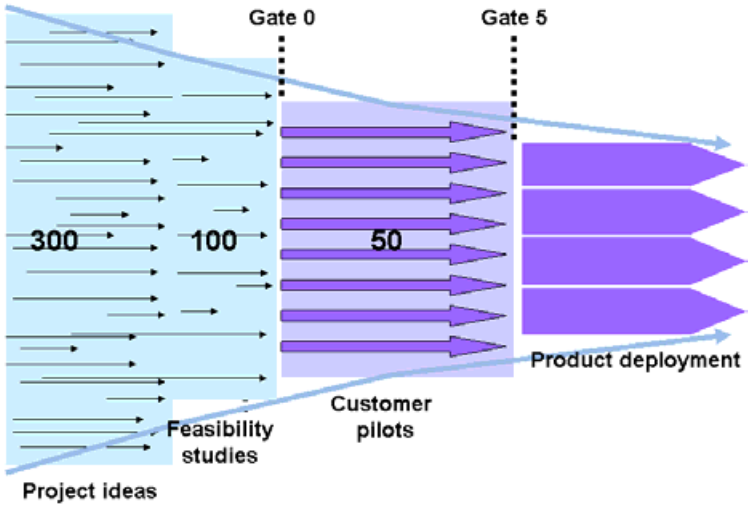



**Figure 2-5: ABB Gate Model (adopted from Chao *et al*, 2005)**

### *2.4.4 General Electric (GE)*

GE is Imagination at Work - a diversified technology, media and financial services company geared towards solving some of the world's toughest problems. With products and services ranging from aircraft engines, power generation; water processing and security technology to medical imaging, business and consumer financing, media content and industrial products, the company serves consumers in more than 100 countries and employs more than 327,000 people worldwide

GE's approach to NPI process is based on Design for Six Sigma (DFSS) tools such as: Quality Function Deployment (QFD) and the scorecard system. The purpose of their process is to understand and manage risk and assess proper usage of supporting NPI tools and techniques. The Tollgate review system as depicted in Figure 2.6 is viewed by GE as a cycle of continuous improvement. For GE each gate has a checklist of deliverables and can be tailored to suit any project. The aim of each tollgate is to review unresolved items with a solution plan, seeking approval prior to the next stage. Scorecards are used to monitor the process.


**Figure 2-6: GE tollgate Review Model (adopted, Chao *et al*, 2005)**

### *2.4.5 Lucent*

The Lucent Gate process is viewed as a high level workflow and decision-making NPI process. The focus here is to support business strategy including customer requirements, fast time to market, limited rework and ISO standards. The intention of the process with its seven gates is to clarify needs and requirements as shown in Figure 2.7 and define roles and responsibilities to ensure successful project completion. The outcome of each review is determined by a *Pass*, *Pass on Condition* or *Not Pass*. A checklist matrix is used at each gate review stage, tracking the required gate inputs, the decision criteria, outputs and the outcome. There are about four steps per stage with about a dozen or two of “yes/no” questions per gate. This process within the review process focuses on roles as well as aid the timing of the project and scheduling.

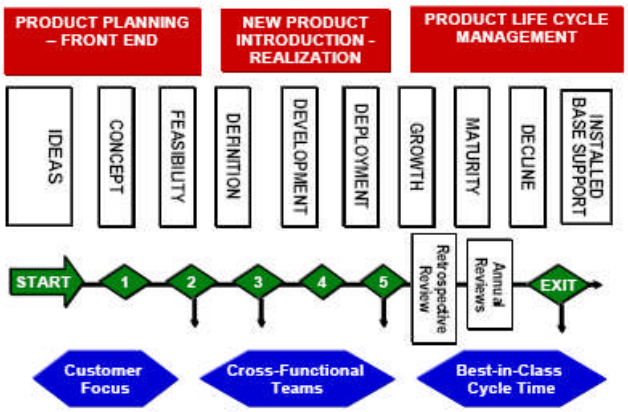



**Figure 2-7: Lucent Product Life-Cycle (adopted from Chao *et al*, 2005)**

### *2.4.6 Whirlpool Corporation, Consumer Goods*

The objective is to prepare and execute the production and market launch plans. The business unit's marketing division is responsible for preparing and executing the market launch plan, however this division is responsible for the preparation and execution of the production launch plan. The PD project team is further accountable for supporting the preparation and execution of both these plans. See Figure 2.8.

Each division has its own process. There is a post-audit meeting to review the lessons learned during product creation and to terminate the PD project. The product business teams within the business units are responsible for the post audit. Each team creates a process for the post audit, to take place within three month's of the product's introduction.

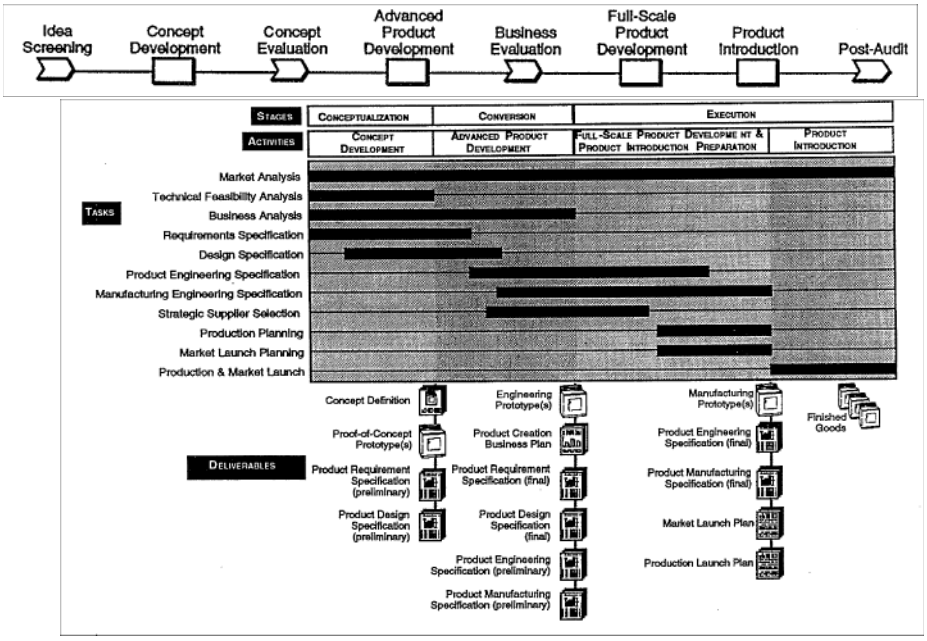



**Figure 2-8: Whirlpool C2C Product Creation Process (Adopted, Whirlpool, 1999)**

## 2.5 Project Management and NPI process

### *2.5.1 Project Management*

Project Management (PM) is a standardised tool used extensively within the automotive industry and other industries. Business cases and customer requirements are modelled using this tool to achieve successful product deliverables. Consequently managing this area of PD necessitates an effective PM leader. The person responsible ensures that the product is delivered on time, within budgetary constraints and the satisfaction of customer requirements.

NPI process complements PM in many ways such as:

- Coordination of resources;
- Communication of stakeholders;
- Maintaining schedules and costs;
- Quality control.

### *2.5.2 NPI Process Correlation with PM*

Other contributory factors include management support, knowledge sharing and re-use, lessons learnt, quality of the project and team collaboration (Driva *et al,* 2000).

#### Top Managerial Support

The success of a product to market could be directly related to the support provided by top management (Cooper *et al,* 2003). The drive of top management helps ensure the return on investment and strategic alliance for the product being developed. Such support is aimed at commiting the resources in terms of finance and time allocation to ensure clear decision making (Tennant *et al* 2001). Top management has to play an active role at both the strategic and detailed level of the NPI process (de Brentani *et al,* 2004)

#### Knowledge Sharing and Re-use

Project management heavily relies on knowledge, which is increasingly becoming a very demanding requirement in the NPI process. Effective strategies need to be in place for successful NPD; this factor reduces risks by collecting and processing relevant data and presenting the information from a range of internal and external sources (Cooper *et al,* 2003). This in turn eliminates uncertainty in the early developmental stages of a product by thoroughly analysing options. Electronic media can be employed to share data and knowledge, retaining the principles of conciseness, focus and visuals to communicate the information required. This helps to facilitate knowledge sharing and reuse.

Acquiring comprehensive contextual knowledge about the PD process is valuable in supporting the needs of relevant stakeholders. Knowledge should at best integrate both formal and informal components of respective activities. This represents the linkages and relationships between the various components and support for the use and maintenance of NPI process. Knowledge is therefore essential for project success (Ramesh *et al* 1999).

With increasing mergers and takeovers; constant advancements in technology; increasing customer demands and expectations, PD is now more complex. Its outcome is now more dependent on the communication, collaboration and integrations of relevant stakeholders within the NPI Process of an organisation. This requires investment in people, skills and experience (Barclay, 2002).

Keizer *et al* (2005), indicate that as a result of the aforementioned changes in requirements, the process becomes complex, thus rendering uncertainty in the outcome of the product. This is further highlighted by providing information from empirical research which shows that success rates for major NPD are still low.

### Feedback Process (Lessons Learnt)

Improving business processes requires the implementation of feedback loops within the process. An instance of feedback involves pre and post sales feedback provided to the PD team. This involves problems, mistakes, things gone wrong or right and market data reviews. Furthermore, information gathered from government regulations, safety information, in-plant manufacturing data, test data, user plant data, warranty data, field data, service data, campaigns, recalls or other sources of information are part of the feedback process.

Feedback is information about actions communicated back to the originator. It has to be bi-directional to ensure continuous improvements within an organisation. Performance feedback indicates the differences between objectives and outcomes, providing the information needed for corrective actions. The most effective derivative result from performance feedback is derived in cases in which participants are closely related to the activities as illustrated in Figure 2.9. The lessons learnt and feedback provided are essential in achieving quality and sustainability (Petkova *et al*., 2005).

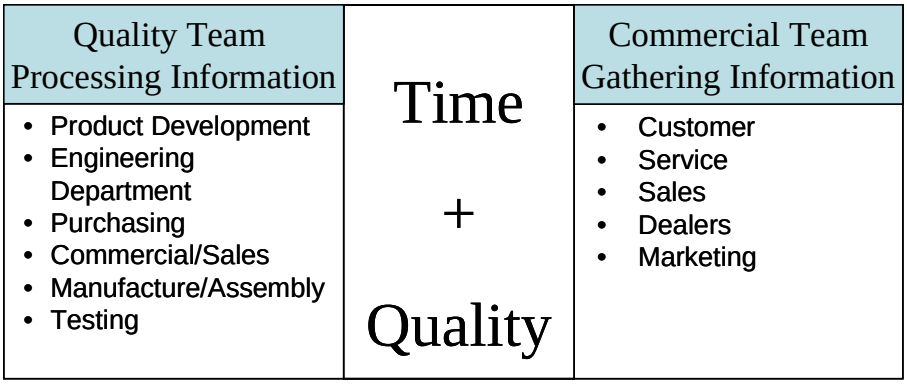



**Figure 2-9: Feedback process (Researcher, 2008 sourced extensive literature review)**

Feedback control loops are a necessity for checking the reliability and application of business processes in accordance with product specification. At each stage of the PD process, reliable information needs to be generated. The processing of feedback should also be designed to meet certain criteria to ensure that accurate information is generated. The contents should be defined in a clear and concise manner, relevant to the recipient. Consequently, the development and introduction of a new product requires quality feedback with control loops for an effective process (Gutierrez *et al*, 2005).

### Project Scoring

Project scoring is used during the early stages of NPI process for screening projects. The project is scored by gatekeepers who follow key criteria, relative to the project. In doing so, the use of scorecards is considered effective and efficient. The real value in using scorecards lies in its behavioural contribution, providing less room for hidden agenda, politics and the like (Cooper, 2008). Other means of scoring a project involve the use of success criteria (profitability, expected sales) and matrices which indicate how well a project is progressing, though this is not a significant measure to determine whether a project goes ahead or not.

### Quality

There are stages of quality within the NPI process, through which all aspects of PD pass prior to the launching phase. Effective PD requires the unification of all parties within the development process. Integration in the form of CE practices exercises an impact on

the capabilities and success of the development process. Competitiveness in product quality is immense as a result of reducing development time and cost (Nanda, 2005).

From the extensive coverage of the literature on NPI, time to market is clearly a preoccupation within the automotive industry and is highly considered to be a key competitive driver for businesses.

To compete successfully, organisations review their NPI process to enhance quality and to shorten product launch lead time due to some or all of the following reasons:

- Increased competition;
- Rapid technological changes;
- Market demands;
- Meeting growth objectives;
- The shortening of the product's life cycle;
- Senior management pressure;
- The emergence of new markets.

The improvement of NPI is required at periodic intervals to eliminate variations, such as technological changes and customer requirements regarding the quality of PD. Continuous improvement is considered routine and assists organisations to enhance performance (Nanda *et al*, 2005).

The focus of continuous product improvement can be through identification and customisation of a process to suit project requirements, in order to improve product quality. To enhance product quality, an understanding of the requirements of each stage is a must to improve the product and documentation of all the design and product processes and procedures. These steps are aimed at monitoring process deviation (Driva, 2000).

As quality and time to market are key competitive business awareness issues, many companies are trying to improve their process by implementing design for manufacture methods, particularly by integrating them into the product definition phase. Table 2.3

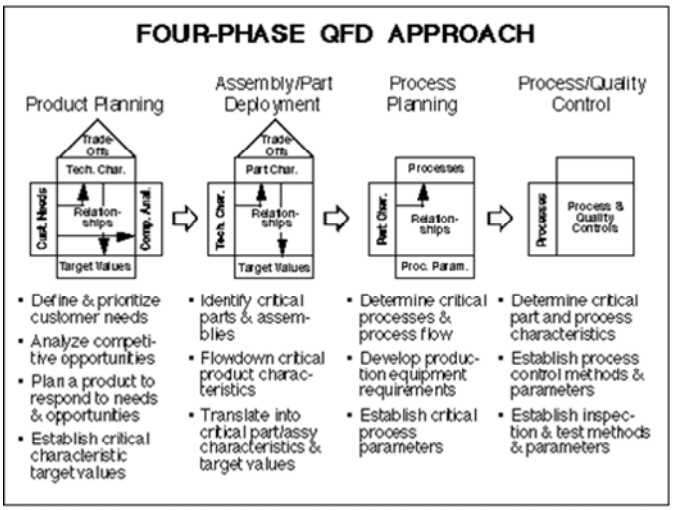
illustrates benchmarking processes by some companies. It exemplifies the processes used, the goals of the processes and the tools supporting the goals.

**Table 2-3: PD Benchmarking (Adapted Chao *et al*, 2005)**

| Company | Focus | Tools |
|---|---|---|
| ABB | PM, Business Objectives | Risk Analysis |
| Delphi | Quality, TTM | QFD, FMEA, Robust Design |
| Denso | Quality, Cost | DFA, Process FMEA, Error Proofing |
| Ford | Quality | APQP |
| GE | Customer Needs, DFSS | Risk Analysis, Scorecards |
| Hitachi | Quality, Productivity | DFA, DFP |
| LG | Quality, Features | QFD, FMEA, DFV |
| Lucent | Customer Focus, Time to Market | Checklist Matrix |
| Sony | TTM, DFSS | Robust Design |
| Toshiba | Quality, TTM | Design Task, Risk Analysis |

### Quality Function Deployment (QFD)

QFD is an integrated set of tools for transforming market requirements into technical requirements and specifications at all project levels (Kao, 2002), with the aim of achieving less time on redesign and modifications. QFD is widely researched and applied to facilitate the clarity of customer needs as well as NPD process (Hung *et al*, 2007). The quality process entails four phases as illustrated in Figure 2.10. These are product planning (HoQ); product design (parts deployment); process planning and process control (quality control charts).




**2-10: Four Phase QFD Approach (Adopted, Crow 2002)**

QFD should be employed to generate information from business cases and client requirements. Requirements and market segment data should further be imported into a QFD matrix and House of Quality (HoQ) for it to generate the engineering information required. An example of the matrix is depicted in Figure 2.11.

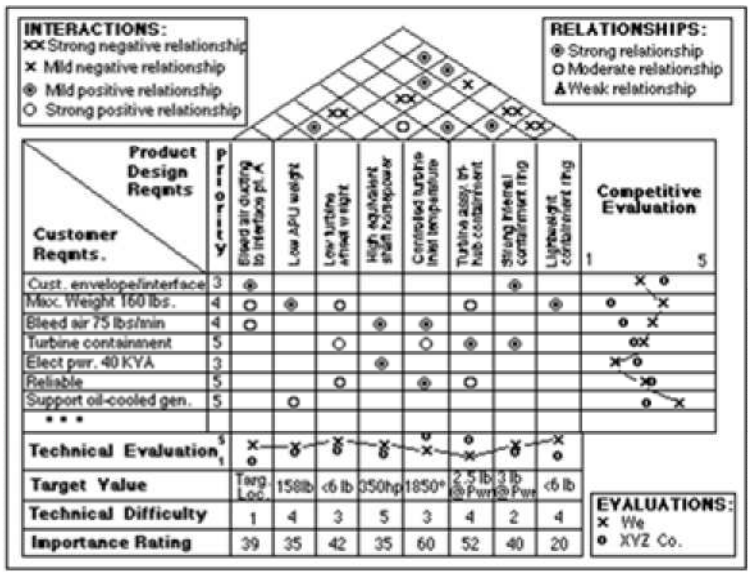



**Figure 2-11: Product Planning using QFD (Adopted, Crow 2002)**

This process was developed to link the needs of the customer (end user) with design, development, engineering, manufacturing, and service functions. QFD is:

- Achieving an understanding of customer requirements;
- Implementing Quality Systems Thinking + Psychology + Knowledge/Epistemology;
- Maximising Positive Quality That Adds Value;
- Securing a comprehensive Quality System for customer satisfaction;
- Devising a workable strategy to stay ahead of the game.

As a quality system that implements elements of Systems Thinking with elements of Psychology and Epistemology (knowledge), QFD provides a system of comprehensive development process for:

- Understanding customer needs;
- Understanding what 'value' means to the customer;
- Understanding how customers or end users become interested, choose, and are satisfied;
- Analysing how we determine the needs of the customer;

- Deciding what features to include;
- Determining what level of performance to deliver;
- Intelligently linking the needs of the customer with design, development, engineering, manufacturing, and service functions;
- Intelligently linking Design for Six Sigma (DFSS) with the front end Voice of Customer analysis and the entire design system.

QFD helps organisations to identify both spoken and unspoken needs, translate these into actions and designs, and focus various business functions toward achieving this common goal, empowering organisations to exceed normal expectations whilst also providing a level of unanticipated excitement that generates value.

## 2.6 Drivers of NPI Process

To aid the successful implementation and utilisation of an NPI/NPD process an adoption of a more flexible approach to strategise PD could be employed. This involves the coming together of all units in unison to arrive at a common goal, the goal being the development of a product and ensuring time to market remains at the fore front of planning (Nonaka *et al*, 1986). However limitations need to be considered (Lint *et al*, 1999). It is increasingly becoming apparent that identifying and managing risks are important issues to consider within the NPD process.

### *2.6.1 Concurrent Engineering (CE)*

NPI process projects can either be parallel or sequential in their activities. The sequential approach is one in which the process is carried out in stages. The parallel approach, on the other hand, is sometimes viewed as overlapping; current engineering; or CE, and as having no structured approach to PD process. This involves a multidisciplinary team working together from conception to the disposal of the product.

CE is defined as “a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause the developers, from the outset, to consider all elements of the

product's life cycle from conception through disposal, including quality, cost, schedule, and user requirements" (Walker, 1996)

For the automotive industry, CE provides support earlier on during PD. CE is an approach to PD in wherein multi-disciplinary teams work together from the requirements stage through to production. The idea behind it is to ensure that the requirements of all the stakeholders involved in the PD are met. For example, manufacturing, engineers work closely with designers to ensure that the design can be manufactured.

CE is supported by different tools such as QFD, FMEA, (RP), etc. It reduces the number of late changes, time-to-market and cost, as decisions at each stage of the PD are based on the common point of view of people from different disciplines involved in the PD. There are two types of CE. The first one is called Point-Based and the second one Set-Based.

Point-Based CE distinguishes the standard approach from the Set-Based wherein the team that designs the product after initial evaluation of several concepts focuses on one, refines and develops it until the production phase. Set-Based CE (SBCE) on the other hand is part of Toyota PD system (TPDS). Design engineers practice SBCE by reasoning, developing, and communicating sets of solutions in parallel forms and in relative independence. As the design progresses, the sets of solutions gradually narrow based on additional information from development; testing; simulation; trade-offs; customer and other participants until a solution is agreed upon (Ward *et al.*, 1995; Sobek *et al.*, 1999).

Traditional design practice such as Point-Based CE tends to quickly converge on a solution, a point in the design space and then synthesise, analyses and eventually modifies the design according to the customer's requirements and feedback from the engineers until it meets the design objectives as shown in Figure 2.12 (A). CE tends to move from Point-Based approach to SBCE. This will help to overcome the limitations

such as iteration, additional communication demands and additional cost (Sobek *et al.*, 1999).

The SBCE approach, illustrated in Figure 2.12 (B), starts by developing and communicating sets of possibilities and gradually eliminating the weakest solution until the optimal solution (workable/functional for all) has been achieved. The decision to eliminate the weaker solution is based on the design requirements, experience of the designer, knowledge, simulation, testing, and trade-off. SBCE approach may take more time during the early design phase to define the solutions, but then moves more quickly toward convergence and ultimately production (Sobek *et al.*, 1999). The three basic principles of SBCE involve the mapping the design stage, integrating by intersection and establishing feasibility before any commitment to develop the product is made (Sobek *et al.*, 1999; Ward, 2007).

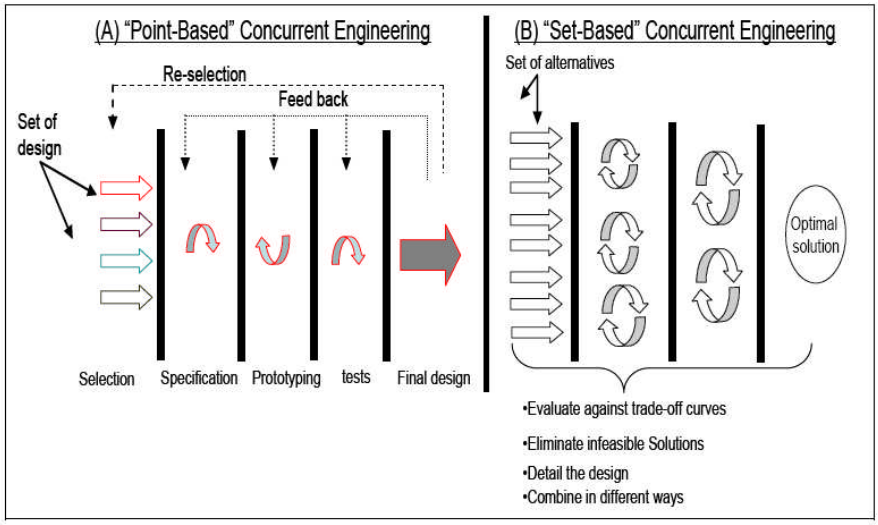



**Figure 2-12: Convergence from a set of Conceptual Ideas to a Single Solution**

Based on the available literature, it is acknowledged that CE resulted from the integration of Japanese working practices. These practices minimised non-value activities from product management, thus dispelling "over-the-wall" engineering, creating a collaborative working culture and increasing time to market.

### *2.6.2 Integrated and Collaborative Working Practices*

Ulrich *et al* (2004), Nanda (2005) have both argued that a structured PD process promotes quality; and facilitate collaboration among cross functional team to improve PD.

To effectively manage projects and their deliverables within the NPI process, the working practices are generally accepted as a collaborative process. Risks associated with projects of PD can be minimised through effective communication. This ensures a viable comprehension of all appropriate product requirements and the utilisation of the appropriate technology. To aid time to market and customer satisfaction, the following practices are known to be effective:

- Flexible unplanned and continuous collaboration;
- Commitment to meeting the goals;
- Ability to make compromises;
- Parallel, overlapping or simultaneous activities (managing interdependencies);
- Effective communication (exchange of information);
- Consensus in spite of disagreement;
- Effective and easy to use documentation;
- Early release, sharing and standardisation of information for effective decision making;
- Continuous improvements in order to increase productivity and reduce process times.

To benefit from the aforementioned drivers, corporate infrastructure needs to operate openly by sharing information and ideas within and between business units. The relevance and significance of adding value lies in communication. A basic element of concurrent PD is team work. Engineering continues to participate even in the production stage to ensure the design specifications are accurately met. This collaborative approach improves NPI time to market and quality, but it also requires increasing levels of communication and coordination amongst the project teams (Figure 2.13).

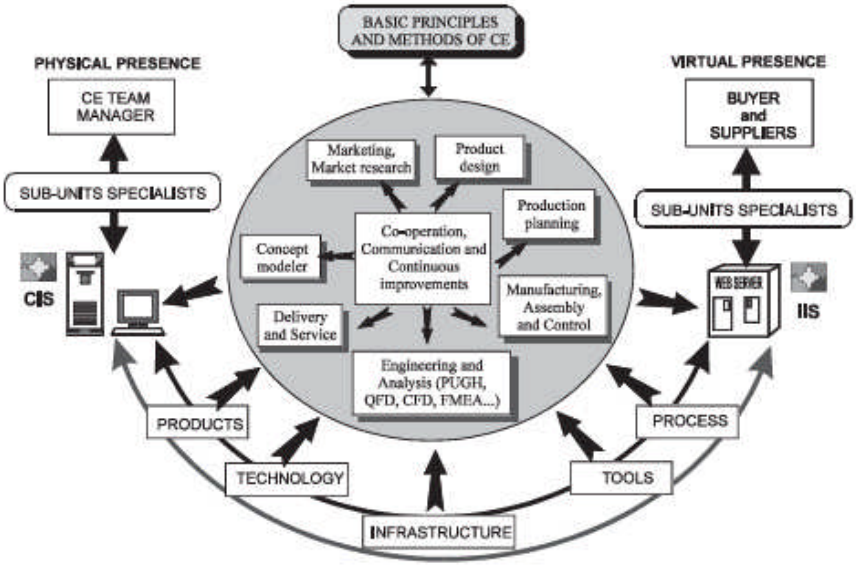



**Figure 2-13: Product Development Team (Adopted, Kušar *et al*, 2004)**

Parker (2000) points out that it is the softer issues (human factors), that are much more of a challenge when considering the development of new products. It is believed that the process and design are relatively easier to introduce. Commitment and enormous effort from all areas of the organisation need to be deployed in implementing the change. The biggest challenge can be the organisation's working culture.

### *2.6.3 Tools and Techniques*

Kumar *et al* (2008), suggests that in order for Engineer-to-order (ETO) firms with 'build to order' manner of business, to maintain competition; minimise design times; improve time to market; and improve quality; it is essential that an effective PM is employed and the generic process modified to incorporate quality and delivery times and support of top management.

Innovative tools and techniques (Figure 2.14) to achieve the goals of on-time delivery, zero defects, low-cost solutions and customer satisfaction for an engineer-to-order manufacturer are defined as including CAD-CAM, QFD and DFMA; RASIC Matrix;

management; human resources; and Policy Deployment Matrix (Sapuan *et al*, 2006). VA/VE is a powerful tool that provides a common measure and method linking customer value to product design, manufacture and supplier processes. A matrix is created for assigning material and manufacturing cost to the functions valued by the customer to determine whether or not value can be enhanced when cost is reduced. (Sapuan *et al*, 2006)

To achieve shorter lead times the use of tools and techniques listed below should be employed to support operational strategies and deliverables (Sapuan *et al*, 2006; Cooper 2003; Kumar *et al* 2008):

- Project Management
- Involvement of key suppliers
- Multi-functional teams
- Design for manufacture and Assembly (DFMA)
- Failure mode effect analysis (FMEA.)
- Design coding/rationalisation
- Customer involvement (Interviews, Prototypes, face-to-face communications)
- Computer-aided tools (CAD, CAM, and CAE – Catia, SmarTeam)
- Quality function deployment (QFD)
- Finite Element Analysis (FEA)

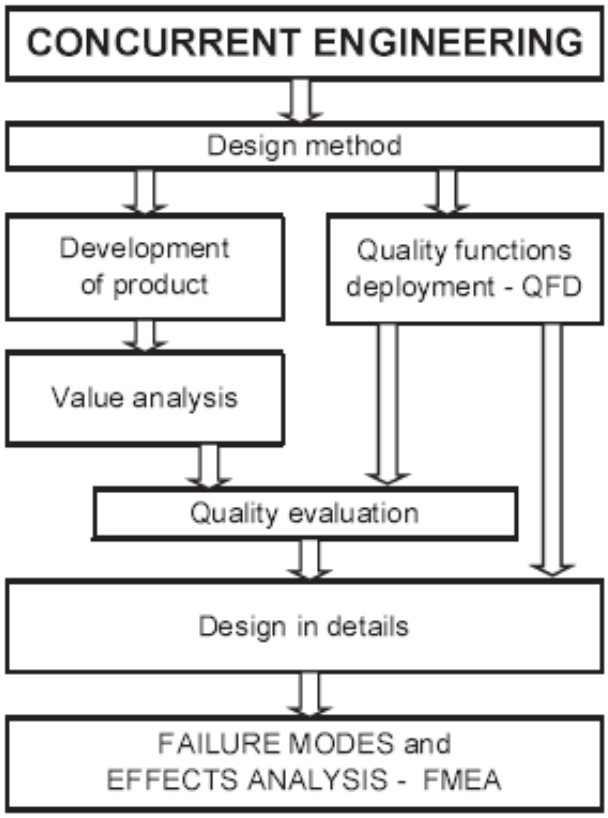



**Figure 2-14: CE Tools (Adopted, Kušar *et al*, 2004)**

## 2.7 NPI Process Challenges

As documented extensively in journals and other related papers; organisations face a number of challenges when working with the NPI process. The aim of NPI process succinctly put is to eliminate the sources of inefficiency on projects by building a culture that fosters an atmosphere of cooperation and one that is success-oriented. Challenges can be attributed to increasing technological advancements, time to market and increasing customer requirements, which in turn impact on the attention to detail which manufacturing companies practice. When faced with these challenges, manufacturing companies shorten the PD process. Consequently, manufacturing companies need to establish goals to:

- To challenge the traditional way of working and apply a process aligned to company strategy and business operational objectives;
- Ensure the process is scalable and distributed;
- Design an evolutionary and maintainable system;
- Execute a development strategy for incremental release to ensure operations staff and systems engineers could gain early operations knowledge, skills and experience;

These aforementioned goals will act as a guide for evaluating how the process works, is managed and how decisions are made. Another challenge lies in acquiring knowledge and managing uncertainty in order to reduce the risk of failure of either the project or the PD process, (Cooper *et al*, 2003). The increasing complexity of PD renders the manufacturer incapable of anticipating any failures that may occur. Measuring the success of PD process goes beyond producing only quality products. It now requires skills to develop a product delivered to the market within a time frame, achieving returns on investments for it to be considered successful (Visser *et al*, 2006).

The increasing customer demands can be viewed as a challenge. Involving the customer in the process can be considered a key to successfully developing the required product. The Voice of the Customer (VOC) variable is intrinsic to the requirement or conceptual stage of the PD process. It has been suggested that (Visser *et al*, 2006) that VOC has resulted in more non-technical reliability issues.

The success of NPD process requires an effective strategy (Cooper *et al*, 2003). The design, development and manufacture of products are sensitive to several risks. The challenge of predicting how a finished product would be used is an example (Petkova *et al*, 2006).

There is also the misalignment of processes and the organisation structure. To compound this challenge, is the clarity and interpretation of information. Understanding how knowledge is managed for the products designed is a challenging issue for

organisations involved in complex PD. It is fundamentally crucial that there is the understanding of the interdependencies across organisational and functional boundaries.

Types of questions that need to be considered during NPD are: (Sosa *et al*, 2004):

- Are the teams communicating about the right things?
- Are all the interfaces between components identified and addressed?
- Why do interfaces between components not correspond to technical interactions between the design team that develop them?

## 2.8 Best Practice

To combat the challenges of the traditional NPI process where the engineer initiates development and manufacture takes over, best practice NPI process integrates manufacturing into the design phase as early as the concept initiation or development, and ramps up manufacturing effort as design progresses to production (Petersen *et al*, 2005). Best practice NPI process encourages collaboration throughout product development (PD) to production.

From a study of the available evidence, it is noticed that there are two factors within the NPI process, which are regarded as positive outcomes in the introduction of new products. The skills required for the activities employed in the individual stages of NPD are design, development, testing and market introduction and the application of market information throughout the NPD process (Ernst, 2002).

A clearly defined product specification prior to PD impacts on the financial success of NPI. The following areas have to be clearly analysed:

- concept and target market;
- feasibility study (technical and market oriented in parallel with commercial evaluation of the project);
- clear point of reference in the process to market demands (market research and competitor analysis)

These need to be considerably analysed. NPI process needs to be flexible and scalable with the decision to proceed with the project built in. For NPI process to successfully introduce product to market the following are quite significant to the effectiveness and success of product introduction:

- Extensive preparatory study prior to development;
- Continuous commercial assessment of the NPD project at all stages of the process;
- Alignment of the process to the requirements of the market;
- The integration of customers/suppliers into the process.

To support the NPI process, the following organisational factors have to be taken into consideration:

- Cross-functional (matrix or task force model) NPD team, comprising of members from different relevant skilled background and expertise;
- An experienced and responsible project leader;
- NPD team empowered with the responsibility to make expert decisions;
- Commitment from top management and relevant stakeholders and clear, concise and effective communication among the team and with relevant participants in the NPD process (information sharing and meetings);

These aforementioned points are complimentary to the success of the process. In other words the success of the process in introducing new products largely depends on the capability, strength and skills of the project team. In an organisation where there is a palpable lack of support for change or innovative ways of processing NPI, a facilitator or champion to promote the benefits is necessary.

The support of senior management and the availability of adequate resource allocation all contribute to the effectiveness of NPI process. This should go beyond the allocation of budgets. The support and commitment of senior management could inadvertently limit the probability of a project termination. The objectives of NPI need to be defined and made clear and the meaning of the different stages clearly communicated (Ernst,

2002). NPI process must have a strategic focus providing an overall direction on individual projects. The presence of a clear strategy positively impacts and influences the success of the NPI process.

### *2.8.1. Measures for Defining Process Success*

Based on the literature regarding success factors in measuring PD projects, various criteria for defining process success has been identified, though not exhaustively. A matrix illustrating the measuring criteria highlighted by different authors is shown in Table 2.4.

**Table 2-4: Matrix defining NPI Process Improvement Criteria**

| Authors / Criteria | Process efficiency | Project Management | Project Scoring | Flexibility / Scalability | Management Support | Communication | Quality Assurance | Feedback (Lessons Learnt) |
|---|---|---|---|---|---|---|---|---|
| Atkinson *et al* (2008) | • | | | • | | ◦ | | |
| Barclay (2002) | • | ◦ | | | | • | • | ◦ |
| Chao *et al* (2005 | • | | | | | | | • |
| Cooper (2001, 2003, 2006, 2008) | • | • | • | • | • | • | • | ◦ |
| de Brentani *et al* (2004) | | | | | | | | |
| Driva *et al* (2000) | | | | | | • | | |
| Ebert *et al* (2005) | | | | | | • | | |
| Ernst (2002) | • | • | | | | • | | |
| Gutierrez *et al* (2005) | • | | | | | | | • |
| Hung *et al* (2007) | | | | | • | • | • | |
| Ibusuki *et al* (2007) | • | | | | • | • | | |
| Kan (2003) | • | • | | | • | • | | |
| Kao (2002) | • | | | | | | • | |
| Keizer *et al* (2005) | | • | | | | • | | |
| Krishnan *et al* (2001) | • | | | | | | | |
| Kumar (2008) | | | | | | | | |
| Kušar *et al*, 2004 | | • | | | | | | |
| Nanda (2005) | • | | | | | | • | |
| Nanda *et al* (2005 | | | | | | | • | • |
| Parker (2000) | • | | | | | • | | |
| Petkova (2005) | | | | • | | | | • |
| Petterson *et al* (2005) | | • | | | | • | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Popp *et al* (2007) | | | | | | | | | |
| Ramesh *et al* (1999) | | | • | | | | • | ° | |
| Sapuan *et al* (2006) | | | • | | | | | | |
| Skold *et al* (2007) | | | | | | • | • | | |
| Sosa *et al*, (2004) | | • | | | | • | • | ° | |
| Tennant *et al* (2001) | | | | | | • | | | |
| Ulrich *et al* (2004) | | | • | | | | | | |
| **Key**<br>• Referenced strongly<br>° Referenced Occasionally | | **13** | 9 | 1 | 3 | 7 | **13** | 6 | 4 |

## 2.9 Research Gap Analysis

This study aims to conduct an in-depth research that identifies and defines improvements for NPI process within the automotive company. From the extensive literature review carried out, the focus is found to be mostly on the relevance and significance of the stages of the NPI process, albeit limited to a study of the following:

- Performance measurement to determine the effectiveness of the process;
- There is limited attention on what should constitute an effective feedback process within the NPI process and how it can be performed;
- How to capture tacit knowledge, particularly within feedback process (lessons learnt).

## 2.10 Summary

The evidence in this chapter shows that NPI without a process, particularly within the automotive industry, will result in poor quality, costly and late delivery of a product to market. It is clearly proven that elements that contribute to the success of an NPI process serve as a guide to ways in which a new product project should be processed. The provision of a structure ensures positive and minimum risks when developing products. There is always an opportunity to improve overall NPI process. This requires an intensive collaborative and integral effort by cross functional teams and a review of the organisation's culture. It is relatively impossible to guarantee that a new product will completely meet customer requirements. Bearing this in mind, companies need to rely on feedback. The subject areas covered in the literature review have been drawn on to identify and specify the criteria for process improvement within an automotive company. Chapter 3 discusses the approach and methodology applied in this research.

# 3 Research Methodology

## 3.1 Introduction

The research focuses on the analysis of NPI process within an automotive company to determine areas requiring improvement. It is from the envisaged gaps within the process that the aim, objectives, scope and methodology of the study were designed. This chapter discusses the sources of data and techniques used in the analysis of data employed in this study. To achieve the aim specified, data and knowledge are sourced from the available literature, observations, interviews, performance measurement survey and company data. As illustrated in Figure 3.1, to effectively achieve the aim of the study, an appropriate structured methodology is drawn up.

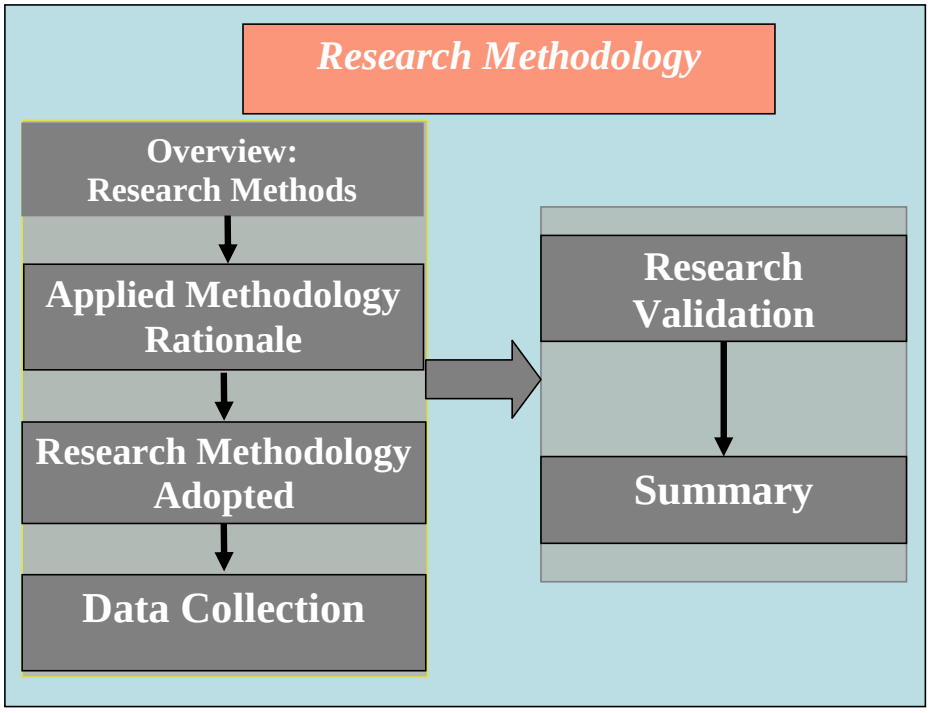



**Figure 3-1: Chapter Structure**

The chapter is structured as follows; Section 3.2 provides an overview of research methods. Section 3.3 provides the rationale for the methodology applied. Section 3.4 explains the approach adopted, based on the qualitative and quantitative approach employed. Section 3.5 describes the data collection technique adopted in detail. Section 3.6 explains the steps taken in validating the approach employed. Finally, section 3.7 summarises the chapter.

## 3.2 An overview of Research Methods

The investigative approach adopted is predicated on the "how" or "why" questions being posed as the focus is on a real-life context. Organisations review their process for effectiveness and to ensure statutory compliance; reaction to market forces and the promotion of integrated computer and information systems (e.g. computer integrated manufacture). To evaluate their business processes, organisations continually review their operations and business overall.

Approaches to research generally assume the form of qualitative or quantitative analysis. Qualitative research is based on an investigative approach, whereby most of the data secured through activities such as interviews and questionnaires. According to Robson, (2002) qualitative research involves directly interacting with the "world". This study argues that the interest lies in people's perspective of a given situation.

A quantitative approach is founded on principles and beliefs, not excluding the assumption that data and knowledge must prove a theory or hypothesis within an investigative remit. A qualitative approach to research though focuses on the objective quantifiable facts; it also determines its outcome based on the manner in which participants in the research understand, interpret and respond to the exercise.

Given the extensive study on NPI process, the approach adopted in this study is of an exploratory nature. The objective is to provide valuable insights, make enquiries and comprehend the current practices in order for the data collected to be informative. This approach is flexible and adaptable as it helps to identify change where appropriate.

Using an exploratory approach not only provides flexibility, it also broadens the research initially but is progressively narrowed as the investigation progresses.

In presenting the findings, there is a level of description providing explanations of situations and events related to the area of study. The explanation also embraces evaluations and conclusions from the data presented. Subsequently, the projected outcome of this study aims to serve a multitude of purposes.

## 3.3 Applied Methodology Rationale

Due to the qualitative character of this study, the use of questionnaires is designed to consolidate knowledge. A set of questions are designed for semi-structured interviews. As the participants are drawn from a cross-section of the functional units of the organisation, the questions vary considerably. These questions exhaustively capture the viewpoints and opinions of the current NPI process, covering PD projects. Company data to back up the information is also provided.

The focus of the questionnaire involved areas of team organisation; information sharing and exchange; technology and human issues. This is calculated to determine:

- if projects get underway effectively, using the NPI process;
- If data sharing and exchange is standardised
- If the team support and skills were appropriate for the current NPI process
- If the existing technology adequately supports NPI and its process
- Areas of concern and opinions on the NPI process

Figure 3.2 illustrates the method and template adopted in gathering information to fulfil the objectives of this study. The underlying and fundamental aspect of the research is the initial review and study of practices that are documented. This is aimed at establishing current state-of-art practices. From the findings, related questions and a questionnaire are drawn up to elicit practical evidence of activities.

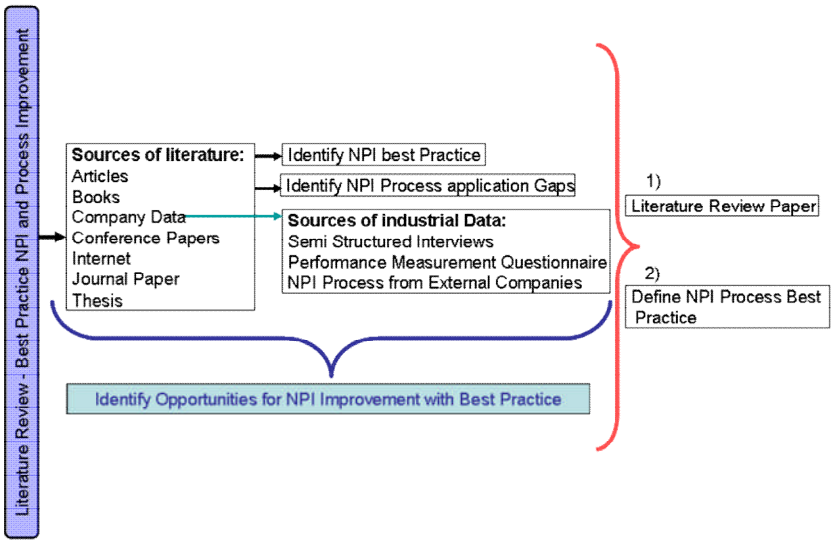



**Figure 3-2: Information gathering Process**

## 3.4 Research Methodology Adopted

This covers clarification of the subject; formulating and designing the interview questions and questionnaire; establishing the aim and objectives; literature review; data collection and analysis and the eventual write up of the report.

The investigative approach offers the possibility to explore and clarify issues where the areas being evaluated have no clear outcomes. The process adopted in investigating designing and processing research questions, is presented within the case study approach. Figure 3.3 illustrates the process employed for this study. The approach establishes the limitations of the this study and the need for improvement, and by so doing provide an opportunity for incorporating a variety of evidence. Consequently the outcome, based on both industrial findings and the literature review constitutes a case for improvement.

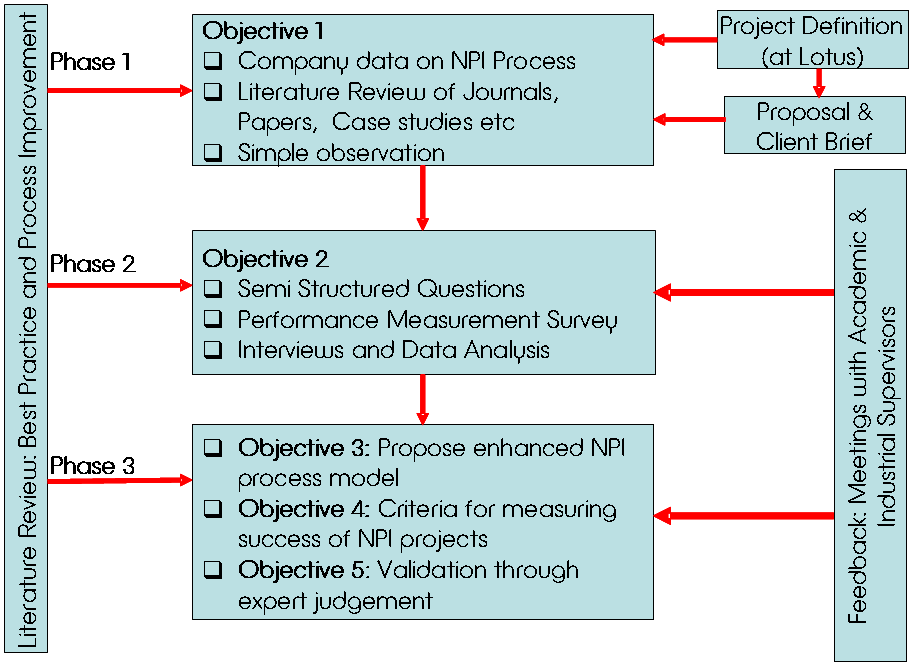



**Figure 3-3: Research Methodology**

Based on the information collected, an inductive approach is adopted. The approach applied consists of three major phases:

- **Phase 1 – Data collection:** Along with the literature review (Journals, Papers and Books), the relevant company data and information from general observation are analysed to gain a better understanding of the current NPI process practices. A comprehensive study of the different approaches for NPI process is conducted. The main aspects of the literature review are the state-of–the-art best practice and application.
- **Phase 2 – Interviews and Information Analysis:** Questions for interviews and performance measurement survey were developed. To determine the best practice, a number of interviews were conducted to capture the ideas and opinions of relevant stakeholders involved in the NPI process, as well as a performance measurement survey. An analysis of the results was then carried out. This which was validated by the stakeholders. This phase provided an

unbiased insight into current practices identifying gaps and areas for improvement.

- **Phase 3 - Propose improvements for NPI process:** This identified opportunities for improvement in the current NPI process and proposed state-of-the-art best practice. The criteria for measuring success of NPI process were also listed. The improvements suggested will also be considered for revising the NPI Quality Planning Process. Validation of the outcome is done through expert judgement.

## 3.5 Data Collection

The project carried out is done within the engineering arm of an automotive company, with emphasis on the NPI process. The questions raised involve analysing the quality of the planning process within the given standards for automotive industries and the process of scoring of project at each deliverable stage. The research questions drawn investigate the challenges related to the application of the company's defined process.

### *3.5.1 Data Sources*

In collecting data used in this study, the techniques employed comprised knowledge, the questionnaire, literature review and interviews. Observation and company documentation complement these sources. This is aimed at limiting the potential for bias and to validate the quality and reliability of information.

#### Semi Structured Interview

In carrying out the qualitative research, interviewing technique are employed to a great extent and these provide a wealth of useful information. The quality of information gathered can be deemed meaningful and quite knowledgeable as it depends to a great extent on the skills and personality of the interviewer. The aim in selecting the interviewees was to obtain a representative selection from different skills and positions. The industrial supervisors selected the majority of the persons interviewed. The interviews provided the opportunity to uncover detailed information, explore new dimensions of an issue and capture concisely an issue which one can put down to experience. A semi-structured approach is adopted, to achieve the following:

- To understand the NPI process from both the engineers and management perspective;
- To identify the current limitations to the process;
- To explore what needs to be improved and how to improve the process.

**Interview Question format**

Some of the questions drawn up are aimed at management and others for engineers. However, due to the interchangeable roles within engineering, the questions are flexible in their application.

**Interview Process**

A flier was created stating the aim, objectives and deliverables of the research project. Prior to the interview, the flier was circulated to all interviewees in an email with a covering mail stating the purpose of the interview, project objectives and how much of their time was requested to fulfil the objectives.

The adoption of an interview process made it possible to probe for further contribution to the investigation from the participants. Throughout the interview process, confidentiality is assured if there are concerns, as the sessions are recorded. The interviews took account of interviewees' length of service with the organisation; the remit of their role and opinion on the effective application of the NPI process.

**Interview Data Analysis**

The data collected is analysed using the recorded interviews and survey results from the performance questionnaire. A number of interpretations were made from the trends that emanated from the data analysis. Findings from the detailed data analysis are discussed in later chapters of this thesis. In-depth analyses of the recorded interviews are also categorised and tabularised in line with the pattern of the results in later chapters.

### *3.5.2 Performance Measurement Questionnaire*

Performance measurement is the quantification of an organisation's effectiveness in running their business operations. A survey of the organisation's NPI process performance was conducted. In carrying out a performance measurement, direct contact

with the automotive company employees provided first hand information deemed neither biased nor distorted. The population sample covers a selection of functionaries. In most cases the questionnaire was presented in a printed form during the interviews for completion. The rationale behind this was to ensure that the response was quick and not deliberated which would have skewed the outcome of the results. The questionnaire provided the relevant data which was then organized into engineering and management categories for reporting purposes.

### *3.5.3 Company documentation*

Reference to company data such as complete product development process documentation which includes the flow charts and the supporting deliverables to the process are used to complement the findings of the interviews and performance measurement survey results.

## 3.6 Research Validation

To validate the research findings, the reliability and validity of the results are examined in order to ensure a true reflection. This stage is considered significant for ensuring the credibility of the outcome of this research project. The following measures are taken to assure quality and reliability of the research:

- Multiple data sources (interviews, questionnaire survey, company documentation, observation and meetings with both industrial and academic supervisors) are used to triangulate the findings.
- Opinions of industrial experts during the course of the research are obtained.
- Research results are disseminated in collaboration with academic supervisors.
- Both interviews and performance measurement questionnaire are documented. Interviews are recorded and referenced, and data collected from the survey are analysed using a defined customised data analysis coding.

## 3.7 Summary

The objective of this chapter is to describe the approach taken to accomplish this study. The next chapter provides an analysis of the automotive company's NPI process practices. This chapter is relevant in identifying the opportunities for improvement and best practices for adaptation.

# 4 NPI Process of an Automotive Company

## 4.1 Introduction

This chapter focuses on the study of an automotive NPI process, providing background information and some observations. It is from this setting that the results from interviews and performance measurement questionnaire survey are to be analysed.

## 4.2 The Automotive Company

It is widely acknowledged that the introduction of the NPI process was more or less imposed rather than based on a gradual change that was introduced using all the known aspects of change management. This company generates most of their income from consultancy, not from the production of their cars, hence the varied portfolio of projects of different sizes and cost tags. As a result of this, it is perceived that the current process is not scalable but only meant for complete product projects, that of manufacturing a whole car. In addition to that, third party clients' projects depending on their size and market position have their own process they would like to the company to follow.

The NPI process (though detailed enough) was introduced and implemented to selected groups and was not a company wide change managed process. To a great extent, this led to limited awareness of the process. During the interview session and from the performance questionnaire survey, some of the participants were of the opinion that the NPI process had no bearing on their work.

To compound this, the deliverables to the NPI process gateway system is not well defined or understood, given the detailed information on process. The Quality Assurance team only get involved in projects they are notified of or learn about at a late stage of the development process, thereby limiting the use of a standard process for communicating and exchanging information at the gateway.

### *4.2.1 Communication*

The impact of change on other interdependent teams apparently is not clearly taken into consideration. A possible explanation can be that the change is not notified via the right

channel or there is knowledge of the change but “hands are tied” situation can be attributed to the project going ahead regardless of the consequences. The effect of this action permeates the decision tree from top to bottom, the result being a delay and increased cost to the development process.

An example of this is evident when SQA is not consulted when there is a change in parts order for a particular component. When the SQA team is then notified for updated orders, the delivery of such part lies outside the schedule for either decision process or progression to the next stage of the project. Another example is that of a confirmed design drawing unaware of a specification change that was approved and was either communicated late to the review team or the supplier. The impact of this is a rework, time delay and cost implications among other factors. A final example is the role out of project Saturn (IFS upgrade). Not all users of the system are involved in the change management of it, which has generated criticism from some quarters that do not understand what the project is about or how it will enable their work to be more efficient and less cumbersome. Information has not been disseminated to get feedback and issues pertinent to all users for evaluation.

### *4.2.2 Team Structure*

As work appears to be organised around projects runs, it is necessary to organise human resource at the start and end of the project. Within engineering, the automotive company appears to align itself with project-lines; functional capacities are identified within each project and headed by project managers. In general the organisation is generally flat, though not particularly of a self-empowerment nature. A number of functional pools exist within the company such as electrical and design engineering, supported by technicians and relevant documentation drawn from functional pools. The benefit of this set-up lies in the fact that resource allocation is flexible and can adapt to the complexities and uncertainty of the environment, though the adverse effect of this is evident in the dual reporting structure. The reliance on departmental heads rather than functional managers should combat this. However this set-up does raise the question of whether this structure effectively enhances the knowledge of the functional sub-groups.

## 4.3 The Automotive Company NPI Process Model

The NPI process is a hybrid of a number of good practices from other automotive companies suitable for the business model. However, though all functional units contribute to the deliverables of the milestones set, it is found that in the main, it is the middle management, heads of departments, directors and the board are the ones who are fully conversant with the process. The lack of awareness across the organisation with the added knowledge that the process is understood to be solely ideal only for complete product development sheds light on its limitation and the ineffective use of the model since its implementation. Figure 4.1 and Figure 4.2 show the NPI process utilised within the company for full vehicle product development sheds and powertrain projects respectively.

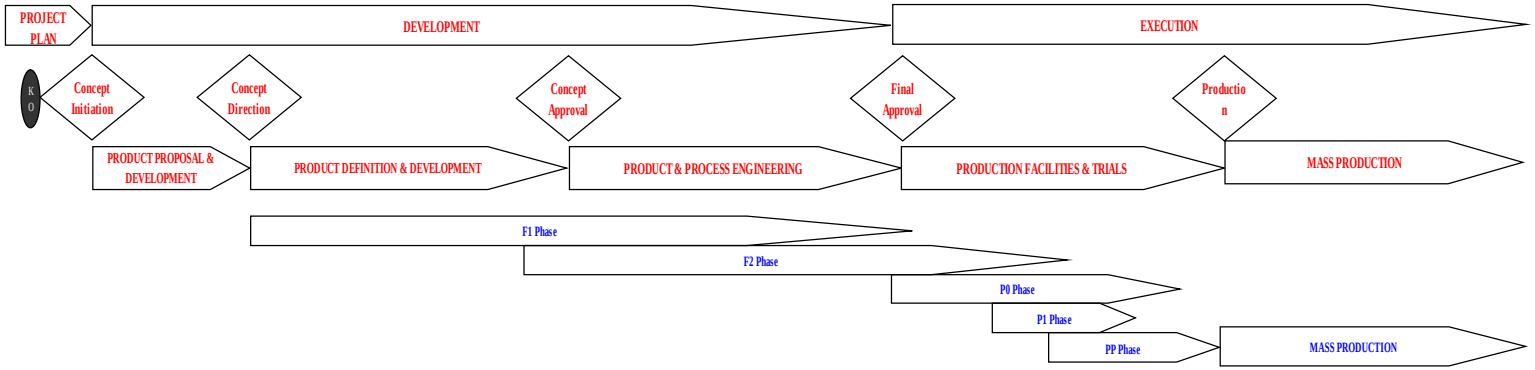



**Figure 4-1: Company Vehicle Wall Chart (NPI Process)**

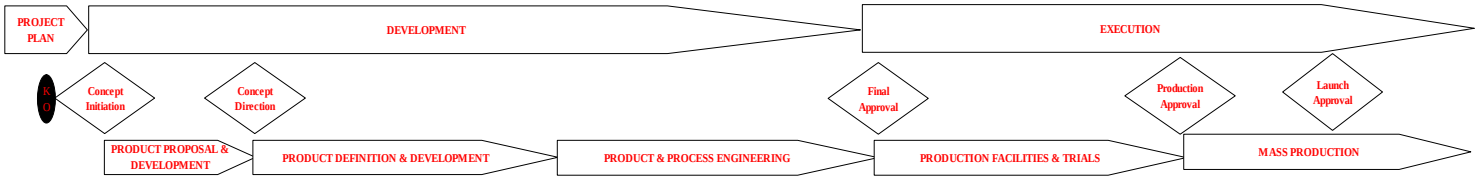



Figure 4-2: Company Powertrain Wall Chart (NPI Process)

## 4.4 NPI Process Model Explanation

The model is understood from a business angle to be a controlling and structured way of evaluating the business case. NPD/NPI, including third party projects is initiated with identifying the business case, going through the stages of concept initiation, analysis, prototyping and production. The model is used to determine the business and financial feasibility of a project which signify whether a project should go ahead or not, depending on the extent of the impact of likely changes. There appears to be a lack of documentation on the process for achieving the deliverables for the gated process.

Stopping a project is one of the most challenging aspects of the NPI process, considering the amount of time and resources that may have been devoted to the project initially. This raises the question of the effectiveness of the front end of NPI process. The company bases its go/no decision on a six gated process, defined as:

**Table 4-1: The automotive company's Gated NPI Process (Adopted, company documentation, 2008)**

| Gate | Definition | Outcome |
|---|---|---|
| 0 | Kick off | |
| 1 | Concept Initiation | Review of the Clients / Product / Market Requirements and the Business Plan/Case. Definition of roles and responsibilities. Review of Proposed Project Timing Plan, Resource Requirements and Funding Profiles up to Completion of the Program. Based on this review a decision is to be made on Funding/Progression of the Project into the next phase. |
| 2 | Concept Direction | Review of the options that offer a solution to the client's / product requirements. This review should cover the Business Plan/Case, Project Timing, Resource, Bill of Materials Targets, Project, Equipment and Tooling Budgets, Technical Feasibility, and Funding relating to each option so as to enable the selection of Product / Project Direction (Design, Technical, Process) and a decision to be made on funding/progression of the Project into the next phase. Selection of any Strategic Engineering Partners (SEPs) that are required to support the Engineering |

| | | |
|---|---|---|
| | | development. |
| 3 | Concept Approval | Review of the Design, Technical, Process Intent, Technical Specification, Packaging, Feasibility and Business Plan, Cost Target to ensure the Product meets the clients' requirements so as to give approval of the final Product selected and enable a decision to be made on Funding/Progression of the Project into the next phase. The purpose of this Gateway is to provide evidence that the Product Meets the Clients requirements and build the confidence with the client and gain their commitment to take the program forward. To build this confidence a review of the Technical or Process Design, Technical Specification, Packaging, Manufacturing Feasibility, and Business Plan, Cost Target to ensure the Product meets the clients' requirements. This enables a decision to be made on Funding/Progression of the Project into the next phase & on to SOP. This approval allows commitment to be made to suppliers and sourcing of parts and Prototype tooling |
| 4 | Final Approval | Review of the results of the First stage Prototype Build and the Test, Development and Validation Program. Review of the actions being undertaken to resolve the issues identified and the Business Plan, Cost Targets Status. Review of the Pre-Production Parts availability, the Build Status and the Manufacturing Plan Status for the Validation Prototype Build. The objective is to ensure the Product / Project meets the clients' requirements and the Program is on plan so as to enable decision to be made on Funding/Progression of the Project to take the product into Production. |
| 5 | Production Approval | Review of the results of the Second phase Prototype Build and the progress of the Test, Development and Validation Program and plan to achieve Engineering Sign-Off. Review of the actions that have been undertaken to Resolve the issues identified throughout this stage and the Business Plan / Cost Targets Status. Review of the activities that are to be taken to launch and support the product in the field. The objective is to ensure the Product / Project is on course to meet the clients' product |

| | | |
|---|---|---|
| | | specification and Program requirements and authorise progression of the Project into the next phase. |
| 6 | Launch Gateway | Validation, Homologation, & Manufacturing Plans complete and Engineering Sign Off achieved. Pilot Build Complete. Quality Targets achieved on Pre-Production Vehicles. Conformity of Production validated. Review of the Business Plan, Cost Target, Field / Service Plan, Product Promotional Launch Plan, and Manufacturing Plan Status. Funding for next Phase agreed. Approval to Produce the first Sale-able product, manufacturing process commencing to ramp-up volume. |

## 4.5 NPI Process Model objectives

The following are identified as supporting elements of the wall charts:

- Business cases are related to the requirements from clients;
- Investment and Bill of Materials (BoM) are linked to the phases to address risks;
- Roles and responsibilities are clearly defined.

Based on the perception and level of awareness of the process within the organisation, challenges for the implementation of the process were identified. The following challenges listed impact on the adoption and adaptation of the NPI process in the variety of projects undertaken:

- Recognition of quality assurance role
- Allocation of relevant and adequate resources
- The process is found to be cumbersome
- Apparent lack of interdepartmental task collaboration
- Unclear requirements, meaning and documentation of deliverables
- Third party project costing
- Projected target costs
- Relevance of the stages to projects
- Organisation and working culture practices

## 4.6 The Automotive Company's Application of NPI process

The NPI process intended as a guideline is not standard however thorough it might be. It is a linear process which identifies a product from its conceptual stage to the launching of the product. Each stage of the PD entails a selection of key activities and deliverables, and are separated by a series of milestones and managed by a number of review points. Though structured to create efficiency using a number of templates coordinated by the QA team, the projects are directed by project and program managers, and then reviewed by the gateway committee through a system of checklist-based activity.

The focus of the interviews is on the company's understanding and practices of the NPI process. The investigation seeks to identify how much significance is placed on the use of the process for projects and to determine the perception of relevant stakeholders in relation to its benefits.

A sample of questions is drawn from direct observations (Sitting in on meetings and explanation of how the company processes its projects) within the company and company information is made available to the researcher. Different sets of questions were drawn up for management and engineers respectively. However, due to the interchangeable roles within engineering, the questions are flexible in their application. Examples of the questions posed to management are shown in (See Appendix 9.1 for the complete list):

1. Is the current NPI process realistic?
2. What is perceived to be the value of the NPI process, how can it be optimised?
3. Are the business cases tested – is there a matrix (manning, resources, BOM, projection)?
4. Is the BOM scheduled against the gateway process?
5. Is there a record of the trend in the project scoring?
    - Does the NPI process manage risks effectively?
    - How well does the NPI process manage uncertainty?
6. What are the criteria used to measure the NPI Process? How well has it worked?

Examples of questions posed to the engineers are:

1. Does the NPI process retain customer focus?
2. How well is the Lessons Learnt taken into consideration on new projects?
3. Should the NPI Process be based on the value of the project?
4. Are there Key Performance Indicators (KPIs) in place to measure the success of the projects?

It must be pointed out that the company currently lacks the flexibility and organisational culture needed to introduce an improvement to the process. This is due to the current team structure, as it hampers social integration or healthy exchange of innovative ideas and working practices. In addition there appears to be no clear evidence of job rotations within teams or throughout the company to facilitate career development and an improvement to the organisational working standards.

Gateway meetings appear to control the progression of projects. At the gateway stage, the deliverables and design reviews are conducted in such a way as to encompass the BoM and business case. All gateway meetings should be headed by a board member; in attendance also should be the director of the respective project, engineers and program manager. The gateway tends to be coordinated and chaired by a member of the quality team. However this may not always be the case due to other commitments and time constraints of members. Very little attention is paid to budgetary control of the project. Based on the interviews, it could be surmised that budgetary review is not incorporated at gateways. There is no visibility or link to project investment points.

It is evident that the company's process provides the benefit of a thorough structure on which projects are run. However, the NPI process at the company is a system of checklists which fails to optimise resources, thereby delaying product delivery. Also as it is not a standardised process company wide, it has not been rigorously followed. The process does not necessarily need to be amended.

A cross section of the Engineering staff were interviewed; a total of 18 over a period of 25 hours. The range of job roles involved in the interview process includes business manager; chief engineers, directors and head of departments.

## 4.7 Summary

NPI process is meant to be an ongoing proactive process, though not a highly repetitive process. Investment is required in improving, adapting and managing the process is required because of the leverage it has on the company and its finances. Chapter 5 analyses the results from the performance measurement survey conducted indicating what the actual practice is as opposed to what is currently being perceived. The interviews were merely summarised with some striking comments.

# 5 Performance Measurement of an Automotive Company's NPI

## 5.1 Introduction

This chapter focuses on the outcome of the NPI process performance measurement survey. An exploratory approach is employed as discussed in Chapter 3 to analyse the results from interviews and performance measurement questionnaire surveys to successfully identify the areas for improvement. The objective is to probe and understand the working practices of the process and together with best practices derived from the literature review propose adaptable improvements that get the buy-in from all participating stakeholders.

## 5.2 Performance Measurement Questionnaire

A total of 34 questionnaires were sent out and all were returned. The questionnaires were targeted at both engineers and management. On the whole, the results were relatively low (average score within range of 2.13-3.94). This leads to the inevitable conclusion that for process improvement to be successfully implemented and utilised, measures need to be in place with a desire for change. The scores below 4 are considered to be relatively low considering the position of the automotive company being studied.

### *5.2.1 Performance Questionnaire Design*

The questionnaire design covered the areas of organisation, information, human issues and technology. This framework is adopted to cover all aspects of the company and product life cycle. An example of a question extracted from the questionnaire is shown in Table 5.1. The interviewee had to rate the questions according to his/her opinion or understanding. Each question was scored from Very Bad through to Not Applicable, coded and transcribed during the data analysis as 1 (Very Bad) – 5 (Very Good) and N/A (Not Applicable) for analytical purposes.

**Table 5-1: The automotive company's Gated NPI Process (Adopted, company documentation, 2008)**

**I4. Documentation and re-use of the Experience and Knowledge:** Lessons learnt are documented and re-used (experience and knowledge gained from tasks performed).

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

To gain the co-operation of the respondents and elicit accurate and required data, respondents' awareness of the subject area, clarity of the questions and elimination of the potential for bias is taken into consideration. The use of non-standard scoring is deliberately designed to elicit unbiased responses. Familiar terminologies were employed for simplicity and conciseness. Figure 5.1 illustrates the approach taken to design the performance measurement questionnaire. The questionnaire was piloted with both industrial and academic supervisors, including academic peers. The process of transition by Fisher, (2003) was adapted and utilised to analyse the opinion of both management and engineers from the survey on their value of the NPI process in relation to their jobs (See Appendix 9.2.1 for results).

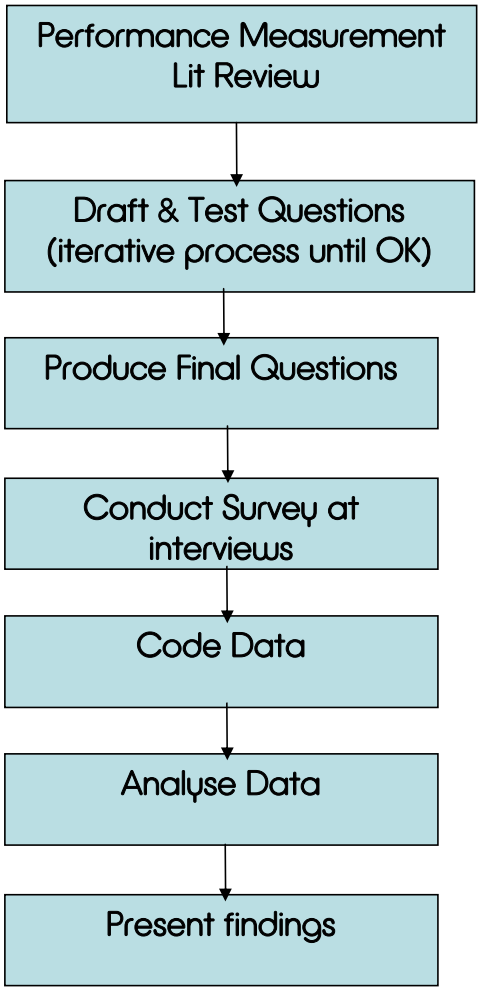



**Figure 5-1: Performance Measurement Design Process**

### *5.2.2 Codification and Analysis of the Performance Measurement*

The process of analysis adopted is by tabulating using MS Excel, the coded questions and the results (Table 5.1). The scoring related to each question is documented with each code to enable the information retrieved from the questionnaire to be analysed. The average value is calculated using the standard mean value. Conclusions drawn from the survey data are based on the mean average for each question and this is used to support findings from the interviews. The data is then used to generate a radar chart (Figure

5.2). Knowledge obtained from this analysis is used in developing the proposed improvements.

Table 5.2 displays the average scores to the questions from the questionnaire. Colour coding of the table is explained as follows:

- O (Organisation) – questions covering aspects of Project Management, coloured blue
- I (Information) – questions covering product data sharing and exchange, coloured green
- H (Human Issues) – questions on resources and the process deployment, coloured yellow.

**Table 5-2: NPI Process Performance Measurement Survey Result Analysis**

| Interviewed Personnel | Management | Engineers |
|---|---|---|
| Question Code | Average | Average |
| O1 - Know NPI | 3.88 | 3.71 |
| O2 - Apply NPI | 3.94 | 3.50 |
| O3 - Know CE | 3.75 | 3.31 |
| O4 - Multi disc PD team | 3.94 | 3.82 |
| O5 - NPI Activities | 3.87 | 3.94 |
| O6 - Comms btwn depts | 3.24 | 2.88 |
| O7 - Customer Focus | 3.50 | 3.65 |
| O8 - Supplier Selection | 3.50 | 3.43 |
| O9 - Top Mgt Support | 3.29 | 3.24 |
| O10 - Clear, Concise & Meas. | 3.35 | 3.24 |
| O11_Tools/Techniques | 3.44 | 3.07 |
| O11_QFD | 3.53 | 2.78 |
| O11_DFM | 3.57 | 3.77 |
| O11_DFA | 3.64 | 3.85 |
| O11_FMEA | 3.56 | 3.69 |
| O12 - Method of Proj. Scoring | 2.87 | 2.79 |
| I1- Prod data sharing & Exch. | 3.23 | 3.14 |
| I2 - Mftr Capabilities | 3.69 | 3.00 |
| I3 - Spec & Reqts Mgt | 3.33 | 3.31 |
| I4 - Doc & Reuse | 2.13 | 2.21 |
| I5 - Feedback Process | 3.69 | 3.43 |
| H1 - Resourcing | 3.13 | 3.06 |
| H2 - NPI Deployment | 3.38 | 3.19 |

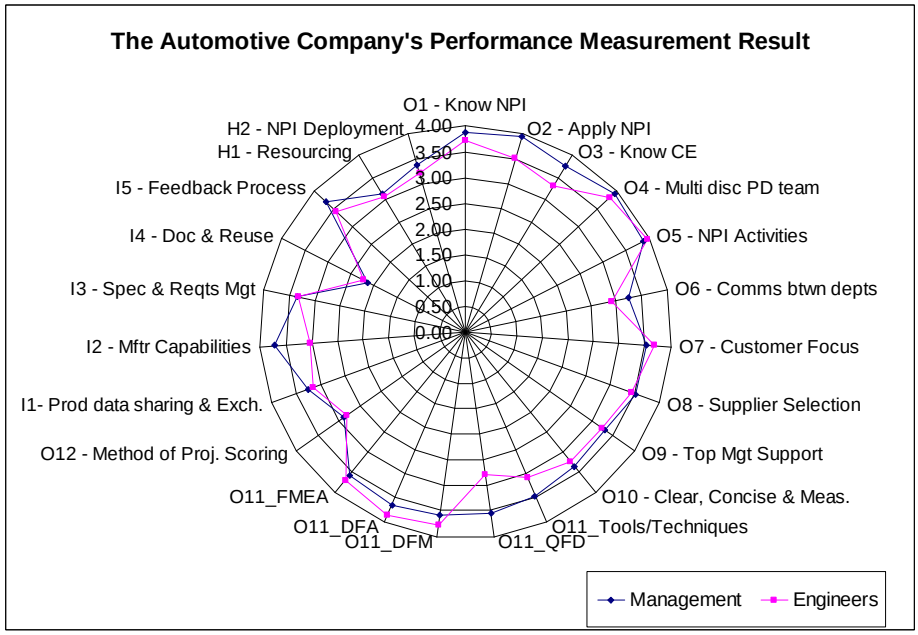



**Figure 5-2: Performance Measurement Survey Results graphically represented**

In general there is a perceived lack of clarity of the process (Q: O1 and O2). The scores are relatively average. From the interviews there is little or no understanding of the process. Comments made in describing the process are:

- "more of a checklist, not a process
- Inconsistent
- Cumbersome
- Time consuming
- Interoperability
- Complicated
- Terminology used unhelpful
- Ill defined deliverables
- Lack of functional integrations…."

The result from O12, method of project scoring is very low evident from responses from both management and engineers. The result indicates a review of the criteria deemed crucial to the decision of whether a project should proceed or not.

The findings on documentation and reuse (I5) indicate that there is limited access to information on past projects. This in relation to lessons learnt, (I4) indicate that these are useful mechanisms, however they are not enforced practices. It also provides an insight into the level of tacit information that is predominant.

On the whole, (Q: H1 and H2. The score relatively low) as seen from the results and comments from the questionnaire, there is no commitment to the process and training is non-existent as the process was foisted on them without prior or post awareness educational training. A comment taken from the questionnaire (essential requirements and support for the application of NPI) was for "specific NPI related training materials to be developed and rolled to all". Top management need to believe in and subscribe to supporting the process and its tools.

From interviews held, it is apparent that there is a lack of standardisation of the tools and techniques currently being employed with engineering projects. The results yielded mixed responses as to their relevance when faced with the question. Although the results do not necessarily confirm the statement, the score on the whole is relatively low (Q: O11 - QFD, DFMA, and FMEA). The extent to which the tools are applied company wide is unclear as it depends on the team, and how meticulous and experienced the engineer managing that team/project is. This then relates to the question on communication between departments (Q: O6). The score is relatively low (average: Mgt =3.24; Engrs =2.88)

NPI process control must be standardised, adhered to and enforced. Quality Assurance team (as the coordinator of the gateway process) must ensure that all projects go through rigorous quality standards and technical review prior to concept approval. This will support the "right first time" doctrines of Toyota's NPI, Lean Thinking and Kaizan; this action will also ensure that the PM issues will be eliminated, enabling the

deliverables for the milestone meetings to be met. The principle of CE would minimise the time and cost of final production.

### *5.2.3 Fundamental Key Issues*

In analysing the data collected from interviews and results from questionnaires, communication is noted as being the underlying factor that hinders the employment of the NPI process. There is no formal evidence of Concurrent Engineering (CE). This is supported by face-to-face interviews held with key stakeholders at the automotive company. Comments from respondents speak for themselves regarding what they would like to see improved, such as:

- ".. overview of what it is all about, First!!
- Total understanding from all involved in NPI
- Clear and equal understanding of the NPI requirements by all project staff
- Training/understanding of the importance of the process".

To summarise the result, to present data from the company to the company, the following are identified as fundamental to the successful application of the process:

- Ref: O1 & O2 – Understanding and Application of NPI process
- Ref: O5 - NPI process activities
- Ref: O6 - Communication between departments
- Ref: O11 - QFD
- Ref: O12 - Project scoring
- Ref: I4 - Documentation and re-use
- Ref: H2 - NPI process deployment

Table 5.3 presents alongside the results of the questionnaire detailed related comments that impact on the timely delivery of projects. The main areas identified by participants of the survey and interviews pertain to communication, practicality of the process, quality and engineering issues that both rely on and require the support of top management.

**Table 5-3: Tabularised representation of key issues**

| | Management | Engineers | Comments in response to "state most important areas you would like to see improved" (Direct Quotes) |
|---|---|---|---|
| **Question Code** | **Average** | **Average** | |
| **O1 - Know NPI** | **3.88** | **3.71** | • Better visibility (Earlier) of new parts. E.g. PR sheet |
| **O2 - Apply NPI** | **3.94** | **3.50** | • Duplication of sheets for reporting purposes - an issue<br>• Less tick in the box process<br>• Ability to streamline to meet different sizes of projects |
| **O3 - Know CE** | **3.75** | **3.31** | • There is no clear evidence of this, though there is knowledge of the terminology. |
| **O4 - Multi disc PD team** | **3.94** | **3.82** | • Improvement to cross functional interaction<br>• More disciplined approach to cross functional APQP meetings and communication<br>• Sound project management/team work<br>• Sales and marketing participation is poor |
| **O5 - NPI Activities** | **3.87** | **3.94** | • Strong independent ownership (i.e. good quality manager)<br>• Quality targets to take priority over cost targets<br>• Gateway needs to be shorter, they are not productive when they take days to complete<br>• Full involvement of all departments e.g. finance and sales/marketing could give better direct support<br>• When NPI tells us that something is wrong and willingness to fix the problem<br>• Efficient/simple change control procedure<br>• Better Cost Planning, tracking and control<br>• Change process too complicated<br>• Milestones not realistic- tailored to other's needs<br>• Business case development - ROI |
| **O6 - Comms btwn depts** | **3.24** | **2.88** | • Legislation specification and changes to be communicated<br>• Better inter-departmental communication and knowledge sharing<br>• Internally agreeing what they want before starting the process |
| **O7 - Customer Focus** | **3.50** | **3.65** | • Customer satisfaction needs to be better understood<br>• Customer feedback accuracy<br>• Improve customer focus<br>• Modification of the process to suit external customer projects |
| **O8 - Supplier Selection** | **3.50** | **3.43** | • Early supplier nomination – before EP build<br>• Within project timing there needs to be allowances for commercial negotiations with suppliers and the acceptance that this can take time |

| | | | |
|---|---|---|---|
| **O9 - Top Mgt Support** | **3.29** | **3.24** | • Top level management understanding the design-release-parts procurement process<br>• Management buy-in and commitment<br>• Respect by top management for engineering decision<br>• Better director decision making; direction from top management<br>• Getting attendance at the right time for the gateways<br>• Gateways supported by directors for full duration<br>• Improved financial approval process, i.e. if budgets are pre-approved, authority should be within the project<br>• Senior Management to better balance project progress with project Risk<br>• Consistent Review by upper management is crucial |
| **O10 - Clear, Concise & Meas.** | **3.35** | **3.24** | • Need knowledge of BoM if too high<br>• Inform on KPIs. What benchmark taken place and against?, What are the competitor information<br>• BoM tracking versus project timing |
| **O11_Tools/Techniques** | **3.44** | **3.07** | • Company business tools need to be improved |
| **O11_QFD** | **3.53** | **2.78** | • Never seen QFD used |
| **O11_DFM** | **3.57** | **3.77** | • Knowledge exist however practice is limited or not applicable |
| **O11_DFA** | **3.64** | **3.85** | • Knowledge exist however practice is limited or not applicable |
| **O11_FMEA** | **3.56** | **3.69** | • FMEA process is followed but not carried out<br>• FMEA focus and continuous tracking |
| **O12 - Method of Proj. Scoring** | **2.87** | **•2.79** | • Link gateways to investment points<br>• Quantifiable and consistent method of scoring<br>• Discipline around organisation release schedule (Ongoing RAG and Actions), instead of periodic gateways simply reporting where we are<br>• Clearer criteria, scoring system to evaluate gateway status<br>• More time to be spent scoring – decisions are made, no debate and depends on who sits on the gateway<br>• Resolution process improvement on red issues (too much time spent on it)<br>• Scoring is too subjective – depends on the management present, normally modified to convince ourselves that all is ok<br>• Commitment to using NPI and abiding by the results of it e.g. gateway results/status is required<br>• Project Scoring to become more objective<br>• Being open – if the item is red, work at it!! |

| | | | |
|---|---|---|---|
| **I1- Prod data sharing & Exch.** | **3.23** | **3.14** | • Proper CAD release system to control data levels sent to suppliers<br>• Data management for input and delivery process<br>• Data compatibility/consistency checks (CAD/CAM)<br>• PC based data reporting/management for project delay<br>• Real time updates of data to measure progress, especially design release and part availability<br>• Continuity of software to provide easier data sharing (MS Project)<br>• IT infrastructure to enable data sharing and tracking |
| **I2 - Mftr Capabilities** | **3.69** | **3.00** | • On average it is considered satisfactory |
| **I3 - Spec & Reqts Mgt** | **3.33** | **3.31** | • On average it is considered satisfactory |
| **I4 - Doc & Reuse** | **2.13** | **2.21** | • Improvement to knowledge sharing<br>• Knowledge and learning to be captured and used<br>• Company Knowledge Management<br>• Knowledge retention poor |
| **I5 - Feedback Process** | **3.69** | **3.43** | • Lessons learnt to be applied to each subsequent project; Lessons learnt process please!<br>• Better feedback from system on deliverables (met/not met)<br>• Lessons learnt events to be listened to – sometimes the same items reoccur<br>• More effective ways of feeding lessons learnt into new project delivery<br>• Standardised reporting format for all deliverables<br>• Expansion of lessons learnt and project closure status; Lessons captured turned into lessons learnt<br>• I've been up to 1 in 8 years and nothing at all came of it. As a result the same mistakes were made |
| **H1 - Resourcing** | **3.13** | **3.06** | • Need Multi-skilled engineers; Required Job Knowledge; basic training of process compulsory<br>• Training, awareness and experience in using IT requirements<br>• More professional in the documentation of the process<br>• Training APQP training for all project personnel<br>• Resource to enable tracking, monitoring and budgeting<br>• Resource - Project rarely build enough resource into plans to follow the process in full. This is usually due to client cost limitations<br>• Training/understanding of the importance of the process (Do not change rules) |

| | | | |
|---|---|---|---|
| **H2 - NPI Deployment** | **3.38** | **3.19** | • Require overview of what it is all about, first!!<br>• Total understanding from all involved in NPI<br>• Flexibility: more flexibility when applying NPI with clients<br>• Improved definitions in NPI documentation<br>• A more flexible system/process that can deal with different projects. E.g. the difference between a Cars project and a client engineering project<br>• Understand the value stream of the process (Basic lean manufacturing is proposed<br>• Measuring in house performances need to be reduced to an absolute minimum (tracking for justification – non value adding)<br>• Project management should change from reactive to proactive mode<br>• To support the NPI, the process should be simpler<br>• To plan and schedule the deliverables around the specific requirements of the programme to maintain its relevance and maximise its use<br>• Standardisation across projects; timing and deliverables linked to project scope<br>• Timing – allowing time to "walk" to the process<br>• Project planning (Upfront) to provide clearly understood tasks and deliverables for all projects<br>• With our intense, short term projects, anything to simplify or streamline the process and reduce the time it takes away from development would be beneficial (without the sacrifice quality of output)<br>• Risk management in particular when using new technologies<br>• For NPI to work effectively, the whole company must follow the process (including clients)<br>• Full NPI process cannot be used for small programmes, although principles can still be followed<br>• Clearly designated leaders for each functional areas<br>• Specific NPI related training materials to be developed and rolled out to all levels of the organisation<br>• Clearer understanding of the project financial justification within the commercial team<br>• Release process – current process quite cumbersome<br>• Run projects as required by the deliverables and scope of work for each particular job and client |

## 5.3 Data Validation

Validation of the performance measurement is done through interviews with relevant stakeholders to get a clear understanding of the result variation between management and engineers. Interviews were held with the departmental heads, a director and the QA team to discuss the trends emanating from the process. To identify the areas of the NPI process improvement, the best practices identified in literature were reviewed and mapped out against the comments from the interviews.

The rationale for the methodology and approach adopted is discussed in section 3.3. The outcome heavily relied on the expertise and knowledge of the interviewees. The ability to clearly identify the issues relating to the study required skills to enumerate information from tacit knowledge of the interviewees. This sometimes proved challenging as there were quite a few abstract responses.

## 5.4 Summary

This chapter provides some factual information on the current practices or perception of the NPI process within an automotive company. To ensure the process is relative to the organisation's business strategy and working culture and is realistically practical to deliver robustly a product that satisfies the end customer, a holistic study of the process is necessary.

There was clear understanding of the relevance of the process. However, as the process was not clearly "sold" to the engineers, it was perceived to be rigid and cumbersome to work with. The NPI process was found not to align well with some types of projects the company engage in, especially projects from third party clients. To ensure the process is relative to the organisation's business strategy and working culture; and is realistically practical to deliver robustly a product that satisfies the end customer; a holistic study of the process is necessary. Due to unavoidable commitments, there were challenges in securing interviews from some pertinent key stakeholders.

Based on the findings in this chapter, Chapter 6 proposes improvements on an incremental scale incorporating state-of-art best practice that fits the size of the

automotive company and level of production gained from automotive organisations that have successfully implemented an NPI process.

# 6 Enhanced NPI Process Model Proposal

## 6.1 Introduction

As the outcome from the performance measurement survey scored below, this chapter analyses aspect of the performance measurement results and interviews deemed to be of priority that can be managed immediately in the short run. Solutions are proposed, sourced from the best practice derived from available literature and knowledge from both the researcher's study and supervisors. These opportunities will then constitute a point for discussion in the following chapter.

## 6.2 NPI Process Deployment – Ref: H2

A clear solution for achieving best practice does not exist; rather a continuous and incremental process can be applied to achieve the desired results. It is proposed that an area of the business (such as the quality team) or project should be selected to determine some of the rules required. These rules can be added, changed, modified and implemented when possible, creating a continuous improvement loop.

The automotive company is considered an ETO as most of its work is project-based. The end products can be complex and for the most times are closely aligned to detailed client specifications; taking into account engineering standards, supply chain capabilities and manufacturing constraints. This can result in the creation of brand new designs of components.

### *6.2.1 Scalability*

There is a need for a scalable, customised NPI process, as the existing one is mainly design and engineering biased and lacks the flexibility to deal with both intangible elements like technology or parts change management. To complement this need is an information development process. Senior and top management support is crucial to any initiative or improvement proposals. The selection of a process owner to perform the regular tasks required for project progression by creating awareness should be a central focus of project teams. The relevant feedback and a mentor for reviewing the process alongside the business case and project requirements are proposed.

### *6.2.2 Process Alignment to Projects*

The challenge for improvement is mainly that of effective collaboration between departments (sales/engineering; engineering/manufacturing) and the interpretation of features and options of projects; critical engineering criteria and changing manufacturing assets. These challenges are further compounded by current use of disparate multiple independent software systems, configurators, spreadsheets and project management tools. Standardisation of procedures and effectively linking commercial, engineering and manufacturing teams are all necessary steps needed to address the challenges.

This study recommends that the current process should be continually refined, with updates to policy and procedures. The process should be "alive"; in order to encourage participants in the process to realise the benefits and apply it to projects, thereby instilling confidence and compliance. With standardisation, delays can be minimised. Flexibility should exist to keep design options open as late as possible. To maximise acceptance and the appropriate mindset, a gradual roll-out will ensure continuous improvement. Process application needs to be realistic and relevant to projects to ensure its adoption. This would prevent confusion later in the process. The solution lies in improving the front-end of the process; stringent screening of projects before going ahead; and QA to provide a standard process to be rolled out.

## 6.3 NPI process Activities – Ref: O5

It is clearly a major challenge to fix what is not understood. Along with the process map that currently exist; an understanding of the information flow with particular attention to the order of when decisions are made in relation to availability of information is recommended. An identification of bottlenecks in the process and relationship to business objectives such as quality is also necessary.

It is also proposed that project managers should establish standard criteria using information such as design process cost; design process duration; and interdependencies. The use of QFD for effective product development (PD) in the early phase of the design stage, incorporating the voice of the customer, needs to be fully

adapted and aligned to the different project portfolios. This will address the challenges of the NPI process and PM issues.

An adequate and stringent pre-design planning is required to fulfil project quality, reduce unnecessary financial outlay and minimise risks. The milestones and gateway should serve as strict checkpoints by which to evaluate and terminate projects. Ultimately the process needs to be flexible, adaptable, and scalable; the required deliverables need to be clearly defined, standardised, simple and concise. QFD, APQP are tools necessary to support product development process; which takes place in the early phase of the design process. To survive the increasing market competition, the attributes of quality and functionality should also be ensured.

## 6.4 Method of Project Scoring – Ref: O12

The proposal is for the NPI process to have an initial stringent screening process for new products, projects, revisions or feature updates. It is further proposed that a milestone and checklist be incorporated for this. To combat the issue of effective time keeping and decision process, the role and expectation from the decision-making standpoint needs to be catered for. The following consideration is necessary to accelerate the gate process:

- What are the risks entailed in and commitment required for progressing with the project?
- What is the expected outcome of the gate process review?
- Are the data presented confirmed and up-to-date?

Expectation have to be clear, ensuring the information provided will generate or improve a decision. The deliverables should be simple to ensure effective and timely decision-making. A standardised presentation format of no more than a few slides is sufficient, as the gate keeping is not an educational session to provide detailed information to a poorly prepared gate-keeping team.

As the PD progresses through the stages of the process, the project can be scored using the current RAG (Red, Amber, and Green) system. This needs to be supported by a

scorecard system applying criteria devised by gatekeepers. The criteria may comprise the following:

- Strategic fit and importance of the project (alignment, importance and impact on the business;
- Product and competitive advantage (customer value; unique benefits; differentiation; test feedback)
- Market attractiveness (market size; growth and future potential; competitiveness and margins)
- Core competency leverage
- Feasibility (Engineering track record)
- Financial opportunity against risks (ROI; NPV; IRR)

## 6.5 Feedback Process – Ref: I5

Feedback process (lessons learnt) has the potential to generate knowledge and encourage interaction between teams. In addressing tacit knowledge, lessons learnt need to be disseminated in a clear concise manner with the use of visual aids and presentations to support project-to-project learning.

The application of a value stream analysis, to support feedback, both at the macro and micro level of project management is valuable to ensure quality, acquire knowledge and eliminate waste (time, materials and money). The full application of the feedback process requires the understanding of the NPI process. This also requires the involvement of all contributors to the project; as the objective is to ensure quality at the lowest possible cost and in the shortest amount of time.

An encouraging attitude to lessons learnt was identified during the interviews as it is perceived as a learning tool. The result from the survey was relatively average. Lessons learnt needs to be supported by senior management, to enforce its practice and encourage a culture of working relationships. When things go right or wrong, participants in the PM process should be empowered to identify, act and record issues and opportunities; for reference when new products are planned or revised.

## 6.6 Communication between Departments – Ref: O6

Educating employees and providing the rationale behind the process are critical elements in engaging the process. As a result there should be a positive impact on the quality and transfer of knowledge. For the NPI process to be embraced fully company wide support is required; this is not only by staff conducting their roles according to the process alone, it needs the full commitment and buy-in of management at all levels. Involvement of relevant departments, such as the commercial department is fundamental to the successful application of the NPI process. Workshops need to be held on strategic alignment for achieving top-down, bottom-up decision processing and feedback.

It should be mentioned here that the process requires periodic reviews to align and scale the deliverables to the varied and dynamic projects being developed; however the actual model, definitions and structure do not appear to require amendments. The deliverables however require clarity and the right use of terminology for adoption by all. Project managers, team leaders and managers must assume a leading role and responsibility for the process.

## 6.7 Documentation and Re-use of the experience and Knowledge - Ref: I4

Improving the NPI process requires the capture and reuse of company knowledge and standards to ensure higher quality, better margin control and overall business growth. Achieving this will ensure client satisfaction, resulting in increased revenues and marketing positioning. Considering the interdependency of sales (market share and completive issues) and engineering (enhanced quality), the choice of ERP system to seamlessly integrate key systems and existing information will provide an environment in which sales, engineering, and manufacturing are integrated while at the same time ensuring that knowledge is accessible in a format that is simple to update and maintain. This depends on the priority of needs and business strategy.

It is proposed that project documentation should be standardised, made available and searchable (Full text index, version tracking) and accessible to all stakeholders in real-

time. This requires analysing and investigating ways to achieve an information-centred perspective (information processing network). This approach is currently underway through another project managed by a Cranfield University, MSc student. A central point of contact needs to be defined for coordinating project engineering change order or more accurately to have a system in place to reflect changes that are communicated to all relevant parties simultaneously.

## 6.8 Application of NPI process and Concurrent Engineering – Ref: O2 and O3

This depends on the priority of needs and business strategy; considering the interdependency of sales (market share and completive issues) and engineering (enhanced quality). The choice of ERP system to seamlessly integrate key systems and existing information will provide an environment in which sales, engineering, and manufacturing integrate while at the same time ensure knowledge is accessible in a format that is simple to update and maintain.

Basically the impetus is for new products to be led by the commercial side rather than engineering and not as currently practiced. Secondly there is the need to project manage in terms of systems and functionality, and not in terms of the elements of a project. This will circumvent the challenges of coordination and collaboration. It is proposed that the automotive company consider analysing fundamental human resources to coordinate the project activity among other activities in the project scope; and how communication and collaboration should take place.

## 6.9 Criteria to measure the success of NPI projects

Following an extensive literature review, a matrix highlighting the criteria for measuring the success of NPI project is presented, as shown in Table 6.1. The following factors for measuring NPI project success detail the corresponding authors and the associated unit of measure (UOM):

**Total Cost of Product:**

The total cost of product, as a metric, is the measurement of the actual cost of the product as opposed to the budgeted cost of development. The associated UOM is pounds/sterling (£'s).

**Time to Market:**

Time to market is a measure of the actual time taken versus the target time for the product development project completion which encompasses the product concept stage through to product launch. The associated UOM is based on time in weeks or months (months).

**Quality of Product:**

The quality of the product is a measure of the product's conformity to the specified quality guidelines and product specifications. The quality of products can be measured as the actual product quality performance versus the predicted performance. The related UOM is the number of defects (No. def.) encountered on the current product development project compared to a previous one.

**Product Novelty:**

Product novelty is a measure of the number of unique and new features of the product compared to previous products and those existing in the current market. The UOM associated with product novelty is simply based on the physical number of new features (No. feat.) introduced compared to similar or previous products.

**Design Alterations:**

A design alteration is used as a metric for measuring project success; it is the number of actions taken on a non-conforming product to make it conform to the original requirements or specifications. The designated UOM for this metric is the amount of effort or time (hours) required to implement the necessary changes.

**Management Satisfaction:**

Management satisfaction is a metric that measures the frequency of complaints received by management per week. The UOM for this metric has been defined as the number of complaints per week (weeks).

**Process Efficiency:**

Process efficiency, measures, tracks and reports on the health of internal processes. It incorporates project milestones and maps these to the ideals (in terms of % of total project). The UOM is efficiency defined as a percentage (%).

**Product Reliability:**

Product reliability, as a metric, measures the *mean time to failure* of the product and its components. The UOM is based on time and usually expressed in hours.

**Table 6-1: Criteria to measure the success of NPI projects**

| ***Criteria*** / ***Author*** | *Total Cost of Product* | *Time To Market* | *Quality of Product* | *Product Novelty* | *Design Alterations* | *Management Satisfaction* | *Process Efficiency* | *Product Reliability* |
|---|---|---|---|---|---|---|---|---|
| Maidique and Zirger (1983) | • | • | | | | • | | |
| Cooper and Kleinschmidt (1987) | • | o | o | • | o | • | | |
| Yap and Souder (1994) | • | • | | | | • | | |
| Cooper and Kleinschmidt (1995) | | | • | • | | • | | |
| Littler *et al* (1995) | • | | | • | | • | | |
| Mishra *et al* (1996) | | | | • | | • | | |
| Souder and Jenssen (1999) | | • | | | | • | | |
| Driva *et al* (2000) | • | • | • | • | • | | • | • |
| Krishnan and Ulrich (2001) | • | • | • | • | o | | | |
| Ernst (2002) | • | • | • | • | | • | | |
| Barclay (2002) | • | • | • | • | | | | |
| Kan (2003) | o | • | • | o | • | • | • | • |
| Ebert *et al* (2005) | o | • | • | o | • | • | • | • |
| Popp *et al* (2007) | • | • | • | | | | | • |
| Forster *et al* (2007) | | • | | • | • | | | • |
| | 8 | **11** | 8 | 9 | 4 | 10 | 3 | 5 |

**Key**
- • Used Extensively
- o Used Infrequently

## 6.10 Summary

The result of the case study carried out at the automotive company was successful. The successful outcome of this study relied heavily on the results of the interviews and performance measurement survey. The methodology employed served as a guide and is considered appropriate in achieving the objectives, as it facilitated the capture of the relevant information with limited or no bias. Given the approach taken and methods employed; supported by the extensive literature review undertaken, the areas of opportunity for improvement were identified and recommendations provided. A gradual re-introduction of the process using the mail system and team/departmental meetings (due to tight scheduling and constraints) backed by an effective senior/top management sponsorship will clarify and create the impetus needed to apply the process.

# 7 Discussion and Conclusion

## 7.1 Introduction

NPI process fundamentally drives businesses today. This brings with it certain complexities and risk-intensity. To successfully improve the NPI process, focus needs to be placed on the softer elements that relate to the behavioural environment of the company; culture, commitment of adequate resources and top-management full commitment.

No company can claim to lack customer focus or exhibit a disinterest in quality. Against this background, this chapter discusses the results of the performance measurement, the NPI process improvements proposed, the limitations and future research opportunities. The first section discusses the methodology. The second section delineates the proposals for improvement and contributions of the study. The third section provides a discussion of the limitations of the study and directions for future research. The fourth section concludes the study.

## 7.2 Research Methodology

The research methodology employed provides an understanding of the methodology adopted which responds to the “how” and “why” questions regarding the current NPI process. The purpose is to identify the issues that are possibly associated with the application of the process; specify areas of opportunities for improvement and recommend improvements to the process. To reveal these issues, the research tools employed were that of semi-structured interviews and an examination of performance measurement. The participants were drawn from a cross section of the company. The questions posed at the interviews varied in order to elicit divergent viewpoints and opinions on the process. The performance measurement questionnaire was standard across the board. It was used to obtain information for analysis on the automotive company’s practices. The research therefore provided the opportunity to build a wide perspective on the application of the process.

The study started with an extensive literature review of NPI process to provide the context within which the study will be conducted. The sources of information comprised papers and journals published during the last 10years. The progress of the study and issues raised were presented in regular workshops. During the second phase of the study, data was collected using the developed semi-structured questions and performance measurement questionnaire. The literature review provided the basis for clarifying the company's requirements and for framing the questions. The questions evolved around the framework of the organisation; information; technology and resources with a view to covering all aspects of the company and its product life cycle. An analysis of the data was then carried out. The second phase ended with a joint review; both with the academic and industrial supervisors. At the third phase, with a better understanding of the current practices, areas for improvement were identified; an enhanced NPI process model was proposed; and a standard list of criteria to measure the success of NPI projects was generated.

The research methodology within this exploratory study worked well with regards to the goal of the study; that is, to enhance the current NPI process within an automotive company. The methodology helped to elicit responses to:

- The applicability of the NPI process;
- Show how project management impact on the NPI process;
- Determine the areas for improvement.

## 7.3. Findings

In chapter 5, the results from the performance measurement survey were all below 4, identifying opportunities for improvement in all areas questioned. A number of proposals presented covered the ones whose scores were very low and were considered of sufficient priority to ensure effective and efficient application of the NPI process. The proposals are deemed practical and possible for roll in the immediate to short term.

The proposals presented in the preceding chapters reveal a slow systematic approach to optimising improved value from the NPI process. It is clear that the implementation and application of the improvements recommended is not going to be smooth but it is hoped that the automotive company would be in a position to face the challenges posed by this

exercise. To strive for superior performance the organisational working culture must push itself to adopt and adapt the improvements. From this investigation, the insight provided into the company's practices forms the basis for the following core recommendations in association with the enhanced model proposed.

### *7.3.1 Standardisation*

This forms the basis for effective adoption and adaptation of the process. It is the driving force that underpins opportunities for cost reduction, enhanced quality and prompt arrival on the market. The automotive company needs to standardise the process, ensuring it is proactive and activity based rather than depending on a checklist system as it is perceived to be. The standards created need be a living document that is continually updated to reflect scalability; market changes, best practices and regulations. On completion of projects, lessons learnt should be mandatory and conducted to determine both successes and failures. Integrated collaborative PM should be maintained to minimise risks.

### *7.3.2 Communication*

Closely linked to standardisation, discussed above, clear business case and definition of the project objectives and client requirements need to be identified and communicated during the initial stage of the NPI process. These definitions tend to change as the project progresses, however there needs to be a formalised system for communicating these changes to all affected participants. Knowledge sharing should also be formalised and integrated into the PD process as valuable outputs.

### *7.3.3 Flexibility*

Flexibility needs to co-exist with standardisation, considering the range and size of projects with different requirements the company is engaged in. NPI process must be flexible and scalable to manage this. An approach/methodology that can manage the proposed changes would be beneficial to the automotive company, as projects are run on short lead time delivery.

## 7.4 Main Benefits of this study

There is no one NPI process model that fits any organisation; the process implemented in any organisation is more of a hybrid framework that is tailored to suit. What is

required to facilitate an improvement is a strong support plan and decision-making process relating to the different aspects of project management. The benefit of this study is the identification of areas for improvement, derived from:

- the results from the performance measurement survey
- semi structured interview;
- an understanding of NPI process;
- identified drivers for successful implementation, adoption and adaptation of NPI process;

The aforementioned are essential for effectively improving the current process. The proposed improvements will facilitate effective project management that will enhance financial control. Effective planning, scheduling and resource allocation are successful outcomes that would enable the early completion of projects within budgetary confines.

## 7.5 Research Limitations

One of the limitations of this study is the relatively low sample size for both the interviews conducted and the performance measurement survey due to unavoidable commitments. There were further challenges in securing interviews with some pertinent key stakeholders. This however did not impact on the reliability of the results; validating the outcome with key personnel was a measure used to combat this.

Subsequently, the results from the interviews were based on tacit knowledge, experience and opinions. However the bias that can be associated with this is minimised by means of validation. In addition the topic was approached from a general standpoint The NPI process was analysed broadly and no aspect of the topic was specifically categorised for detailed exploration.

It goes without saying that a case study exercise as the one carried out for this study will be dependent on the researcher's skills for extracting the relevant and appropriate information; given the approach and methodology employed. The impact of this limitation is minimised with the extensive literature review; company documentation and the supervision received.

## 7.6 Contribution to Knowledge

- Practical methodology was applied to analysing NPI process within an automotive company
- Proposed enhancement to the current NPI process that is state-of-the-art derived from literature review and discussions with supervisors. The proposals are practical; and applicable within immediate, medium and long term.
- Research analysis on real case NPI process within an automotive company; this study provides the step towards mitigating the challenges of the process application. This is the first study within the company in the context of the entire process. The previous work was conducted within the context of "Delivery focused NPI Projects"
- Interfacing NPI process with project management – this study is an interdisciplinary work which brings together the concepts of NPI process and project management to identify with the commercial concept of NPI.
- Increase knowledge and understanding of NPI process, in real and practical terms.

## 7.7 Conclusion

The key observation is that a structured process creates an understanding and manages the flow of information within complex projects by simplifying the details. It is therefore imperative that all participants have a process that is simple to learn and follow. It is therefore safe to conclude that the aim and objectives of the research have been addressed and accomplished against the background of the following observations:

- The literature review was both theory and practice oriented;
- Fostering NPI process without formal education or training materials causes problems;
- The methodology employed proved to be very practical yielding results and reflecting the expectation of the company through regular meetings held;
- Research tools employed (semi-structured interviews and performance measurement) were simple yet effective; the tools used were good at identifying the issues and opportunities for improvement;
- For the solutions to be feasible and practical, they need to be viewed along the lines of immediate, medium and long term objectives;

- Finally, some of the solutions need an incentive approach, as it is difficult to satisfy every one.

## 7.8 Future Research

As a result of this study, the following are identified as areas for further research:

- The need to develop processes and tools for scalable range of projects;
- The creation of a common project activity list within IFS2 with definition of activity; responsibility; delivery/completion time; and lesson learnt actions;
- The need to implement a central supporting technological system that supports standardisation of information sharing and knowledge management.

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# 9 APPENDIX: Documented Supporting Materials

## 9.1 Semi Structure Interview Questions

## 9.2 Performance Measurement Questionnaire

### 9.2.1 *Process of Transition*

# Appendix 9.1:

# Semi Structured Interview Questions

**Objectives**

1. Understanding current practice of the automotive company's product development processes, product architectures, process architecture and organisational structure.
2. Identify example of overlapping activities.
3. Define dependency type of activities within PD.
4. Capture current practice in estimation PD effort and lead time.
5. Capture sources of design rework in practice.
6. Capture impacts of design rework in practice.
7. Identify information exchange policy among activities and team within PD
8. Identify design matrix.

**Management Questions**

M1. What strategy is employed for NPI?
M2. In your opinion what is good and bad about the NPI Process?
M3. What are your suggestions for improvements?
M4. Would it be ok for me to book another meeting with you?

**General Questions**

From your gateway, we need to understand details of your NPI process. Please provide information related to the questions below:

- Model in use – well established?
    - Company model
    - How much is adhered to (performance measurement)
    - How well is the documentation
    - User friendly
    - Clarity

- Understandable

- Product Development Team – What is the practice (multidisciplinary CE)
  - How is the team selected; (Rotation, skills, etc)
  - How is product development decomposed into sub-level processes?
- Techniques within Product Development – "live document?"
  - Customer driver approach (Face to Face)
  - Good interaction with the market
- Tools & Methods
- Champion (Facilitator) – Is there one in place?
- Technology – to deploy the latest, if not what facilities are in place to get them
  - What supporting technologies are in place for product development, E.g. CAM/CAE etc
- Communication – cross departmental (between chassis and Power-train, body work etc)

**Design Process**

I1. Please explain product development processes used in your Team? (Please identify dependency type for each activity)
I2. How do you define product architecture in product development process (Sub-system)?
I3. How do you structure PD team?
I4. Do you parallel or overlap activities within PD? Please specify.
I5. What matrices do you use to evaluate the achievement of each design task in PD?

**Design Rework**

G1. How do you estimate effort and lead time in PD?
G2. How do you estimate design rework?
G3. From previous projects, how much design rework is realised?
G4. Are there any standard tools to evaluate impacts from design rework?

**Design Change**

S1. How do you record design change request?
S2. How are changes communicated to the relevant people?
S3. Are the design changes documented for re-use?

**Preliminary data sharing**

PI1. How do you make decision for releasing preliminary data on overlapping activities?
PI2. Is there a standard format to share data?
PI3. How often does the preliminary data changed?
PI4. What are the causes of preliminary data change?
PI5. What are the resulting consequences from preliminary data change?
PI6. How do you evaluate the impacts of preliminary of data changed?
PI7. What relational impact occurs from preliminary data change on cost and lead-time?

**Key to the numbering:**

G: General design rework question
M: Management questions
PI: Preliminary Information on data sharing
I: General information on design process
S:

# Appendix 9.2:

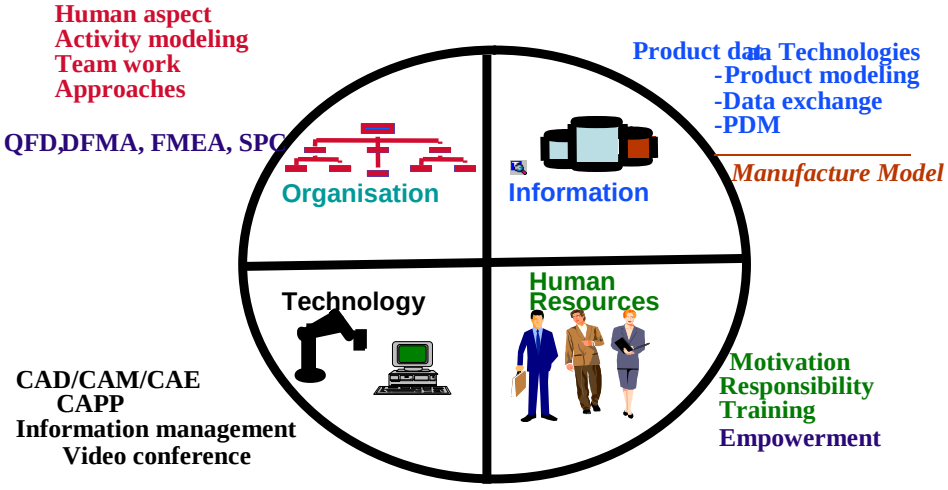
# Performance Measurement Survey Questionnaire

**Performance Measurement Questionnaire on the NPI Process within an Automotive Company's Engineering section**

*Please read the statements below and **tick the most appropriate response***

*It is advised that you do not spend too much time on each statement.*

**Framework**




*This survey should take approximately 15 minutes.*

*Name (Optional):*
*Department:* *Position (Optional):*

**Organisation** - Project Management (Ensuring projects get underway effectively)

**O1. Understanding the NPI:** I know and understand the activities of the NPI Process including the activities that have to be performed with the suppliers.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O2. Applying NPI:** I apply and adhere to the principles of NPI process

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O3. Knowledge of Concurrent Engineering (CE):** I know the concept, tools, methodologies and specifications concerning CE.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O4. Multidisciplinary Product Development Team:** NPI process practices are cross-functional within the team.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O5. NPI Activities:** Parallel activities are applicable in Product Development Process

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O6. Communication between departments:** communication among departments is frequent and efficient.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O7. Customer Focus:** We take into account and understand the needs of the customer.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O8. Suppliers' selection takes into account Supplier capabilities**.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O9. Top Level Management Support**: Top level management understand and support the critical issues of the NPI Process.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O10.** NPI Process is clearly defined and measurable (guidelines, manuals, flow diagrams)

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O11. Design and development tools and techniques:** Within the NPI Process, tools and techniques are applied correctly and used as a part of the working ethos

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

a) Quality Function Deployment (QFD)

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

b) Design for Manufacturing (DFM);

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

c) Design for Assembly (DFA);

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

d) Failure Mode Effect Analysis (FMEA)

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**O12. Method of Project Scoring**

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**Please state 3 most important areas you would like to see improve**

| |
|---|
| |

**Information:** Product Data Sharing and Exchange (Standardisation of NPI product data for the electronic communication between different incompatible CAD/CAM/CAE systems) and the rest of Product Development Activities

**I1. Product Data Sharing and Exchange:** Product data is properly managed, updated and controlled. Product data is up to date and shared within the team throughout the NPI Process.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**I2. Manufacturing Capabilities:** Information regarding the manufacturing process capabilities is correctly documented and properly understood and are used to support decision taking throughout the NPI Process

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**I3. Specifications and Requirements Management:** Documentations of the specifications and requirements are kept up to date when a change occurs.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**I4. Documentation and re-use of the Experience and Knowledge:** Lessons learnt are documented and re-used (experience and knowledge gained from tasks performed).

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**I5. Feedback Process:** Prototype - Build feedback.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**Please state 3 most important areas you would like to see improve**

| |
|---|
| |

**Human Issues**: (Resources - Team setup and vital skills development for the benefits of the NPI process)

**H1. Resourcing:** I have the required training to develop the skills to deliver the NPI Milestones

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

**H2. NPI Deployment:** Know how to deploy the NPI Process.

| Very Bad | Bad | Satisfactory | Good | Very Good | Not Applicable |
|---|---|---|---|---|---|
| | | | | | |

In your opinion what's the most essential requirements needed to support the application of NPI?

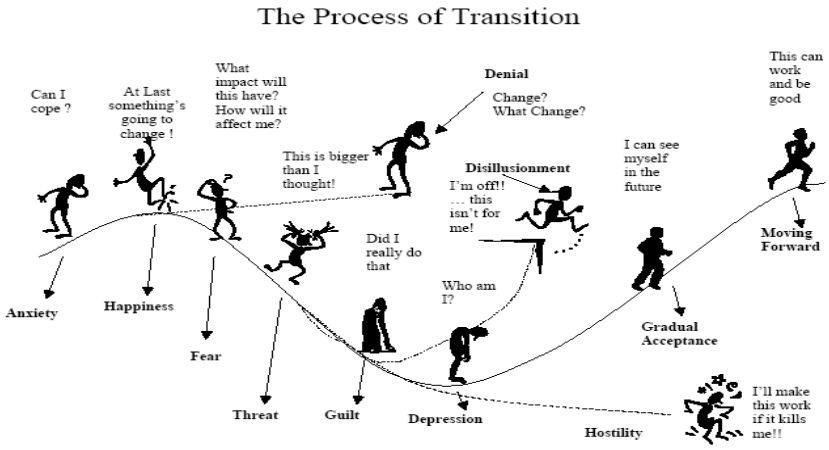
**Technology:** New Product Introduction

What are the 3 main changes or improvements you would like introduced into the NPI process?

**Comments**

If there are any other comments or suggestions that you would like to share or issues that you would like to raise, please do so here. These may be in your specific areas of work or simply in general

**Please place an X where you feel you are on the curve below in relation to the value of the NPI process**




**End of Questionnaire**
**Thank you very much for participating!**

# Appendix 9.2.1:

# Performance Measurement Survey: Process of Transition Results