

Global New Product Introduction and Development in the Automotive Sector

David Atkinson BEng

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Abstract

A Global New Product Introduction and Development (GNPID) process is one of the cornerstones towards a competitive advantage in the automotive marketplace today. A fully optimised GNPID process in combination with other lean and agile manufacturing techniques and systems is guaranteed to reduce lead-time and save on cost.

In the typical post-launch product life-cycle the problems faced by most manufacturing companies lies not only in accelerating and maintaining sales after the launch but in reducing the costly development time before the launch. In an effort to improve timelines and effectiveness, a number of firms within the automotive industry are experimenting with different best practices in their NPID processes. While much of the previous research has focused on NPID in a single location, little has been reported on how actual companies are addressing the problems with globalisation of NPID.

The author aims to develop a set of methodologies for rapid new product introduction in a global manufacturing environment using an integrated framework of concurrent engineering tools and methods. This is to support the development of customer focused agile product and to meet customer expectations in terms of innovation and customisation, quality, competitive price, sustainable and environmentally friendly product.

Definition of terms and abbreviations

APQP - Advanced Product Quality Planning
CAD - Computer Aided Drawing
CE - Concurrent Engineering
CIM - Computer Integrated Manufacturing
CAE - Computer Aided Engineering
DFA - Design for Assembly
DFMEA - Design Failure Effect Mode Analysis
DFX - Design for Excellence
EDI - Electronic Data Interchange
FEM - Finite Element method
FTA - Fault tree analysis
GNPID - Global New Product Introduction and Development
IPD - Integrated Product Development
IT - Information Technology
JIT - Just In Time
KM - Knowledge management
MRP - Manufacturing Resource Planning
OEM – Original Equipment Manufacturer
PDM - Product Data Management
PFMEA - Process Failure Effect Mode Analysis
QFD - Quality Function Deployment
TQM - Total Quality Management
SPC - Statistical Process Control
VOC - Voice of the Customer

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1.0. Chapter 1 Introduction

1.1. Research rationale

In order to successfully compete in today's competitive business environment a company is required to provide quality new products on time and at the right cost. Speed to market has become a paradigm of world-class manufacturing. According to Griffin (2000) most large companies have developed and installed a new product introduction and development (NPID) process. However, globalisation of the world market means that global manufacturing collaboration is a reality and, as a prerequisite, corporations must consider Global NPID (GNPID).

Product development is a broad field of endeavour dealing with the design, creation, and marketing of new products. Referred to as new product introduction and development (NPID), the discipline is focused on developing systematic methods for guiding all the processes involved in getting a new product to market. The main focus for this study is to explore the philosophy of NPID within today's automotive industry. The pressures and requirements of the automotive industry demand a different and more agile approach to product development. This approach should include a product-centric view of products from concept to end of life in a global environment, and a capability that minimises the use of physical resources while fostering innovation. Other NPID problem areas that will constitute the focus of this study are:

- project-to-project knowledge transfer
- rapid problem-solving
- decreased NPID lead time
- increasing cost constraints
- the lack of a global quality system
- interface difficulties in the regional markets, involving customers and suppliers.
- real time communication problems.

- concurrent availability of information and knowledge in the time, place and format required.
- the application of the NPID activities relating to all the departments of the company that are the foundations for product design and development.
- the disparity of regional proficiency and erudition of the personnel involved in product design and development.
- the lack of global quality standard for the automotive industry.
- the diverse emphasis of regionalised environmental issues and legislation.
- the continuous demand/requirement for greater variety of customised products, delivered within a compacted schedule.

1.2. Aim

The aim of this study therefore is to develop a new approach for rapid product introduction in a global manufacturing environment using an integrated framework of concurrent engineering tools and methods. This will support the development of customer focused agile product as well as meet customer expectations in terms of innovation and customisation, quality, competitive price and steps to ensure a sustainable and environmentally friendly product.

1.3. Objectives

The research objectives are to:

- Identify the contemporary models for global new product introduction and development (GNPID) in the automotive industry by surveying and analysing current industry convention and synthesis of the best practices.
- Benchmark NPID within the automotive industry and ascertain the strategic areas of challenge that would support a new definition for a GNPID model.
- Propose a GNPID model for global automotive manufacturing environment.

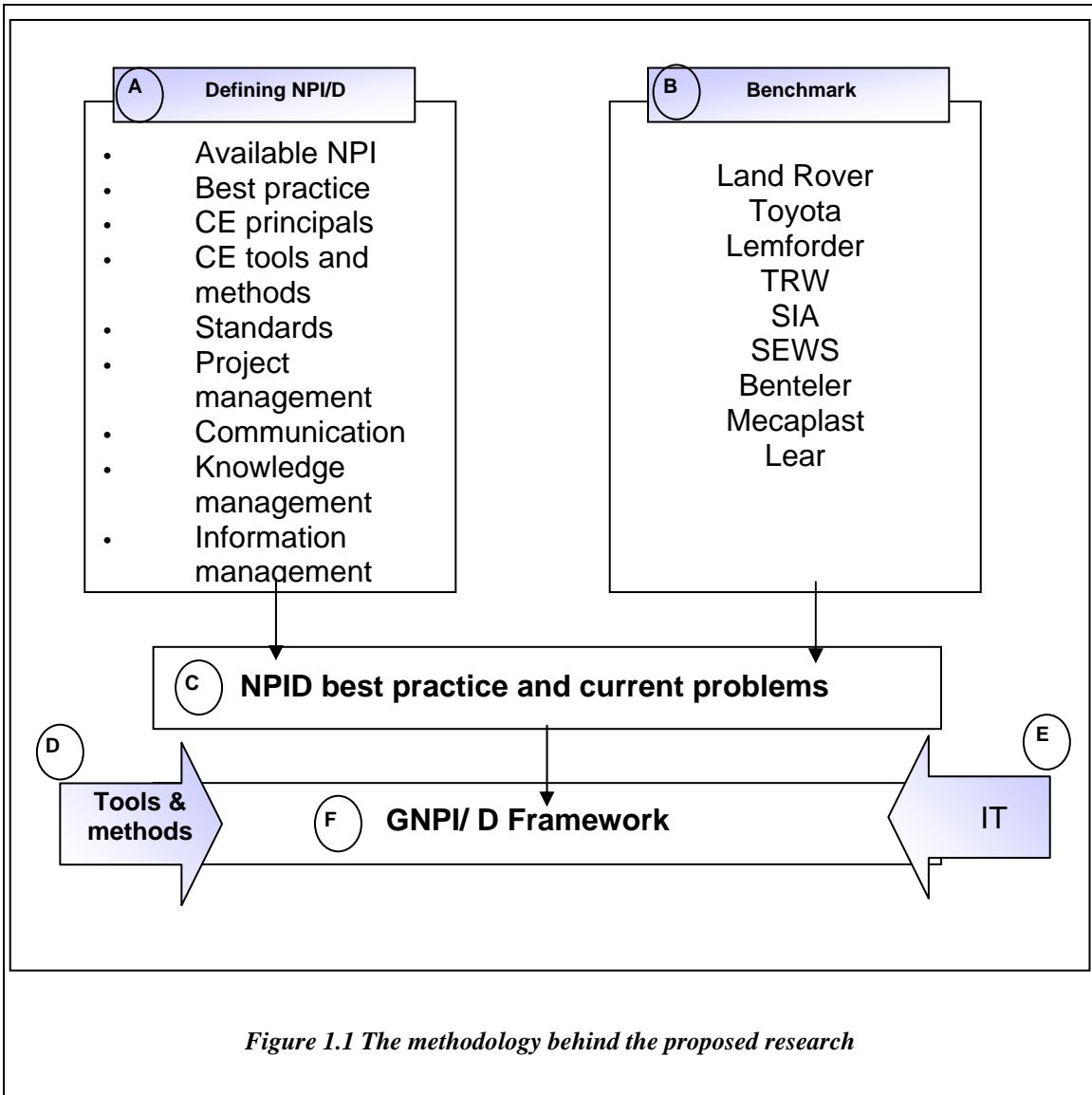
1.4. Methodology

In order to address the previously mentioned objectives the following methodology would be adopted as shown in figure 1.1: -

- a) To research on the state of new product introduction and development process through literature review and available internal documents for the automotive industry. To study and extract from the literature best practice in NPID in the areas of;
 - a. Project management
 - b. Concurrent engineering principles
 - c. NPID activities and methods
 - d. Knowledge and information management
 - e. Communications
 - f. Customer and supplier interface.

To develop a questionnaire based on best practice as stated in the NPID literature.

- b) Perform a benchmark activity using the best practice questionnaire to a range of companies that will include two OEM's, five 1st tier suppliers and two 2nd tier suppliers.
- c) Perform a general mapping of the findings from both the literature and practical experience in order to define the GNPID challenging areas that have not been addressed from global manufacturing enterprise perspective. This will address the issues from a social, economical and environmental point of view.
- d) Using quantitative and qualitative tools to analyse and identify the issues and challenges involved in introducing new products
- e) Propose improvements to tools, methods and IT techniques that would support the GNPID.
- f) Identifying and developing a set of methodology for GNPID. Proposing a GNPID model that will be suitable to address all the challenging issues identified above within the automotive industry.



Chapter 2.0. Review of New Product Introduction and Development literature

2.1. Introduction

This section will explicate and appraise the literature that is applicable to this research. Traditional characterisations of New Product Introduction and Development (NPID) are described and discussed predominantly from a global NPID (GNPID) perspective. These descriptions have provided the foundation for the questionnaire used during the benchmarking survey (refer to chapter 3) and the evaluation of actual industry practice for NPID. This literature survey will provide a more detailed evaluation of existing NPID systems and produce a definitive model with particular consideration to global aspects of NPID.

2.2. Definition of New Product Introduction and Development (NPID)

Clark and Fujimoto (1999) state, “New Product Introduction and Development (NPID) is information and knowledge intensive work”. Developing successful new products is possible through the integration of the abilities of both upstream (design engineers) and down stream manufacturing expertise and a firms development capabilities are derived from their ability to create, distribute and utilise knowledge throughout the process. Nonaka and Takeuchi (1995) consider knowledge that is shared to be “one of the unique, valuable and critical resources that is central to having a competitive advantage”.

“NPID typically consists of a set of historically uninterrupted and inter-related activities” (Cooper et al 2001). A product development effort may not only develop a successful new product for current customers, but it may also create technological knowledge available for potential projects (Mahajan and Wind 1998). In this manner, companies “continuously accumulate competencies for product development through sequences of new product development activities” (Wheelwright and Sasser 1999).

2.3. Criteria for analysing and discussing NPID

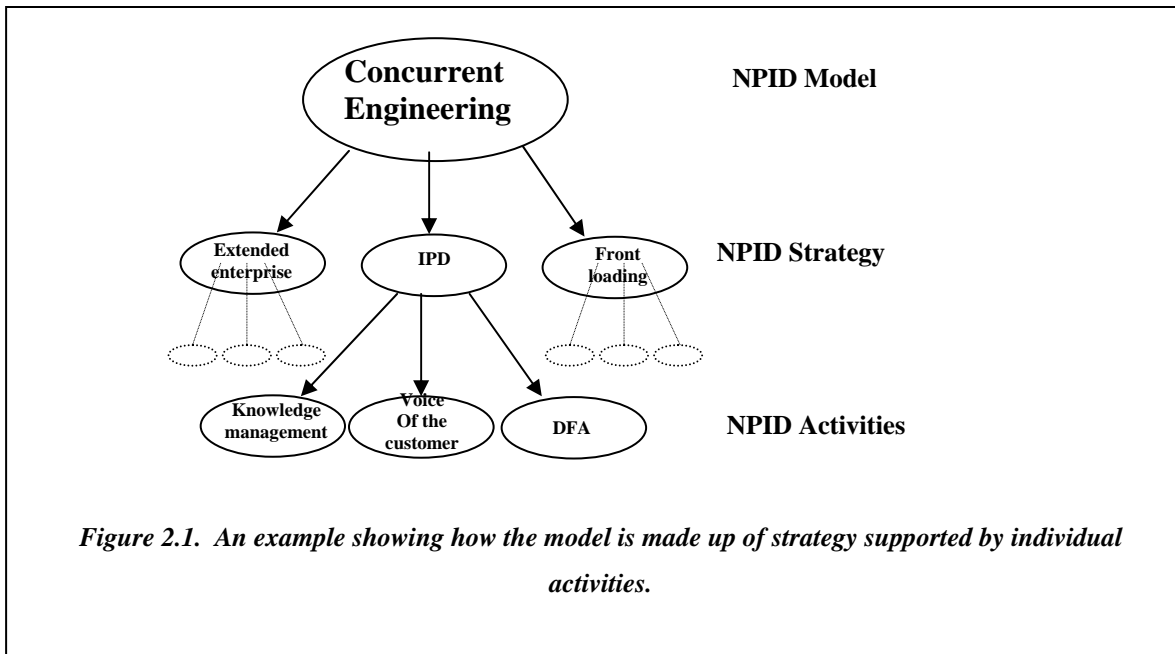
The first step to defining the criteria for NPID for the author was to attempt to standardise the terminology used in order to analyse the NPID. A confusion that needs to be publicised is in the inconsistent terminology used (as illustrated in the randomly selected authors terminology shown in table 2.1.) The subject matter may be the same but the terminology used by various authors is different. The most commonly agreed terminology is “NPID model” “NPID strategy” and “NPID activities” and therefore these terms will be adopted from now onwards.

| Terminology | | Policy deployment | NPID Model | NPID framework | NPID Process | NPID Organisation | NPID roadmap | NPID structure | NPID strategy | NPID architecture | NPID Tools | NPID Activity |
|-------------|------------------------|-------------------|------------|----------------|--------------|-------------------|--------------|----------------|---------------|-------------------|------------|---------------|
| Author | | | | | | | | | | | | |
| 1 | McGrath (2004) | ○ | ● | ● | ● | ● | ● | ○ | ● | ● | ○ | ● |
| 2 | Terwiesch et al (1999) | | ● | | ○ | | | ○ | ● | | | ● |
| 3 | Cooper (2004) | ● | ● | ● | ● | ● | ○ | | ● | ● | ● | ● |
| 4 | Kahn (2004) | ● | ● | | ● | ● | ○ | ○ | ● | | ○ | ● |
| 5 | Kennedy (2003) | ○ | ● | | ○ | | | | ● | | | ● |
| 6 | Kucmarski (2000) | ● | | ○ | ● | ● | | ○ | ● | ● | ● | ● |
| 7 | Patterson (1999) | ● | ● | ● | | ● | ○ | ● | ● | ● | ○ | ● |
| 8 | Griffin et al (2002) | ● | ● | ● | ● | ● | ● | | ● | ● | ● | ○ |
| 9 | Cagan (2002) | ● | ● | ○ | ● | ● | ● | ○ | ● | ● | ● | ● |
| 10 | Roseau (1999) | ● | ● | ● | ● | ○ | ○ | ● | ○ | ● | ● | ● |
| | | 7 | 9 | 5 | 7 | | 7 | 2 | 9 | 7 | 5 | 9 |

Key methods and standards to achieve quality targets ● Used extensively ○ Used infrequently

Table 2.1 The various terminologies used in some of the NPID literature.

The definitions discussed above will be used as a foundation when analysing NPID and how these conditions are inter-related is shown in figure 2.1. The illustration indicates that combining numerous interrelated strategies, such as front-loading or integrated product development (IPD), gives structure to the NPID model. These in turn have numerous activities within the strategy, like voice of the customer or knowledge management.



NPID model: Contains the management of the finite development of capacity within an organisation. The model is actually the master plan that guides the company’s product innovation and development. It consists of a set of historically continuous and interrelated strategies.

NPID strategy: The individual strategies used for NPID, which make up the complete model. In the example shown in figure 2.1 strategies like Integrated Product development (IPD) includes activities like Voice of the customer, knowledge management and Design for Assembly (DFA). The strategy of a company contains the individual activities and systems. The strategic plan should reflect the interpretation of market opportunity and demands of the customer.

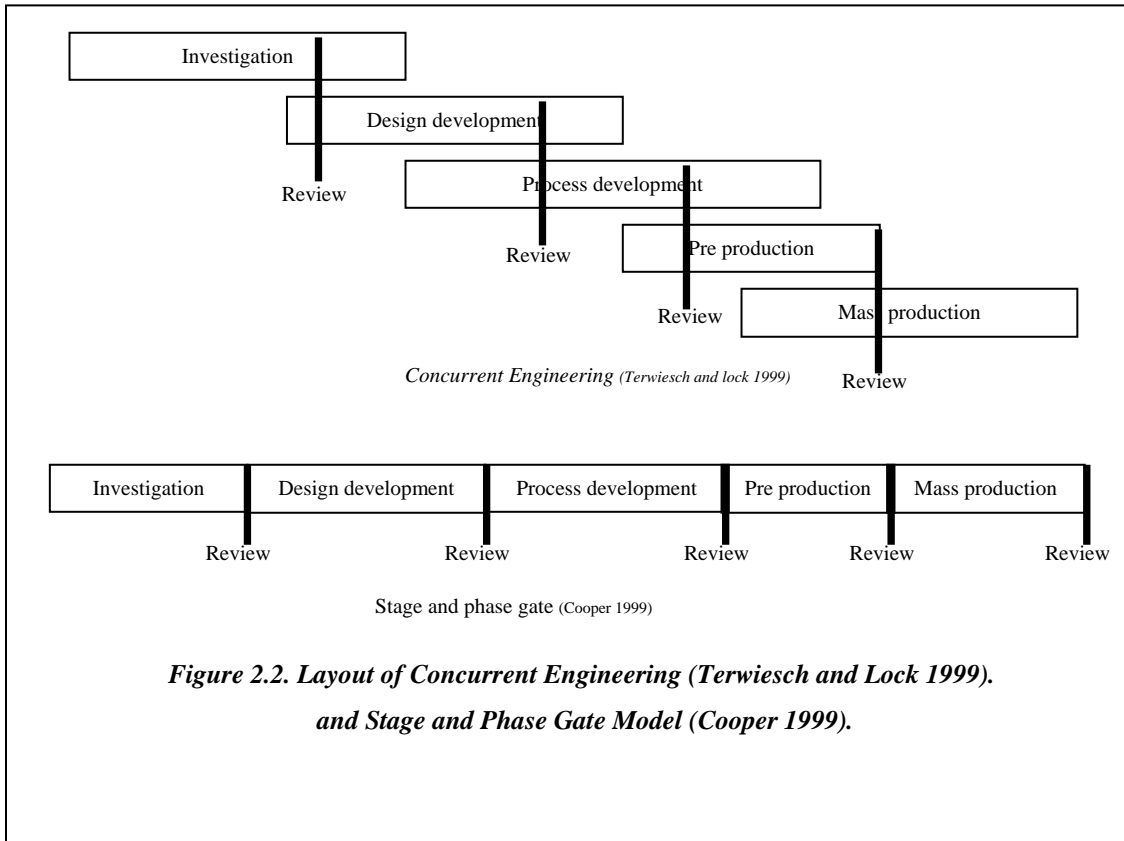
NPID activities: The NPID activities contain the coordinated efforts in timing and substance of the various disciplines and the organisation that spans the life cycle of the product.

2.3.1. Existing New Product Introduction and Development Models

Numerous models of NPID that have been researched over the past decade these include:

- 1 NPID based Concurrent Engineering Model (Terwiesch and Loch 1999)
- 2 Phase and Stage Gate Model (Cooper 1999),
- 3 Response Model (Chen 2000)
- 4 Front End Loading Model (Clark et al 2000)

Concurrent Engineering and Phase and Stage Gate models will be discussed in detail as they closely match the two models used extensively in the literature and also within industry. These models will be further analysed in the benchmarking section. The Response Model and Front End Loading will be reviewed briefly at the end of this section. CE and Phase and Stage Gate Model are in distinct contrast to each other as shown in figure 2.2. CE relies on simultaneous tasks running concurrently, as opposed to the Phase and Stage Gate Model, which has structured activities within each phase and regular reviews constantly updating the project situation. The reality is that the individual strategies and activities within the actual models are very similar to each other. In order to form a different perspective and judge the practicality of the various models available, the various levels of complexity will be reviewed against the previously mentioned criteria.



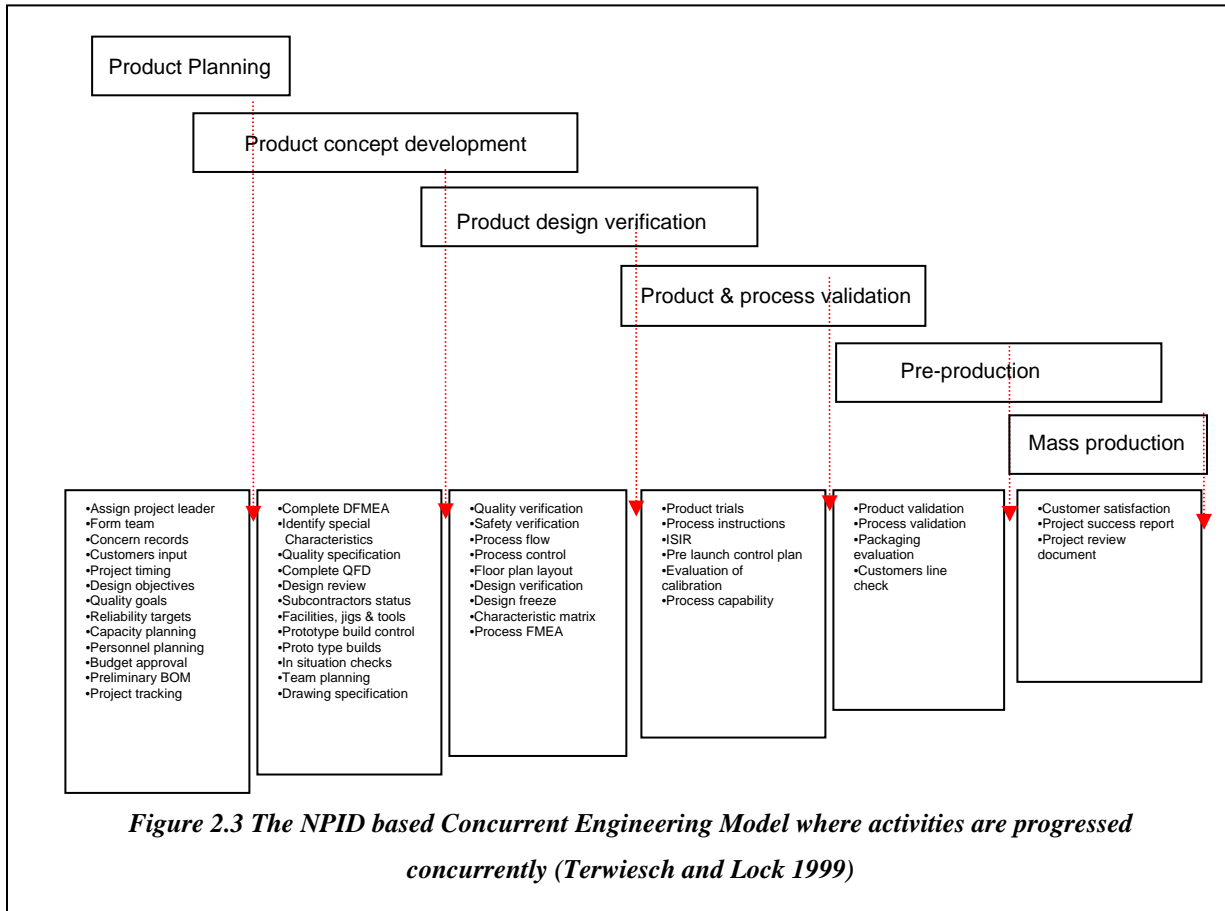
**Figure 2.2. Layout of Concurrent Engineering (Terwiesch and Lock 1999).
and Stage and Phase Gate Model (Cooper 1999).**

2.3.1.1. NPID based Concurrent Engineering Model (CE)

Concurrent Engineering (CE) is a product development methodology, which enhances productivity and can lead to better overall designs; it still relies heavily on the quality of information, interpretation, execution and implementation. CE, is a “non-linear product or project approach where all activities of NPID operate simultaneously” (Parsaei and Williams 2001). Product and process are closely coordinated to achieve optimal matching of requirements for effective cost, quality, and delivery. This relationship between the product and process is crucial. Life cycle engineering will evaluate the impact for example of future upgrades or product recycling, whilst lean manufacturing has as a criterion for product and process, the elimination of unnecessary (and wasteful) steps. The automotive industry is the front-runner in many of the disciplines in their race to cut cost whilst remaining competitive.

Terwiesch and Loch (1999) discussed that in the development of a product, there are many aspects to be considered. These include final cost, manufacturability, safety, packaging and recyclability. These aspects represent different phases in the product's life cycle. In traditional design methodologies, the product is evaluated after each phase is completed. Rosenthal (2002) however points out “the downstream aspects are affected by decisions made during the design phase”. Consequently, these aspects should be taken into account during the design phase, considerably difficult in globally dispersed teams.

Smith and Reinertsen (1998) suggest that automotive suppliers seeking to take on major design responsibilities will need to significantly improve their ability to effectively conduct concurrent engineering early and often throughout the production process. Figure 2.3 shows a diagram representing the Concurrent Engineering (CE) Model as defined by Terwiesch et al (1999). Activities in the model are progressed concurrently and completed simultaneously and the phases within the project are completed simultaneously thereby reducing project lead-time and cost. Within the model the individual strategy can be broken down into NPID activities that are crucial to that period of the NPID process. For instance the completion of the design FMEA is imperative before commencing product design verification in order to reduce cost, lead-time and process complications.



The literature is unanimous in agreement with the variety of activities involved in concurrent engineering but far less lucid about their role within Global NPID, (Clark and Fujimoto 1999, Highsmith 2004, Ernst 2002, Smith and Reinertsen 1998). These Concurrent Engineering (CE) issues from a global perspective are;

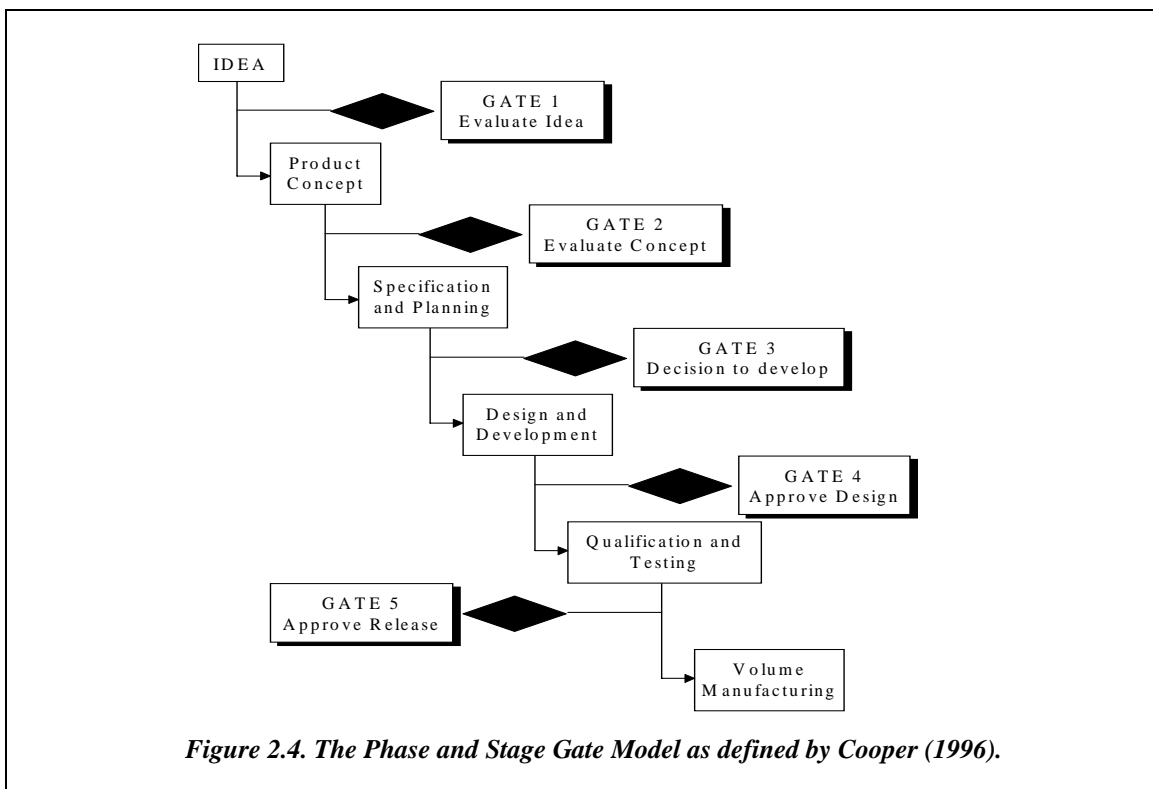
- 1 Cross-functional and extended project team management – team management is particular by strenuous in GNPID and can “lead to numerous project managers in diverse locations all pulling in different directions” (Highsmith 2004).
- 2 Overlapping activities - dependence and confidence in dispersed team members.
- 3 Direct communication through teamwork – distance and time difference make this almost impossible, strong information technology (IT) support is also required.

- 4 Rich partial information transfer, which allows the merging of upstream and downstream activities – difficult to generate at a distance, and will necessitate a strong and expensive technical support.
- 5 Directions and decisions, which take downstream activities into account. Particular suppositions such as manufacturing made at the start of the project have a direct bearing on downstream departments.
- 6 Front loading of information – information pertinent to the initial team may not be as crucial to a downstream department like manufacturing and the reverse is equally true.
- 7 Problem solving, review and response between the product and process phases – an activity that will be completely disregarded in most GNPID projects.
- 8 Integrated supply based management by early involvement – a globally dispersed supplier base has the added complications of communications, currency fluctuations, which are not perceived in local NPID projects
- 9 Development tool integration with customers and suppliers – global NPID can often lack the suppliers or customers’ integration and are therefore reliant on the extended team for this activity.
- 10 Senior management focused project phase reviews – the management team within GNPID may change during the various phases of the project, and maintaining the concentration can be difficult with the continual membership changes.
- 11 Strategic cross-generation product and platform management
- 12 Technical, team-based evaluation, reward and promotion systems – within GNPID team evaluation and reward is impossible to achieve.

The challenge for GNPID is to successfully negotiate these activities with teams that are dispersed by distance and time, as well as language and culture.

2.3.1.2. Phase and Stage Gate Model

The Phase and Stage Gate Model constructed by Cooper in the eighties (illustrated in figure 2.4) and then further developed by Cooper et al (2001) is described as a template for NPID projects. The phases are separated by gateways to complete the phase before starting the next phase. Utilising this model, managers can review the progress of a project at the various stages of development and verify that all the objectives have been achieved prior to progressing to the next stage.



Various authors have described a phase and gateway process under different names, with similar descriptions of NPID as a staged process (Kessler and Brierly 2002) as shown in figure 2.4. The key points noted are:

- it is less expensive to screen products in the early stages
- each stage control improves the product and increases the success rate.

Booz, Allen and Hamilton (2001) deliberate over a Phase and Stage Gate Model process as additional contributors to product success. Fig 2.5 shows the project phases that are similarly described (but with some variation on the name) by Booz, Allen and Hamilton (2001), Buttrick (2001) and Cooper (1999), ranging from a seven-phase and gate introduction down to as low as a five phase and gate introduction, (Toyota use 11 phases and few gate ways whilst Land Rover has 14 phases divided into commonly distinct and deliberate gate ways. The phases that are commonly cited by different authors are 1) idea generation, 2) development 3) commercialisation.

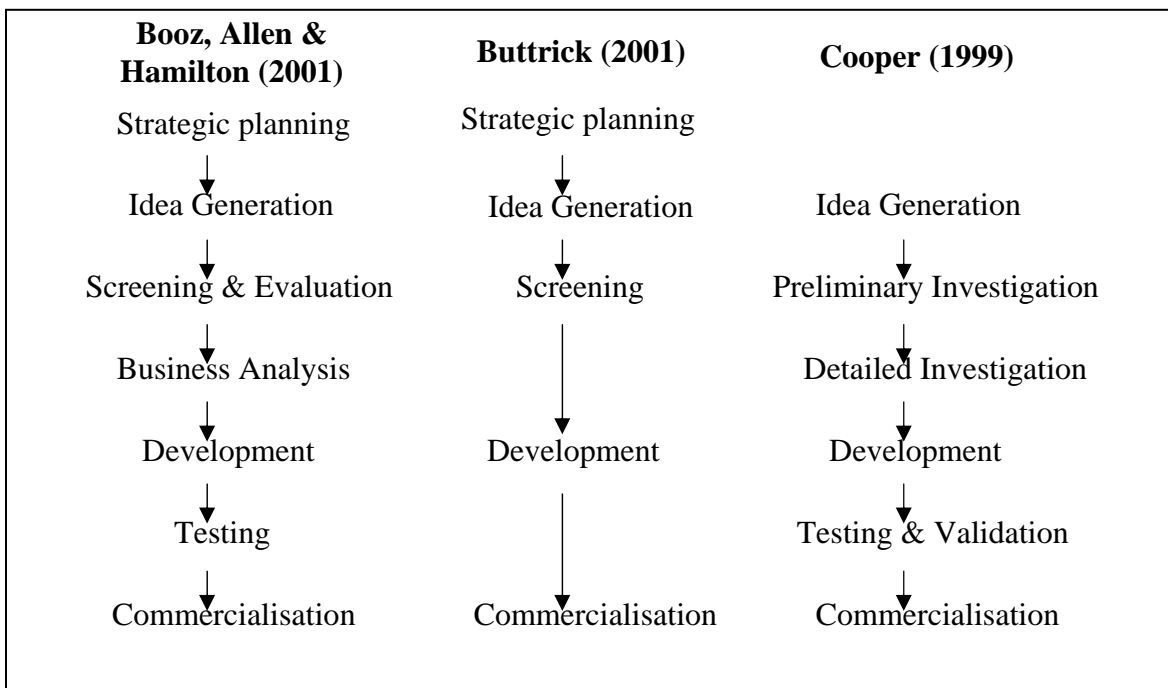
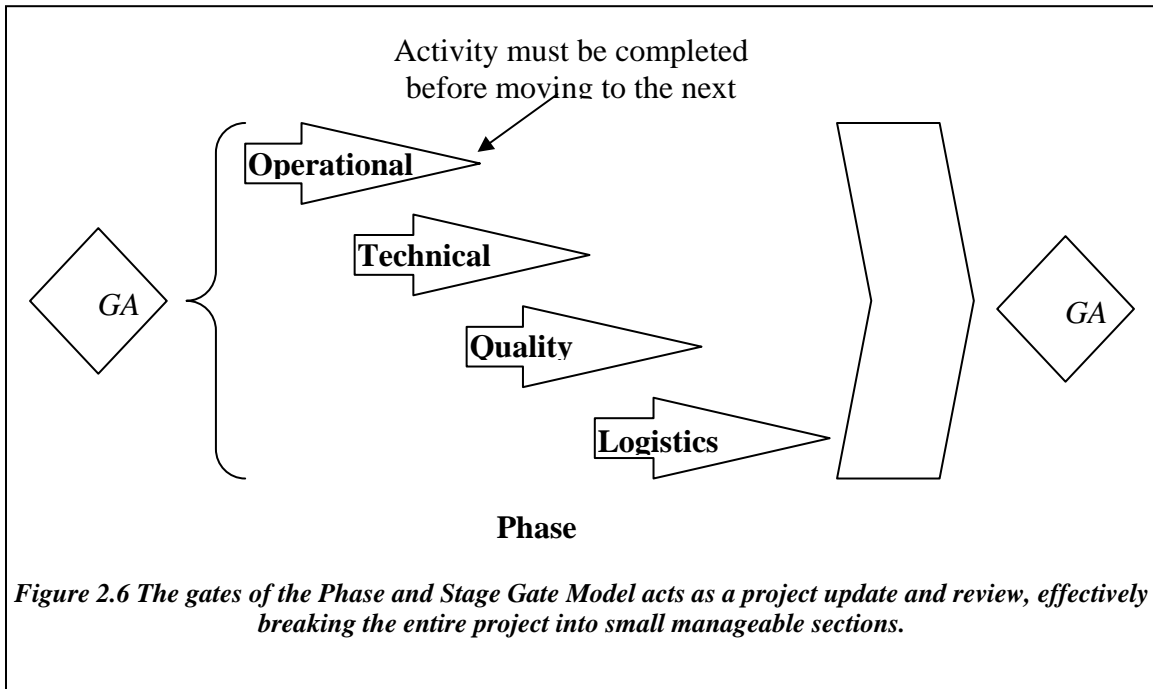


Fig 2.5 Phases of the NPID process described by various authors Booz, Allen and Hamilton (2001), Buttrick (2001), and Cooper (1999).

The gates (figure 2.6) operate as milestones and are there to ensure the activities of that phase are complete before handing on to the next phase. Phase and gate reviews should be staged to coincide with the level of risk encountered within the project, and not the amount of time between the reviews (Cooper 1999).



The Phase and Stage Gate Model process is a conceptual and operational road map for moving a new product from idea to launch. The approach is a widely employed product development process that divides the effort into distinct time-sequenced stages separated by management decision gates. Multifunctional 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 product development.

The primary benefit of the model is “clear delineation points where projects are identified as unattainable and are subsequently stopped or killed off” (Cooper 2001). These “go or kill” gates ensure that at the earliest (and most economic) point in time the project is concluded, thereby saving time and money. Cooper debates the use of the model as a risk management tool, the higher the risk involved the closer the adherence to the model. During the review of this model it was found that despite its advantages the model still requires some enhancement as not all the literature agrees with the phase and stage gate approach.

Muffatto and Roveda (2002) argue that the Phase and Stage Gate model control systems are “overly cumbersome and that most companies tend to use a less formal system, particularly at a local level for global projects”. Dinsmore (2000) suggests that structured gates can be restrictive; they do however allow team members to focus on the task and not on what should be done next. “The traditional stage-gate process becomes cumbersome and inappropriate in today’s’ complex, uncertain, non-linear, and interwoven market environment” (Mahajan and Wind, 2001).

Carter et al (2002) suggest that some companies over complicate the process and that the stages should be kept as short as possible or problems may compound and the opportunity to settle problems quickly by management intervention is lost. Kerzner (2005) identifies that the stage gate process allows order and senior management participation through a series of stop, go and recycle points which “often restrict the project flow rather than act as a filter they become the blockages”.

Other NPID models are discussed briefly in this next section, particularly in relation to the global aspects of NPID.

2.3.1.3. Alternative models employed in NPID

The responsive model for NPID is an extension of technological, organisational and human resources to adapt to the unpredictable changes in the way those products are introduced into a global economy. The main challenge in a global NPID is the integration of the superfluties themselves, rather than the technologies, organisations and people that cause the greatest inconvenience rather than the technology that they employ. Poor communications and bad project management are two commonly stated problems. Most of the stages in the response model occur before manufacturing is involved and it is feasible to scrutinise these steps as strategic information processing or as links between effective strategy and effective responsive manufacturing. For further details refer to Joseph (1999), Dean (1996), and Chen (1998).

One significant model that has appeared in recent NPID literature is front-loading. Problem solving activities and knowledge gathering is "front-loaded" (Smith and Reinertsen 1998) to the earliest stage possible in order to reduce uncertainty and resolve problems before they start. This enables a prompt and efficient project execution with fewer and less severe belated design iterations.

Cooper (1999) divides the front-end model up into four phases from idea generation, initial screening, and preliminary evaluation to concept evaluation and stresses the importance of both market-related and technical activities. Khurana and Rosenthal (1997) define the front end "to include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and executive reviews"

2.3.2. New Product Introduction and Development Strategy

A definition of NPID strategy is the direction that a company takes within the phases of the NPID model and is based on different product structures that have an impact on product development and introduction (Calatone et al 2004, Susman 2002). Sometimes what many researchers regard as a model, others refer to as a strategy or element. For instance Dooley (2001) discusses front loading as a model, and Rainey (2005) also discusses Integrated Product Development (IPD) as an NPID model. The lack of a definition can be accounted for in two ways, the lack of understanding of the actual content of the model and creating or renaming models to add originality.

Table 2.2 shows the strategy best practice of New Product Introduction and Development (NPID) and the underlying reasons as specified by the different authors. Strategic, tactical, and information-gathering activities influencing the launch success of the major strategies this will be discussed in the next section.

| Author | Best Practice | Reason |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dooley (2001) | Senior management support and involvement Dedicated cross functional teams Customer and supplier integration Metrics management Strong product concepts Concurrent Engineering Strong Project management Knowledge management | Early commitment of resources Project focus Extend the working group knowledge Direction and targets set at the project start Organisation to focus on concept Reduction in project lead time Control of milestones and resources Lessons learned fed back into the system |
| Koen et al (2001) | Frequent Project milestones Multiple design integration Product validation Dedicated cross functional teams Strong product concepts Concurrent Engineering Strong Project management Computer Aided Design Overlapping development | Completion of project deadline Cost reduction Extensive testing and confirmation of parts Improved project focus and commitment Organisation to focus on concept Reduction in design lead time Project cost and resource management Reduction in design cost and leadtime Design lead time |
| Calatone, Vickery and Drago (1999) | Customisation Strong new product introduction strategy Design Innovation Original Product Development | Design and tooling cost reduction Reduction in product development cycle Original product development advantages First to market advantage |
| Urban (1999) | Front end management Strong new product introduction strategy Cross functional teams | Improved project focus and understanding Defined phases and gateway Continuous transfer of knowledge |
| Susman (2002) | Customer involvement Front end management Development of human resources | Improved understanding of requirements Improved project design and development Continuous improvement of projects |
| Ettlie (1997) | Integrated product and process design Market study Concurrent Engineering | Improved development cost Understanding of customer requirements Reduced development and project time |
| Thomke et al (2002) | Knowledge transfer Product Strategy Information management | Knowledge retention between projects Defined objectives and direction Improved communications |
| Ulrich et al (2004) | Cross functional teams Concurrent Engineering | Overlapping problem solving DFMA, cost and time reduction |
| Parsaei (2001) | Market proficiency Process skills Knowledge Management | Product strategy based on requirement Cost reduction through experience Past problem retention into new products |
| Cooper (2001) | Formal NPID strategy Customer focus Market orientation Front end loading | Defined stages and gateways for progress Development of the voice of the customer Specific products at known markets Adequate resources and better scheduling |

Table 2.2 Critical elements for the success of projects as described in literature, together with a brief explanation of the benefits or outcome.

The lack of definition will be discussed in the benchmarking section (chapter 3) and the relevance, particularly of some of the new models and strategies has been investigated within industry. A further table showing the literature based on actual case studies can be seen in table 2.3. The main proposals indicate a strong inclination in modern companies towards concurrent engineering, with improved management of the front-end activities. One area of weakness highlighted by Griffin (1997) is the lack of research into how the culture of the organisation influences the NPID strategy or the success rates of NPID projects.

| Author | Main recommendations for success in NPID | Firm or industry researched |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Cooper et al (1996) | Strong cross functional team organisation Professional project manager Top management support and reviews Defined phases and constant reviews and updates | 103 firms involved in the chemical industry |
| Calatone et al (1996) | Strong development activities Constant market analysis and reviews | Over 500 firms involved from various industries |
| Giffin (1999) | Formal and phased NPID process Constant use of multi functional teams Defined and document NPID strategy Constant measurement of NPID performance | Over 200 firms involved from various industries |
| Song & Parry (1997) | Strong IT support Top management activate involvement and support Strong process activities in early stages and development Cross functional integration Strong internal and external communications Continuous commercial assessment | Over 700 firms involved from Japanese industries |
| Hauptman et al (1996) | Proficiency of market launch Strong and continuous market research Intensity of customer involvement | Over 50 global firms involved from automotive, chemical, electronic, ship building and telecommunications |
| Kessler (2002) | Market alignment and constant updates Customer involvement in the early and later stages Dedicated project organisation with generic characteristics Involvement of dedicated cross functional teams Strong and continuous project management Senior management involvement in reviews and updates | Over 75 firms involved from various industries |

Table 2.3 The main recommendation from literature pertaining to actual case studies.

Currently due to market demands, companies are being pressured into making decisions regarding product variety, standardisation and customisation (Tennant and Roberts 2003). Companies now need to assess their product strategy in order to evaluate the importance of the definition of product architecture, platforms, modularisation and standardisation (Muffatto and Roveda 2002). Recently suggested strategies on GNPID researched over the past decade are:

- 1 Portfolio Management strategy (Cooper et al 2001)
- 2 Product lifecycle management strategy (Stark 2004)
- 3 Metric based NPID (Jordan et al 2001)
- 4 Integrated Product development (Rainey 2005)
- 5 Pipeline development strategy (Kahn 2004)
- 6 Agile Product Development strategy (Anderson 1997)
- 7 Extended enterprise (Boeder and Burton2003)

The relationship between NPID strategies and continuous improvement tools is shown in table 2.4 and will be defined in the following section particularly in reference to a global NPID process.

| | NPID tools | | | | | | | | | | | | | |
|------------------------------|------------|-----|------|-----|-----------|-----|----------|-------|-------|------------|--------------|-----|-----|-------------|
| | QFD | VOC | FMEA | FEM | Cost only | DFA | CF teams | Proto | CAD/M | Reengineer | Supply chain | JIT | TQM | Project mgt |
| Portfolio management | ○ | ○ | | | ● | | ● | | | ● | ● | | ● | ● |
| Product lifecycle management | ● | ● | ● | ● | ● | ● | ● | ○ | | ○ | ● | | ● | ● |
| Metric based NPID | ○ | ○ | | | ● | | ● | | | ● | ○ | | ● | ● |
| IPD | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● |
| Pipeline management | ○ | ○ | | | ● | | ● | | | ● | ● | | ● | ● |
| Agile product development | ○ | ○ | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● |
| Extended enterprise | ● | ● | | ○ | ● | ○ | ● | ● | ● | ● | ● | | ● | ● |

Key ● Essential element ○ None critical element

Table 2.4 Matrix showing the relationship of NPID strategies with continuous improvement tools.

The continuous improvement tools are Quality Function Deployment (QFD), Voice of the Customer (VOC) Failure Mode Effect Analysis (FMEA), Cost Analysis, Design for assembly, Cross Functional (CF) teams, Prototyping, Computer Aided Design or Manufacturing (CAD/M), Reengineering, supply chain excellence, Just in Time (JIT), Total Quality Management (TQM) and project management. The table indicates the strong use of CF team and project management and Reengineering if the NPID project is a model upgrade.

2.3.2.1. Portfolio Management Strategy

Portfolio management strategy is a “dynamic decision process, whereby a business list of active projects is constantly updated and revised through a series of meetings and pre set goals and objectives. In this way a project can be constantly reviewed and revised as the business case warrants” (Cooper et al 2001). The global aspect of portfolio management will require frequent communications and decision-making criteria that have been agreed in advance of the project starting, giving ownership to dispersed teams. Cooper et al (2001) and Wheelwright and Sasser (1999) have researched on Portfolio Management Strategy.

2.3.2.2. Product Lifecycle Management

Product lifecycle management strategy aims to streamline product development and boost innovation (Dahan and Schmidt 2002). It is not so much a system as a strategy for integrating and sharing information about products between applications and among different departments, such as engineering, purchasing, manufacturing, marketing and after market support. Schilling and Hill (1998) state that it is achieved by having a knowledge management system that is strongly supported by IT support for instant retrieval. This kind of system is ideal for global teams that are dispersed in time and distance; knowledge control is essential for successful GNPID projects. Stark (2004) Dahan and Schmidt (2000), and Baldwin and Clark (2000) researched on Product Lifecycle Management.

2.3.2.3. Metric Based New Product Introduction and Development

Metric based NPID involves the development of organisational template, using metrics design to achieve the company's goals. Baker et al (1999) state that there is a growing trend toward metrics-based management of NPID. As the process becomes more dispersed throughout the world and products become more complex, there is an increased need to balance management of key areas with the empowerment of self-managed, cross-functional teams. Baker et al (1999) have researched on Metric Based NPID.

2.3.2.4. Integrated Product Development

Rainey (2005) describes integrated product development (IPD) as “a strategy that integrates all activities from product concept through to production. IPD is a multidisciplinary management strategy that uses product teams and design tools such as modelling and simulation teams to develop products and processes to meet cost and performance objectives concurrently.

IPD involves understanding the customers needs and managing those requirements together with,

- suppliers as partners,
- integrating product development and research and development with the business strategy and business plans,
- integrating the design of manufacturing and product support processes and managing cost from the start by effective planning,
- low-risk development and managing project scope.

In global NPID the performance objectives such as product flexibility, product development time, design innovation, and product technology reveal the significance of integrating product development and Quality management systems. Rainey (2005), Khurana et al (1997), and Calatone et al (1999) have previously researched on Integrated Product Development.

2.3.2.5. Pipeline Development Strategy

Pipeline development is the management of the finite development capacity of an NPID organisation. Most companies have a limited amount of resources that they try to apply to too many projects. This results in over-allocation or exceeding the capacity of those scarce resources, and the system becomes constrained by a limited capacity of scarce resources (Kahn 2004).

2.3.2.6. Agile Product Development Strategy

Agile product development strategy encompasses different methods that began to emerge from the mid 90's. Emphasis of this methodology is on creativity, change, speed and quality. Using the agile NPID strategy, development is not overburdened with different processes, the emphasis is on early involvement design activity, rather than on a later manufacturing activity. MacCormack's study (2001) tried to identify the key success practices for agile NPID process as "an early release of the evolving product design to customers, rapid feedback on design changes, a team with broad-based experience of shipping multiple projects and major investments in the design of the product architecture".

Embracing an agile product development implies applying approaches and processes that maximise an organisation's effectiveness in bringing a product to market quickly and effectively with minimal costs or waste. Anderson (1997) states that "agile product development approaches promote high levels of visibility, predictability, and quality". Visibility is achieved through frequent, regular team status checks and product confirmation as well as predictability through continuous monitoring and updating of the project schedule and goals. Quality is maximised by embracing test-first approaches eliminating the "over-the-fence" problems of some development methodologies.

“Agile product development aims to remove artificial barriers separating people working together” (Anderson 1997). Dispersed teams have different processes and methodologies and need to formalise their communications such as gate way reviews, documentation, and knowledge management. Often team members are far removed from the actual end users of the products and must often interpret documentation rather than ascertaining direct communications. Strong evidence exists in literature stating that agile product developers do gain significant competitive advantage in many market sectors. Anderson (1997), Dyer (2000) and Davies and Spekman (2003) have researched on Agile Product Development Strategy.

2.3.2.7. Extended Enterprise

Boeder and Burton (2003) suggest that the extended enterprise represents the concept that a company is made up not just of its employees, but also the board members, executive directors, business partners, suppliers, and customers. The extended enterprise can only be successful if all of the component groups and individuals have the information they need in order to do business effectively. “An efficient supply chain network encompasses a firms’ internal functions, which include all transformation processes, upstream suppliers, and downstream distributors who aim to reach end customers, distributors and retailers” (Tidd et al 2001). Boeder and Burton (2003) and Song et al (1997) have previously researched extensively on the Extended Enterprise.

2.3.3. The tools and activities of New Product Introduction and Development

Numerous studies have investigated the dynamics affecting the success of NPID. Buttrick (2001) states that the activities for NPID are not ‘standardised’ as for Advanced Product Quality Planning (APQP), which is the NPID system applied by automotive companies. Often the activities are based around,

- 1 Cross-functional teams
- 2 Customer focus, Quality Function Deployment (QFD) or voice of the customer (VOC))
- 3 Failure Mode Effect Analysis (FMEA) for both process and design
- 4 Supply chain development and management
- 5 Process development specific to product complexities
- 6 Product-specific quality plan development
- 7 Prototype fabrication and assembly

| Critical Elements | Tools and | Authors |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Design Techniques | Quick product specification Quality Function deployment (QFD) Conjoint analysis Design for excellence (DFX) Design for manufacturing Assembly (DFMA) Robust design Design optimisation Modular design Incremental innovation Rapid design transfer Rapid proto typing and tooling Failure mode effect analysis | Ulrich and Eppinger (2004) Akao (2004) Pullman et al (2002) Adler et al (2004) Nobeoka and Cusumano (1999) Holmes (2004) Griffin (1997) Egan (2004) Khurana, A. and Rosentahl (1998) Baldwin et al (2000) Wright (2001) Nevins and Whitney (1999) |
| Organisation models | Concurrent Engineering (CE) Stage gate process | Smith and Reinerstsen (1998) Cooper (1999) |
| Manufacturing Techniques | Just in Time Manufacturing Resource Planning (MRP) Optimal product technology Statistical Process Control (SPC) | Kennedy (2003) Sheikh (2003) Wind (2000) Tennant (2002) |
| Supplier & Cust integration | Customer as a team member Supplier as a team member | Handfield (2000) Di Benedetto (2003) |
| Information Knowledge | Computer Aided Engineering (CAE) Computer Aided Design (CAD) Computer Aided Manufacturing (CAM) Computer Integrated Manufacturing (CIM) Knowledge Management (KM) Electronic data interchange (EDI) Groupware Product Data management (PDM) | Raphael (2003) Hastings (1997) Carter and Baker (2002) Groover (2000) Davenport et al (1998) Hunt (1998) Calatone (2004) Susman (2002) |
| Project Management | Pipeline management Front end loading Metric management Platform strategy Agile development Portfolio management | Urban and Hauser (1999) Tomke and Fujimoto (2000) Baker et al (2004) Kleese et al (2005) Cooper et al (2001) Cooper (1999) |

Table 2.5 NPID tools and techniques.

Table 2.5 presents the main tools and techniques in NPID as researched by the author. The main conclusion drawn from the table is that Engineers from design and production should work together in project teams towards specified gates or decision points through the product life cycle. Computer aided engineering (CAE) tools should be used from project start. Typical analytical tools such as QFD (Quality Function Deployment), TQM (Total Quality Management), FEM (Finite Elements Method), FMEA/FTA (Failure Mode Effect Analysis/Failure Tree Analyses), DFMA (Design for Manufacture and Assembly), JIT (Just in Time), and various other optimisation tools.

Griffin's (1997) empirical research on multiple industries states that using a formal development process to reduce NPID cycle-time is situational dependent. First, Griffin (1997) has noted that using a formal development process like front end loading before the physical design does not reduce NPID cycle-time, processes reduce NPID cycle-time only once the project has entered the physical design phase. However, Nobeoka and Cusumano (1999) suggest in their article "formal processes could be efficiently applied to the front-end phase of NPID projects".

The activities involved in the NPID processes have become increasingly complex and difficult to apply especially within a global environment. Given this complexity of the concept and diversity of its usage in the literature, it is imperative to provide an overall view for these tools and techniques. There exists a whole realm of activities to complete during NPID planning processes, however, the decisions by individual researchers are subjective and differ markedly along several dimensions. The main tools and techniques for NPID cited in literature are reviewed in the next section.

2.3.3.1. Design integration

Design integration is a “management process that integrates all activities from product concept through to production using multidisciplinary teams, to simultaneously optimise the product and its manufacturing processes to meet cost and performance objectives” (King and Majchrzak 1996). Design integration uses design tools such as modelling and simulation, teams and processes to develop products and their related processes concurrently (Griffin 1997). Design integration evolved in industry as an extension of work, such as Concurrent Engineering to improve customer satisfaction and competitiveness in a global economy.

Verganti (1999) presents a comprehensive framework in which he illustrates the importance of anticipating the capabilities of design integration during early development of the product. Early anticipation, which he also refers to as feed forward planning means that information is anticipated as early as possible in the product development process so that solutions generated in the early phases already account for downstream constraints and opportunities. The challenge for global NPID with design integration is to achieve the prescribed activity whilst operating under the problems faced by extended teams, such as:

- Communication, time and cultural differences.
- Problems caused when the design team is separated from the customer and an intermediate department controls communications, acting as a filter.
- Lack of understanding of the basic requirement or restriction in the manufacturing process
- Poor contact with the suppliers causing manufacturing or logistical concerns
- Management within the separated team working towards different targets, goals or schedules.

2.3.3.2. Project management, cross- functional teams and the activities of NPID

Project management

Brown and Eisenhardt (1995) describe project management as planning, organising, directing and controlling the company resources for a relatively short-term objective that has been established to complete a specific goal or objective. Kerzner (2005) describes a common problem with NPID projects suffering serious set backs due to political, social, environmental and community challenges and through statutory processes. However despite their vital influence on the eventual state of a project these factors are often managed informally. Large sections of recent project management texts are concerned with the project variables and trade off analysis (Kerzner 2005, Gupta and Wilemon 2002, Lock 2000).

Thomke and Fujimoto (2000) suggest an alternative methodology to project management, which has been presented in the form of “lean project management”. This methodology is derived from the combination of lean production with management of projects. The approach contributes to project management performance by focusing on the effectiveness and efficiency of delivering value, such as satisfying the client needs. This methodology utilises elements of both lean production and the management of projects.

McGrath et al (2004) states that lean project management enhances the conventional production methodology by emphasising the efficient provision of value, which is achieved by introducing flow management and the management of value on an equal par to input, conversion, and output management. King and Majchrzak (1996) point out that the management of projects enhances conventional project management methodology by emphasising the effective provision of value. Wider factors for management such as environmental issues complementing time, cost and quality elements are considered. If a company is capable of achieving a fast cycle production, it should be able to transfer those skills to produce a fast cycle development.

Cross functional teams structure and utilisation in NPID

The use of multi-disciplined teams as a tool for improving, not only product development timescales but also product quality, pervades much of the NPID literature (Griffin and Hauser 2002, Zirger and Hartley 1996, Lock 2000). The activity, states that the people involved with the project, with different skill-sets and representing different resource groupings in the organisation tackle problems jointly. Lynn et al (1999) explain that the requirements are thus identified to all participants simultaneously, any necessary clarification takes place immediately and the scene is set for as many activities as possible to take place concurrently.

Lock (2000) found that “cross-functional teams were more important in terms of reducing development cycle time when product designs were original and novel, and that a structured, formal development process helps reduce development cycle time more when developing complex products”. There is also a great deal of academic literature that provides evidence of collaboration leading to success (Griffin and Hauser 2002, Griffin 1997). However there are still several problems to overcome before reaching a well operating cross-functional collaboration particularly in GNPID teams. “Some of the most common barriers in GNPID are personality, culture, language, organisational responsibilities and physical barriers” (Lock 2000).

Activities and methods utilised during NPID process

The activities of NPID are designed to:

- bring together opinions, experiences and perspectives from around the business and support teamwork
- encourage a customer focus and involvement
- promote creativity and divergence when developing alternatives
- encourage decision making based on information

Common NPID activities and challenges faced when they are operated within GNPID projects,

1) Market analysis and study, creating a competitive advantage.

Within global teams the market can be in multiple sites, with numerous and dispersed competitors. This “diversity can cause over complication of design, under estimation of production and process costs at a local level or miss understanding the local market requirements” (Griffin 1997).

2) Customer understanding and involvement.

The main activities are focus groups and creating user profiles. These can be difficult and costly to organise in GNPID dispersed across the globe.

3) Product definition.

The key activities are Quality Function Deployment (QFD), and Computer Aided Design (CAD). The key challenge for GNPID projects is to ensure that these activities are completed and then cascaded to all the relevant departments. It is also crucial that these activities are constantly repeated at all stages of the project.

4) Concept design and prototyping for product validation.

Smith and Reinertson (1998) write that due to the spiralling costs involved many companies simply miss this activity out all together and the discipline is overlooked. Problems occur in GNPID if the design concept and prototyping has not been completed and can lead to increased costs, processing problems and Quality concerns all due to a lack of analysis of the design concept.

5) Design verification using VA/VE and Process FMEA.

“Without prototyping it is possible for companies to launch a product without proper evaluation of cost (Griffin 1997). VA/VE activity can reduce product and processing costs. The challenge for GNPID is to ensure this is completed at local level, so that suppliers and customers can be involved as well as the manufacturing plant.

6) Process and project management.

The usual tools for project management are stretched during GNPID as discussed earlier in this section.

Brown and Eisenhardt (1995) in their research found that there is strong evidence that senior management support and control, concurrency of activities, internal and external team communication, and cross-functional team composition have a positive effect on NPID process performance. However in GNPID the management team can be as dispersed as the working groups and management support can be sporadic and inconsistent. A method or procedure for managing the standardisation and control of GNPID projects will be discussed in section six.

2.3.3.3. Documentation

Song and Parry (1997) state that in a manufacturing environment, reducing the time needed for NPID is paramount to success for project management. It is crucial to balance the reduced time with maintaining the highest levels of product quality and process control and therefore document control is vitally important in NPID. According to Addler (2004) ensuring high standards of documentation and rapidly deploying critical manufacturing information to all parties in the process are important elements of reducing development cost and time.

The challenge for GNPID is to collate the relevant documentation into one master file, after it has been completed in the various locations. This means that there must be a core language for the project and that all documentation has to be created (or reproduced) in that language, an expensive and time consuming process.

2.3.3.4. Information and knowledge management

Dahan and Hauser (2000) have reviewed knowledge management as a critical activity during the NPID process. This should be consistent and reliable by making it available across the organisation. Knowledge should also be “retained to eliminate time spent retraining staff when employees leave the organisation” (Clark and Fujimoto 1999). Ulrich and Eppinger (2004) state that “process flow analysis should be used to identify key information assets, which should be vertically and horizontally transferred to provide a speedy and effective series of problem solving cycles”. Davenport et al (1998) discuss that GNPID projects have additional problems, as knowledge needs to be shared across vast distances otherwise the benefits will be lost.

2.3.3.5. Information Technology support for New Product Introduction and Development

Kerzner (2005) states that information technology in NPID is viewed as an enabler of teams working together in the product development process. Technology is no longer pursued as an end in itself, but for its contribution to cost control, product quality and most importantly, time to profit. While a case can be made that traditional technology components themselves, for example Computer aided design (CAD) and Computer Aided Production Progress (CAPP) systems, make some contribution to these business goals, the big payoff in team performance comes from integrating the technology in a networked computing environment backed up with shared product and process data. Song and Parry (1997), and Eppinger (2001) have researched on Information Technology support in NPID.

2.4. Conclusion and evolving issues

During this study the contemporary literature researched in this field fell into two categories;

- Engineering orientated books, containing extensive research into design and customer orientation, but without the discussion on organisational or managerial issues in NPID
- Literature that focuses on management practices but does not discuss many engineering issues, such as the role of manufacturing in design. Additionally much of the texts failed to provide hands on case based approach and are therefore theoretical.

The literature which closely harmonised the practical approach (seen in Table 2.6) combined with covering all aspects of the subject during actual case studies were Jiao et al (2004), Calatone et al (2004), Nilsson et al (2005) Smith et al (1998) and Clarke et al (2000) Highsmith (2004).

The existing literature describes and documents recent fundamental changes in the NPID process organisation, from a sequential functional approach to a concurrent team approach. Several tactical activities were related to successful NPD projects: high quality of selling effort, advertising, and technical support; good launch management and good management of support programs; and excellent launch timing relative to customers and competitors. Furthermore, information-gathering activities of all kinds (market testing, customer feedback, advertising testing, etc.) were very important to successful launches.

| Model | | Eng design | Case study | Management | Activities | Organisational | IT support | H/R | Knowledge management | EE | Information management |
|----------------------------|----|------------------------|------------|------------|------------|----------------|------------|-----|----------------------|----|------------------------|
| Concurrent Engineering | 1 | Calatone et al (2004) | ● | ○ | ● | ● | ○ | ● | ● | ○ | ● |
| | 2 | Ernst (2002) | ● | | | ● | ○ | | | | |
| | 3 | Ettlie (1999) | ● | ● | ● | ● | | ● | ● | ● | ● |
| | 4 | Ulrich et al (2004) | ● | ● | | ● | ○ | ● | | ○ | |
| | 5 | Lindbeck (1998) | ● | ○ | | ● | | | | | |
| | 6 | Brookes (1998) | | ● | ● | ● | ○ | ● | ● | ● | ● |
| | 7 | Susman (2002) | ● | ● | ● | ● | ● | ● | ● | ○ | ● |
| | 8 | Parsaei (2001) | ● | ● | ● | ● | ● | | ● | ● | ○ |
| | 9 | Terwiesch et al (1999) | ● | ● | ● | ● | ○ | ● | ● | ● | ● |
| | 10 | Nevins et al (1999) | ● | ● | ● | ● | ○ | ● | ○ | ● | ● |
| | 11 | Smith et al (1998) | ● | ● | ● | ● | ● | ● | ● | ○ | ● |
| | 12 | Jiao et al (2004) | ● | ● | ● | ● | ● | ● | ○ | ● | ● |
| | 13 | Highsmith (2004) | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ |
| | 14 | Koen et al (2003) | ● | ● | ● | ● | ● | ○ | ○ | ○ | ○ |
| Stage and Phase Gate Model | 15 | Nilsson et al (2005) | ● | ● | ● | ● | ● | ● | ○ | ● | ○ |
| | 16 | Kennedy (2003) | ● | ○ | ● | ● | ○ | ● | | ● | |
| | 17 | Dinsmore (2000) | ● | ○ | ● | ● | ● | | | | |
| Response model | 18 | Kerzner (2005) | ● | ● | ● | ○ | ● | ○ | ○ | ○ | ○ |
| | 19 | Chen et al (2000) | ● | ○ | ● | ● | ● | ○ | | ○ | ● |
| Platform model | 20 | Wind et al (2000) | ● | ● | ○ | ● | ● | | ○ | ○ | ○ |
| | 21 | Simpson et al (2004) | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Front end loading | 22 | Siddique et al (1998) | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | 23 | Thomke et al (2000) | ● | ● | ● | ● | ○ | ● | ○ | ○ | ○ |
| | 24 | Clark et al (2000) | ● | ● | ● | ● | ● | ● | ○ | ● | ○ |

Key ● Covered extensively ○ Not discussed in detail

Table 2.6. Evaluation of papers illustrating the main contrast between Concurrent Engineering and the Phase and Stage Gate Model.

The review of the extant literature on NPID identified the most critical strategic, tactical, and information-gathering activities influencing NPID success. The key questions extracted from the literature search that require further research through the benchmarking survey are:

- what are the drivers of an on-time and profitable NPID project?
- is the use of a cross-functional teams with managerial support essential?
- what front end loading or predevelopment should be done (e.g. building in the VOC)?
- what is the link between timeliness and profitability?

This chapter has examined the literature and has raised some issues for further discussion as raised by numerous researchers (Cooper, Edgett and Rleinschmidt 1999, Cooper 1996 Tennant and Roberts 2003, King and Majchrzak 1996, Nevins and Whitney 1999 Kerzner 1999, Kessler and Brierly 2002, Menon, Chowhurdy and Lukas, 2002 Nobeoka and Cusumano 1999). Section 3.2 will discuss translating the following bullet points of best practice extracted from the literature:

- 1) The control of the NPID model and the use of dispersed multifunctional teams.
- 2) Parallel product and process development in globally dispersed teams
- 3) The suppliers as partners in an extended supply chain
- 4) Global project coordination and development lead-time, real time control of teams and maintaining team dynamics
- 5) Integration of the abilities of both upstream (design) and downstream (manufacturing) processes.
- 6) Knowledge integration or sharing particularly within dispersed teams.
- 7) Effective and efficient communication projects to be performed in company networks
- 8) A GNPID process that is divided between several companies.
- 9) Communication across company borders poses additional difficulties, due to factors like lack of trust, language and culture, differing ways of working, and legal issues as well as something as basic as different time zones.
- 10) Project management and the control and management of dispersed teams, communication and time barriers
- 11) The increasing requirement for lean thinking during GNPID projects.
- 12) Conflicting Quality accreditation and the lack a global standard for determining supplier Quality expectations.
- 13) Overlapping activities - requires dependence and confidence in your fellow team members, which is difficult to create in globally dispersed teams.
- 14) Information pertinent to the initial team may not be as crucial to a downstream department like manufacturing and the reverse is equally true.
- 15) Problem solving, review and response between the extended team.

- 16) Development tool integration with customers.
- 17) Senior management focused project phase reviews
- 18) Strategic cross-generation product and platform management
- 19) Technical, team-based evaluation, reward and promotion systems – within GNPID team evaluation and reward is impossible to achieve.
- 20) Creating a competitive advantage with numerous and dispersed competitors.
- 21) Ensuring GNPID activities are completed and then cascaded to all the relevant departments.
- 22) A cross-functional team is involved with the design and development of new products.
- 23) All projects are run according to a set procedure, documented and stored for retrieval and learning purposes in the future.
- 24) Cross-functional teams that include operators, engineers and management review all new projects and products that are planned for automation prior to purchase and installation.
- 25) Project team that are responsible for setting goals and objectives that are empowered to manage the project, taking ownership, responsible and assessing risk.
- 26) CAD/ CAM used extensively for new product introduction.
- 27) Development of Quality function deployment (QFD) and failure effect mode analysis documents that are used proactively and updated regularly throughout the products life cycle.
- 28) Manufacturing capabilities, including systems and process that are current, agile and lean.

The NPID process is being transformed into a highly efficient, highly automated, and highly integrated enterprise-wide process. As has been the case in the past this transformation is so significant that it has the potential to change the competitive balance within an industry. Very few companies that did not make the transition to the previous generation of product development are still in business today, and those that led the transition gained notable competitive advantages. Similarly, companies that make this

transformation to the new practices and supporting systems before their rivals will create significant competitive advantages for themselves. And all companies will eventually need to make the same transformation if they are to remain competitively viable.

The contribution that will form the basis of this work will be to introduce a framework for a model that is designed around overcoming the challenges faced by globally dispersed GNPID teams. The model will be developed from the concurrent engineering model, but will incorporate elements from the phase and stage gate model. The strategies involved are examined against the best practice in industry, as will the activities and tools used within GNPID.

3.0. Benchmark for best practice in NPID

3.1. Introduction

The frame of reference for this section of the report is developed in accordance with the New Product Introduction and Development (NPID) model, strategy and activities discussed in chapter 2. According to that perspective, emphasis is placed on understanding the NPID model and market priorities of the business unit, the translation of the model into strategic objectives and practices and areas of NPID management and activities.

The utilisation and the organisation of the resources of a company to support the NPID model are important areas of analysis. On the basis of a survey of automotive suppliers and Original Equipment Manufacturers (OEM) the NPID model of the companies will be analysed. The next section of the report will discuss the method of choosing the benchmarking partners and the questionnaire that was developed and employed during site visits investigating how the different resources of the company are:

1. Organised, for example the models employed for NPID, and how the company strategies are aligned to the model.
2. Utilising NPID activities like QFD, benchmarking, DFA/DFM.
3. Using technological facilities such as CAD and CAD/CAM.
4. Monitoring GNPID performance and how the company model is maintained in terms of management and working group members.

3.2. Developing the initial benchmarking partners

In an effort to improve timeliness and effectiveness a number of firms within the automotive industry are experimenting with different best practices in their NPID processes. Previous research has focused on NPID in a single location; little has been reported (Kahn 2005) on how actual companies are addressing the problems with globalisation of NPID (refer to previous section 2.4).

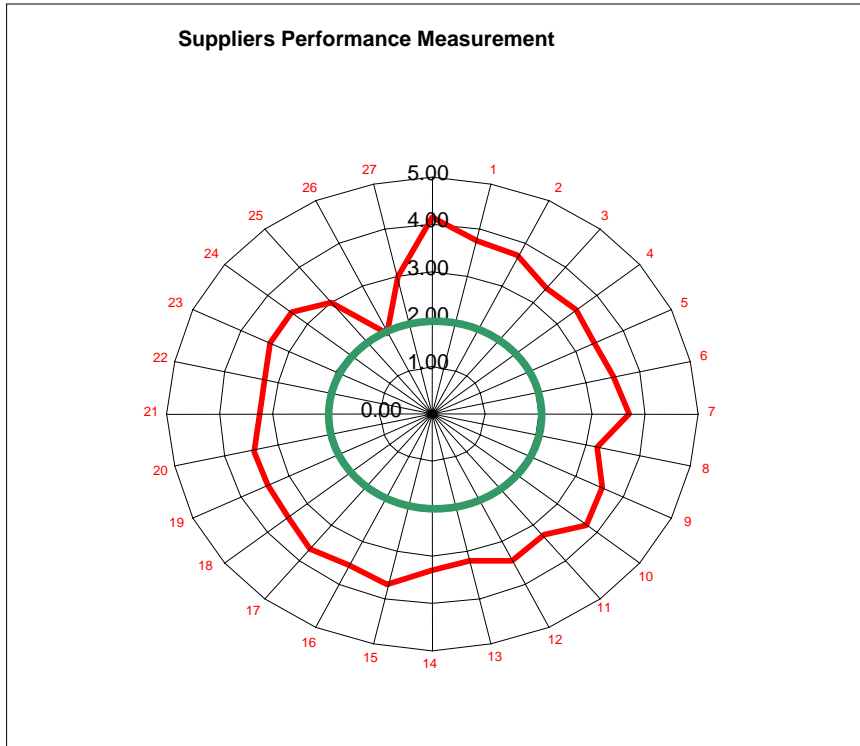
To address this question the author developed two questionnaires from issues raised during the literature search (refer to previous section 2.4). The first questionnaire was designed to indicate generally the current standards within industry, but also to identify the benchmarking partners who the author felt would give a true representation of the best practice for Global New Product Introduction and Development (GNPID). The second questionnaire will be discussed in section 3.2.2.

3.2.1. The initial postal survey to determine what is the current best practice.

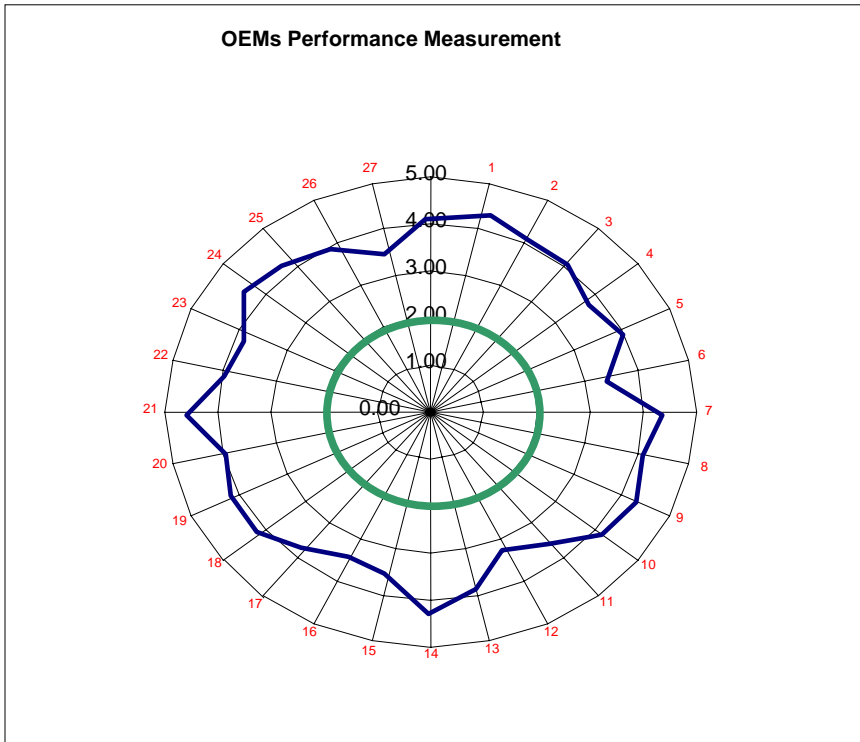
3.2.1.1. The companies involved.

The initial postal survey was sent to the operations or project manager of 43 automotive suppliers, in total 24 people responded with a completed form. The firms involved had manufacturing processes that included injection moulding, pressed metal work, stamping and welding, hydro forming and the production of tailor-welded blanks. The companies were all based in Europe and served the major automotive companies. Many of the plants included manual assembly lines and finishing operations, working to high aesthetic levels and standards. Frequently the up stream sections like design and downstream manufacturing plant were located separately, often in different countries. The companies all compete in the international market and were mainly 1st tier suppliers to the automotive industry, the exception being four OEM's (original equipment manufacturers). Sales abroad for the companies ranged from 40% to 60%, and several companies out source or import at least 60%-75% of the components, essentially only

3.2.1.3.Results from postal questionnaire



Key 1. Very bad 2. Average 3. Good 4. Very good 5. Excellent



Key 1. Very bad 2. Average 3. Good 4. Very good 5. Excellent

| OEM | Supp | Code | Topic |
|------|------|------|-------------------------------------|
| 4.13 | 3.73 | 1 | Business and product strategy |
| 4.25 | 3.75 | 2 | Product planning and management |
| 4.10 | 3.69 | 3 | Technology management |
| 3.74 | 3.38 | 4 | Management leadership |
| 4.01 | 3.50 | 5 | Early involvement |
| 3.41 | 3.38 | 6 | Product development teams |
| 3.56 | 3.50 | 7 | Organisational environment |
| 4.11 | 3.69 | 8 | Process management |
| 4.07 | 3.19 | 9 | Process improvements |
| 4.11 | 3.56 | 10 | Understanding the customer |
| 4.15 | 3.69 | 11 | Requirements for lean manufacturing |
| 4.01 | 3.31 | 12 | Development of Quality systems |
| 3.54 | 3.44 | 13 | Supplier integration |
| 3.10 | 3.19 | 14 | Transition into production |
| 3.92 | 3.31 | 15 | Training |
| 4.14 | 3.69 | 16 | Development tool |
| 3.66 | 3.56 | 17 | Management reviews |
| 3.44 | 3.63 | 18 | Design for manufacture |
| 3.72 | 3.50 | 19 | Product cost management |
| 4.10 | 3.44 | 20 | Flexibility in design |
| 4.11 | 3.44 | 21 | Design for operation |
| 4.35 | 3.25 | 22 | Product data |
| 4.05 | 3.25 | 23 | Design for automation |
| 3.88 | 3.38 | 24 | Computer aided design |
| 4.18 | 3.38 | 25 | Support technology |
| 3.91 | 3.00 | 26 | Empowerment |
| 3.25 | 1.88 | 27 | QFD, FMEA living documents |
| 3.51 | 3.00 | 28 | Manufacturing capabilities |

Figure 3.2 The response to the postal questions shown in two polar graphs and in the table.

3.3. Introduction of the benchmarking partners.

Using both the postal questionnaire replies and the criteria raised in the literature survey (refer to section 2.4) nine corporations competing in the international market were chosen as close benchmarking partners (table 3.1). These companies had all scored highly on the initial questionnaire and had responded favourably to further benchmarking. They all indicated that they had a disciplined and well-documented approach to NPID, with strong team based NPID models. Between 3 to 5 people ranging from engineers and project managers from each company were interviewed, out of a total of 40 individuals consulted. The survey extended over 18 months, from August 2003 until December 2005.

| Company | Level | Interviewees | Total |
|------------|--------|-------------------------------------------------------|-------|
| Mecaplast | Tier 1 | Manufacturing manager, engineers | 5 |
| Benteler | Tier 1 | Project manager, engineers, staff | 5 |
| Lear | Tier 1 | Manufacturing and project managers, Technicians | 5 |
| SAI auto | Tier 1 | Project manager, Quality and supplier engineer, staff | 5 |
| SEWS-S | Tier 2 | Project manager, engineer, plant manager | 5 |
| Lemforder | Tier 1 | Project manager, Technicians | 4 |
| TRW | Tier 2 | Manufacturing manager, logistics manager, engineers | 5 |
| Toyota | OEM | Project engineer, Technicians, Quality engineer | 5 |
| Land Rover | OEM | Quality Engineer, project managers, Technicians | 5 |

Table 3.1 Benchmarking survey showing suppliers and their interviewees.

The original equipment manufacturers (OEM) chosen are two of the biggest automotive suppliers in the world, with distinctive and vastly different approaches to NPID. The companies produce high Quality vehicles; one from a purpose built green field site, the other from a plant that has evolved into a large sprawling complex over a number of years. Both Toyota and Land Rover have defined and documented NPID. Toyotas is based on the Supplier Quality Assurance Manual (SQAM), while Land Rover operate the Advance Product Quality Planning (APQP) system.

3.3.1. Layout of the benchmarking questionnaire.

The second questionnaire (see appendix 2) was based on the same format as the initial postal document (see figure 3.3) but with more detail. The intention was to allow a broader response and understanding of the companies' opinions. The scoring was increased from 1 (totally disagree) to 7 (totally agree) to allow more flexibility. The objective of the forms design was for the questionnaire to be used as an aid for the interviewer during a series of on-site visits to ensure continuity in the questions posed. The questions themselves derived from the challenges outlined during the literature search (refer to section 2.4) and from the issues raised during the postal survey (refer to section 3.1.2.3.) as well as from the authors own experience. The author investigated the individual companies and their approach to GNPID spending an average of 50 minutes in conversation with each person, and completed a new form for each individual. This gave the author a broad perspective of the company from a number of different personnel and varying levels within the same company

| | |
|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27) Capturing project history is a means of keeping track of design decisions and the reason for them | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> |
| | Disagree Neutral Agree |

Figure 3.3 Sample of the benchmarking questionnaire.

The questionnaire comprised of 48 questions, was divided into four main sections:

Section one (Q 1-6) reviewing the NPID models used. How that NPID model is translated into the companies' organisation and methodology and how that methodology is documented and maintained.

Section two (Q7- 16) reviewing the company's strategy within the NPID model and the role of the management in GNPID projects, how GNPID is monitored and progressed, and how the projects are managed.

Section three (Q17- 31) reviewing the employment of the NPID activities including the IT support and the knowledge management, how GNPID is monitored and progressed.

Section four (Q 32 – 48) reviewing the communications, internally and externally, with reference to the customer and supplier interface in GNPID projects, as well as communication and controls.

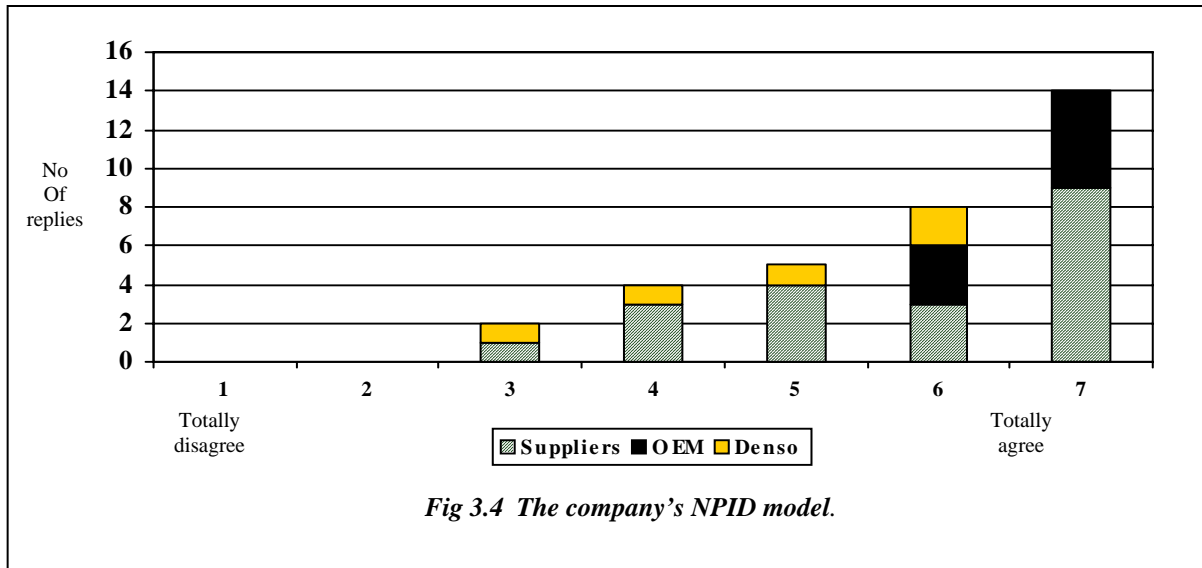
3.4. Field results and study (Q 1-6) reviewing the NPID models

In the first section of the questionnaire, the benchmarking partners were asked to indicate the strategic directions of the company according to products and goals for market share.

3.4.1. There is a clearly defined model that each project follows

The graph illustrated in figure 3.4 will be the method of displaying the majority of the results from the survey. In the case of figure 3.4 it can be clearly stated that for both OEM and suppliers the majority of the responses were very positive. Most of the participating companies stated that their defined and documented NPID model, usually managed by a central department (product engineering, R&D, design section) who co-ordinate and developed the model. The companies had NPID lead-times ranging from one to five years, dependant on the product and project scope.

During the survey the author discovered numerous differences between the models adopted by the different companies. Many had redefined their model based on the customers demand for products being introduced to market at an elevated pace.



Some companies had detailed plans and numerous milestones on different layers and group levels. Others had vague guidelines that could be applied if the project warranted, actual examples taken from the companies' written procedures of the optional (or vague) approach taken by some companies are;

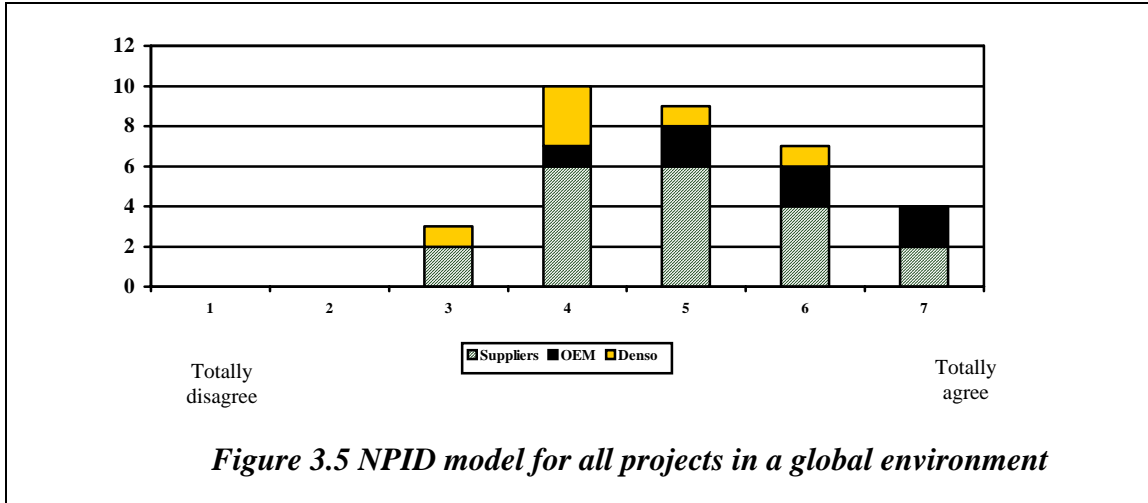
Where possible and if the operation manager decides it is required, the New Product team should be formed. The project manager is responsible for submitting the project sheet (the gate sign off for the phase) if it is deemed necessary by the plant manager. Procedure XXX should be used for all projects over a value of £XXX unless prior agreement has been reached with the project director.

One company stated they had a different approach to account for their own diverse products and regional markets. Others explained that they had a set of global guidelines

that may or may not be used at regional level. The responses demonstrated that many peoples perception of a defined and documented NPID contrast to those found in books, largely due to the time constraints and localised legal differences. Maintaining APQP style documentation supplied by the customer was the most commonly used system. However many expressed the opinion that strict adherence to it would restrict the project and cause delays. This could be because of the formal nature of the system, delays due to management signing of the phases, or interference with the process from customers. Understanding these delays is key to developing a model that will improve on the current system.

3.4.2. There is complete use of the NPID model for all projects particularly in a global context (figure 3.5)

Figure 3.5 illustrates the response to the question relating to a “specific, well-documented and formalised NPID model”, to which each interviewee generally responded with a negative reply. The general comment was that due to global team problems, communication failures and schedule compression the model was rarely adhered to. Personnel interviewed within the companies considered they had great models for NPID, but that they were never properly utilised, as they did not function within distanced projects. The personnel involved in global NPID found their process rigid and therefore constrictive. A Toyota engineer described the company system as “restrictive” with yes /no alternatives and no grey areas, while the project manager found the system agile enough to allow compromise and flexibility. The authors main concern with a defined model as applied by Toyota within GNPID was the lack of agility or response to “critical” situations at a local level.



3.4.3. The Company uses a Concurrent Engineering approach

The usage of CE in current projects led to some interesting responses. Most considered that CE was operating within their companies, with the main goal being the reduction of lead-time and the improvement of inter company communication. However some stated that CE was not a current strategy, although on examination they appeared to practice most of the disciplines, leading the author to question if the personnel involved could define CE.

With regard to concurrent engineering (CE) Toyota and Land Rover operate two very different systems, due to cultural differences and the way the two companies had historically been managed. Land Rover has a defined stage and phase gate process, which they use continuously to assess their suppliers against those of personnel visits from their own engineers. Toyota relies heavily on self-assessment with a monthly submission from the supplier; the phases have less definition and allow for more concurrent activities. This management style has been employed by Toyota since the mid 1970's. Many suppliers are now adopting Toyota philosophies into their own GNPID process, in a similar way that suppliers adopt the Toyota Production system (TPS).

Every one of the companies stated during questioning that project performance is often measured in terms of schedule, cost and other organisation objectives. One supplier interviewed for example stated that the purpose of the development process is to meet cost and performance objectives; their emphasis was on better, faster and cheaper products. Denso defines project performance as the degree to which project schedule, cost, and other objectives are met. There is however no universally accepted measure for project success other than, on time delivery, many companies stated that the cost of achieving this goal is quite often not measured.

The design of effective NPID processes has received considerable attention from scholars and practitioners as seen in chapter 2. Unfortunately however practice does not necessarily follow theory. Many of the engineers questioned experienced considerable difficulty in following the development processes prescribed in the literature, and the authors evidence suggests that in many organisations the desired development process and the sequence of tasks actually used to create products are two very different things. During the interviews of numerous project managers and engineers this situation seemed to be repeated in a number of companies. The organisations seemed to have a system in place, but rarely used it. Academic literature has made numerous contributions to understanding how product development should work; less attention has been paid to the question of why organisations often fail to execute their development processes as desired.

3.5 Field results and study (Q7- 16) reviewing the company's strategy

This next set of questions was aimed at determining the underlying strategies within the NPID project that supported the companies NPID model. The author was particularly interested in the changes or adaptations designed to support Global NPID

3.5.1. The company’s NPID process defines specific activities and follows a standardised process

The question asking if “ the company’s NPID process defines specific activities and follows a standardised process” (fig 3.6) resulted in most stating that they followed a similar pattern, with some terminology differences. The flow diagram illustrates the generic NPID template drawn up from discussions with the benchmarking partners. Each of the companies discussed a minimum of six clear sequential phases with the average time line started 24 months prior to start of production (SOP). Each of the phases was succeeded by a gate review process, some formal others with quite a loose format dependant on the project and time line urgency.

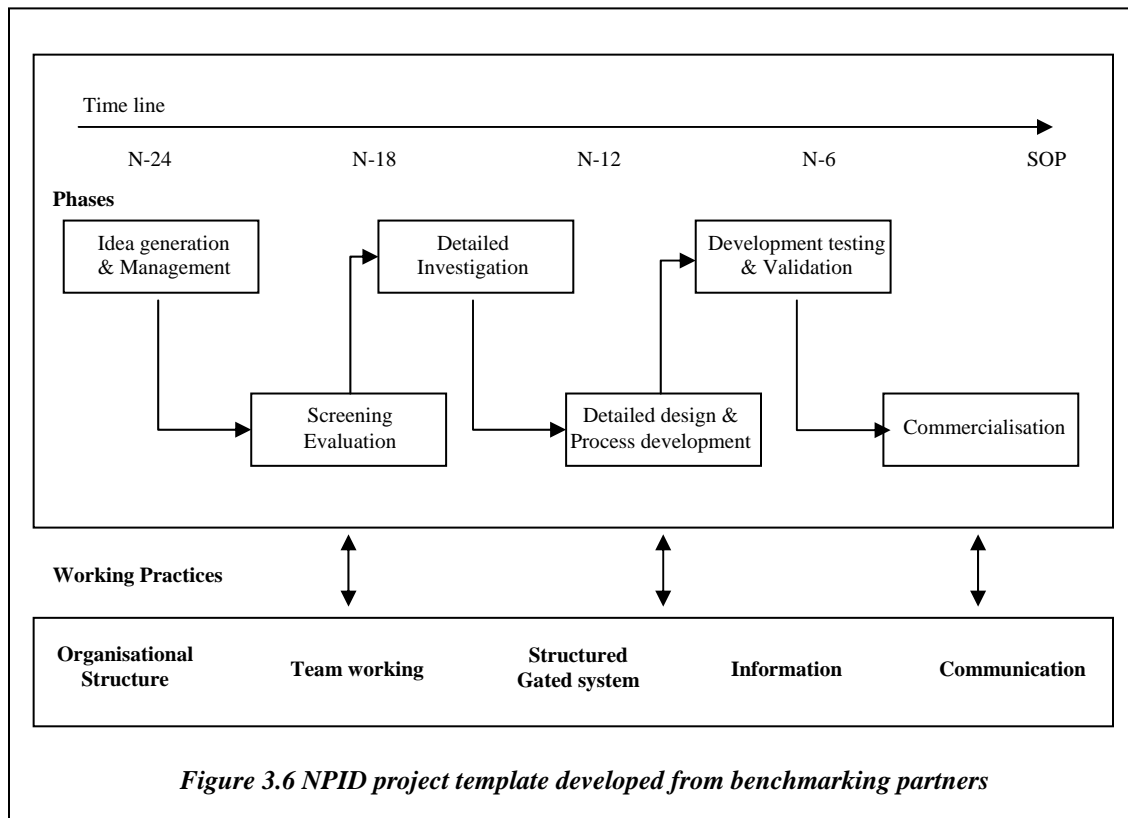


Figure 3.6 NPID project template developed from benchmarking partners

The main working practices at each of these stages were supported in general by standard working practices, a documented method of ensuring the same procedure is followed every time. All the nine manufacturers promoted multi functional teams working as a method of NPID. Many of the suppliers had well defined and clearly structured gating systems (refer to section 2.3.2.1) for regular project review. The final two key points were considered to be information management and clear and concise communications at all levels of the company.

The questions relating to project resources led to the companies agreeing that the level of resources allocated to NPID is extremely important. However an argument was introduced that pressure is not applied until the later stages of the project, and that rapid deployment of resources from the very early stages is crucial. There was a general agreement that improving resources involved in NPID and paying particular attention to the front end of NPID would improved the final project deliverables of cost and time. However despite this agreement on the whole everyone admitted to be giving it little attention. Researchers (see section 2.3.1.5) have discussed front loading strategies as being the answer to many questions, however the author found no evidence of actual use at any of the benchmarking partners plants.

The NPID model (shown in figure 3.7 as supplied by Denso) illustrates the phases and activities to support their concurrent NPID model. This model is used for all of their development projects, from a model change to an entirely new product line. The Denso system has been developed from a need to be responsive, agile and flexible, key attributes to those working in the volatile automotive industry. The Denso system was developed over many years jointly with Toyota, and has resulted in an almost seamless transition between the two companies from concept to product. The model indicates that the engineering section manages the product planning and design phases; activities include QFD and drawing reviews. It also illustrates that for Denso the quality assurance (QA) section manages the specification and manufacturing inspection standards as they develop the voice of the customer (VOC).

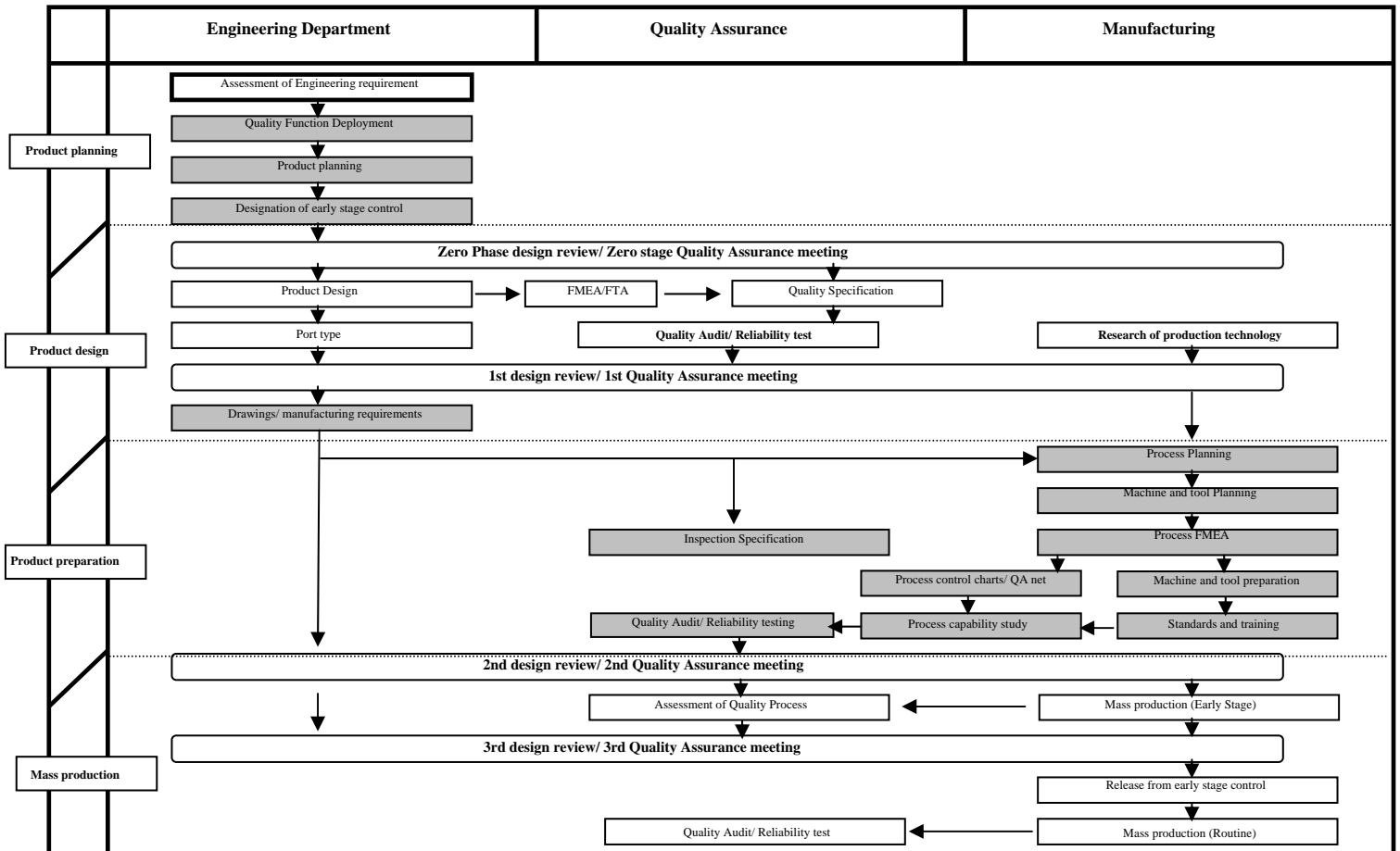


Figure 3.7. NPID model currently utilised at Denso manufacturing

The companies involved in the survey all had similar models although not so well defined, however all report similar problems operating the NPID model within their global projects;

- Over the wall engineering
- Poor communication
- Lack of project ownership
- Poor management support

These and other problems will be discussed later in this chapter.

3.6. Field results and study (Q17- 31) reviewing the employment of the NPID activities

3.6.1. The companies NPID activities include the VOC, OFD or market research

During the literature search best practice regarding the use of NPID activities was discussed (section 2.3.3.4) Figure 3.8 shows the resulting graph from the question “does your company strategy cover VOC, market research etc” and relates to specific activities. Examples of early stage control techniques are “Voice of the Customer” (VOC) or Quality Function Deployment (QFD). During the early stages of a project most companies agreed that QFD was an essential tool as was the creation of the NPID model. However when asked to show an example of the results of QFD the companies involved had no “formal record”, or couldn’t put their hand on the document, leading the author to question the validity of their comments. This inconsistency could be due to the fact that many of the companies were only satellite manufacturing plants and had very little interaction in the early stages of product development. Similarly as in the case of Denso they may have sold through to a sales company and therefore had very little interaction with the final customer.

This result concurs with a previous report by Mahajan and Wind (1998), who found that 75% of firms who were aware of the available disciplines actually used them. Some activities like QFD and VOC show low usage rates because firms are not aware of their existence or are not convinced of their benefits, or use the tool under a different name. An issue for the author to discuss in Chapter 4 is to examine which NPID tools within a global project have been used and discarded and for what reason.

A central concept for many firms with regard to project management was the separation of “planning from activity”. Reducing the activity lead-time of a project for them started with deliberate planning to establish a schedule for the reduction. Concurrent or simultaneous engineering, overlapping problem solving, collocation, event quality and early sourcing were all raised by those interviewed. There was general agreement that these ideas had merit, but that none are the definitive answer and none conflict with their view of the clear and encompassing principles of NPID.

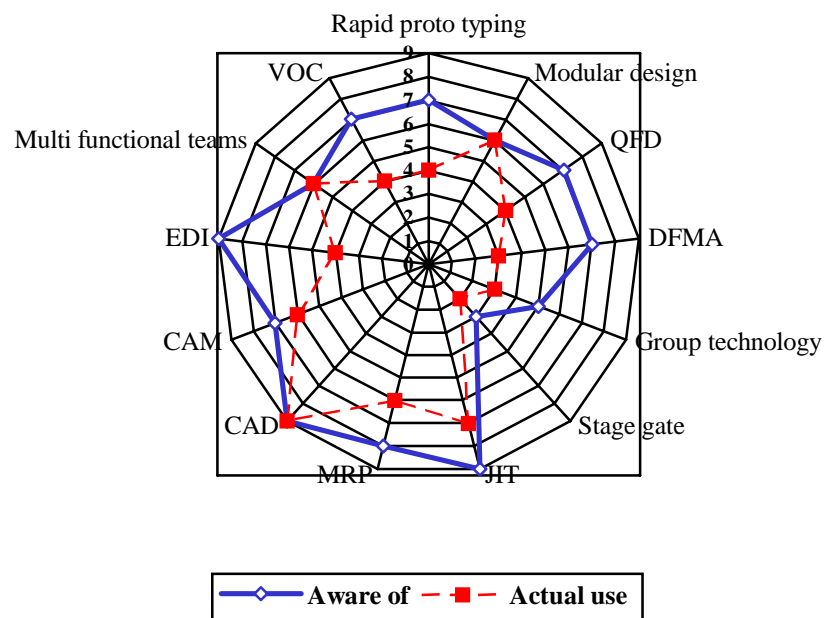
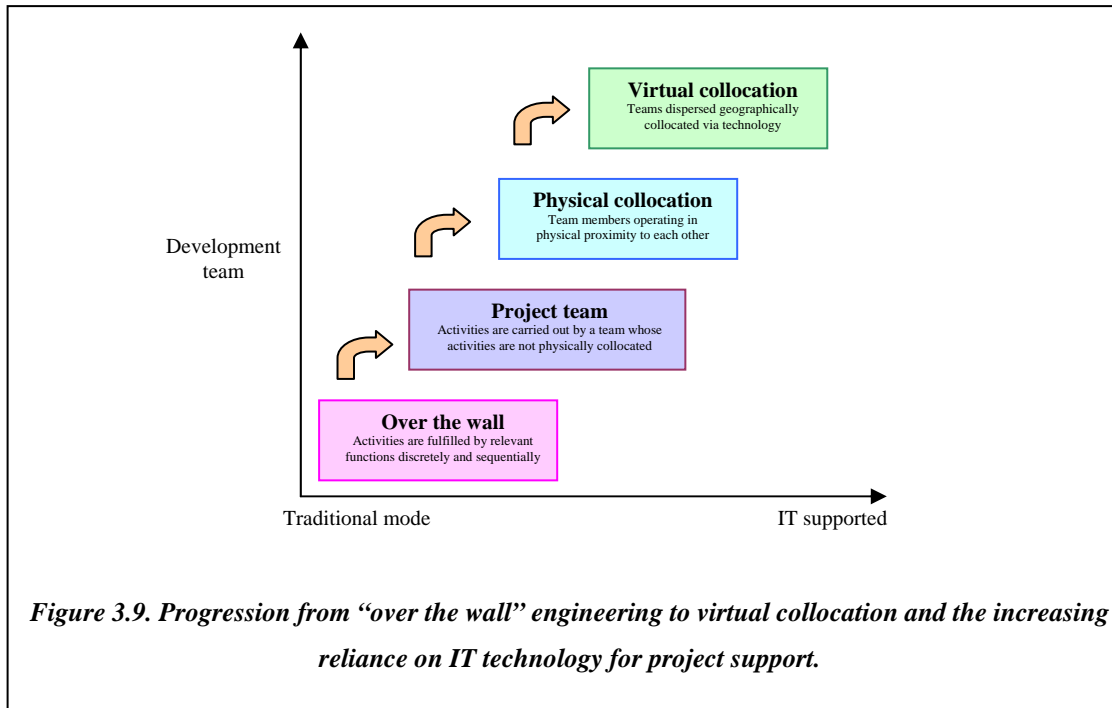


Figure 3.8 Relationship between the usage rate and awareness levels

The emphasis for many of the automotive suppliers questioned was on analytical or advanced planning, team building and programme focus. Support for the GNPID project by computer-aided scheduling (MS project), the interviewees agreed is the only proven way to effectively orchestrate people, concepts, work and money. One of the challenging issues to be identified is the role of the project manager in GNPID teams, how problems are resolved and how the communication problems are conquered. The graph in figure 3.9. illustrates the change from a traditional “over the wall approach” to the virtual collocation teams in GNPID teams. The diagram clearly shows that as the project teams

become increasingly separated the reliance on IT technology is essential for project success.



3.6.2. The customer is fully integrated in the GNPID process and are they considered a member of the GNPID team.

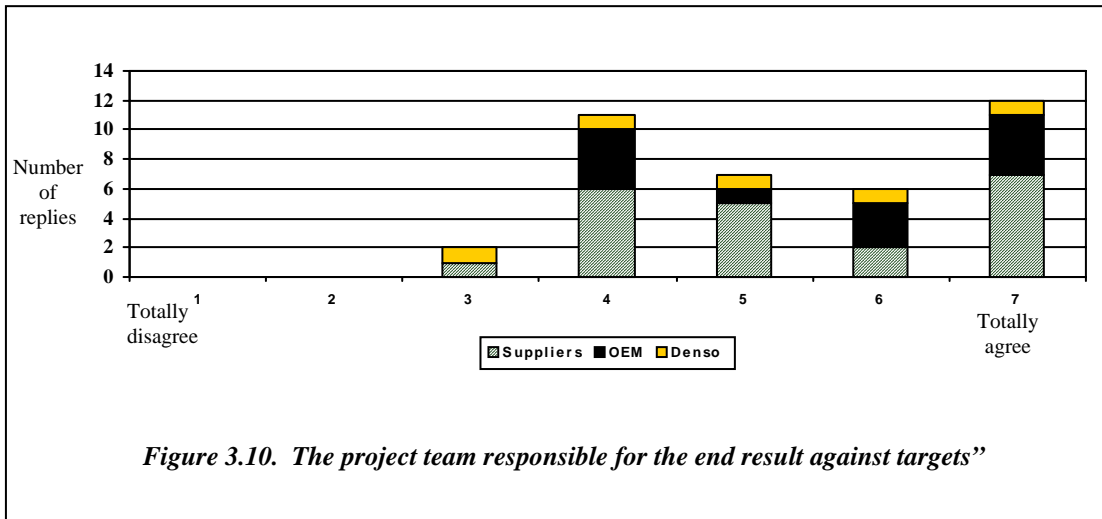
The question “the customer is fully integrated in the GNPID process and are they considered a member of the GNPID team” brought different responses from the OEM’s and the suppliers. Developing a clear understanding of the customers’ requirements was paramount for the OEMs, as was obtaining customer input. However the suppliers did not consider this as important as the OEM’s. The reason for this could be because most of the suppliers develop specific products for specific applications. One challenge for NPID in a global project is to develop a VOC mentality without actual contact with the customer, how the urgency is transmitted or fostered inside the team.

The evaluation of the companies that use techniques like DFM/DFA and QFD during NPID projects is very positive (refer to figure 3.8). The difference in evaluation between companies that use concurrent engineering and those who do not is obvious. The importance of being “Just in Time” (JIT) for most of the companies is one of the two variables related to reaching the technical goals, and the use of concurrent engineering and special techniques (QFD) are both related to being on time. This indicated that there are many factors that used together give the prerequisites for a successful NPID project. It is not enough just to organise the development process according to the principles of concurrent engineering or integrated product development, or to use cross-functional teams. What is required is a clear model that is flexible enough to give an agile response should complications develop and still deliver the project measurables of cost, delivery, and Quality.

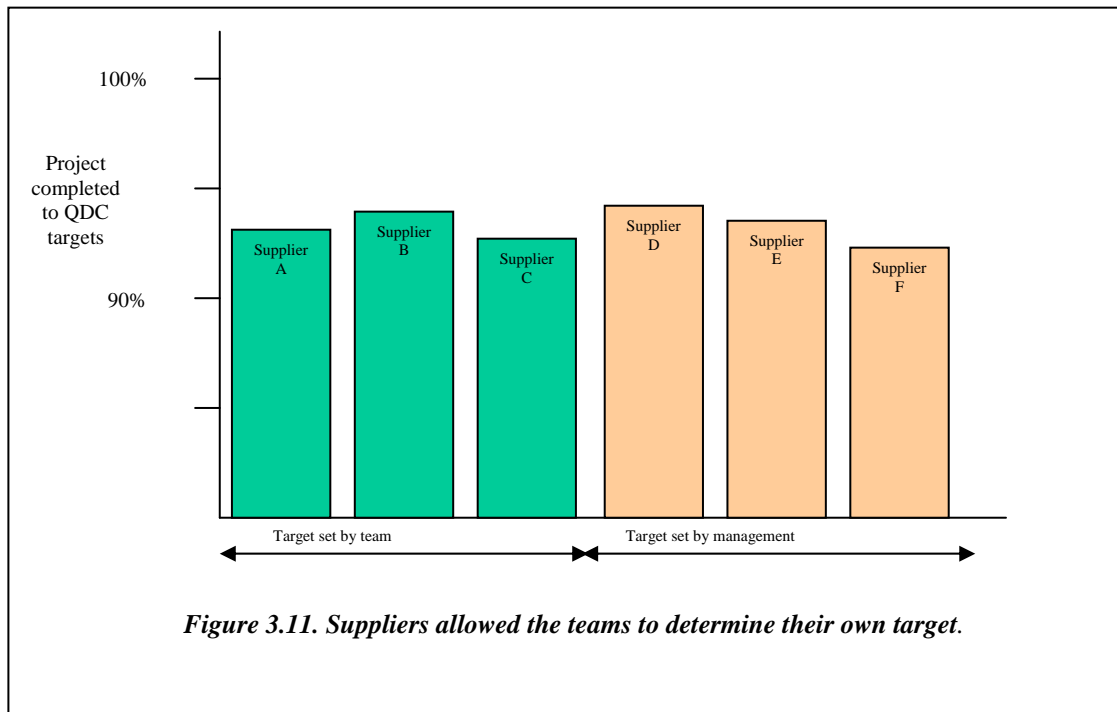
3.6.3. The team responsible for the end result meeting the original targets

The next set of questions related to the approach towards teams and team working during NPID, figure 3.10 shows the graph relating to the first team questions “ the team responsible for the end result meeting the original targets”. The response was quite broad, with many commenting that the team was responsible for installing the management’s direction and was therefore exempt from blame, but also original target setting. An interesting point of note is that the companies who did allow teams to set targets and goals did not report a greater success rate with projects than those that did not, as indicated in figure 3.11.

Introducing an entirely new model or product in the automotive sector is long, expensive, complex, and risky. A typical project for the suppliers interviewed usually takes three to five years to complete with a wide variety of costs involved. Many of the projects discussed involved several hundred, or even thousands, of people from many functional organisations and facilities spread across the country and throughout the world.



Additional problems for the companies were that very few of the people who began the project were there at the end. This has obvious implications for continuity of vision, goals, and philosophy, especially if the documentation system is absent.



3.6.4. The Company promoted participation from all members of the global team

However many of the companies stated that the globally dispersed teams operate in certain isolation at regional level as seen in Figure 3.12 The question asked if “ the company promoted true participation from all members of the global team”. Due to the dispersed nature of some of the projects many questioned found that the regional teams operated their own schedule and set local, not global targets and goals, inferring that most did not operate global teams as effectively as they believed themselves to do.

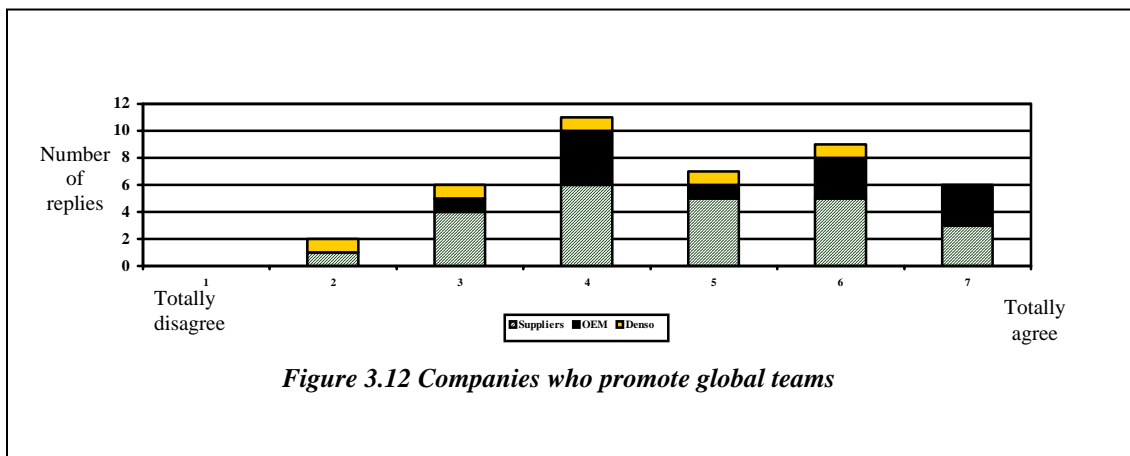


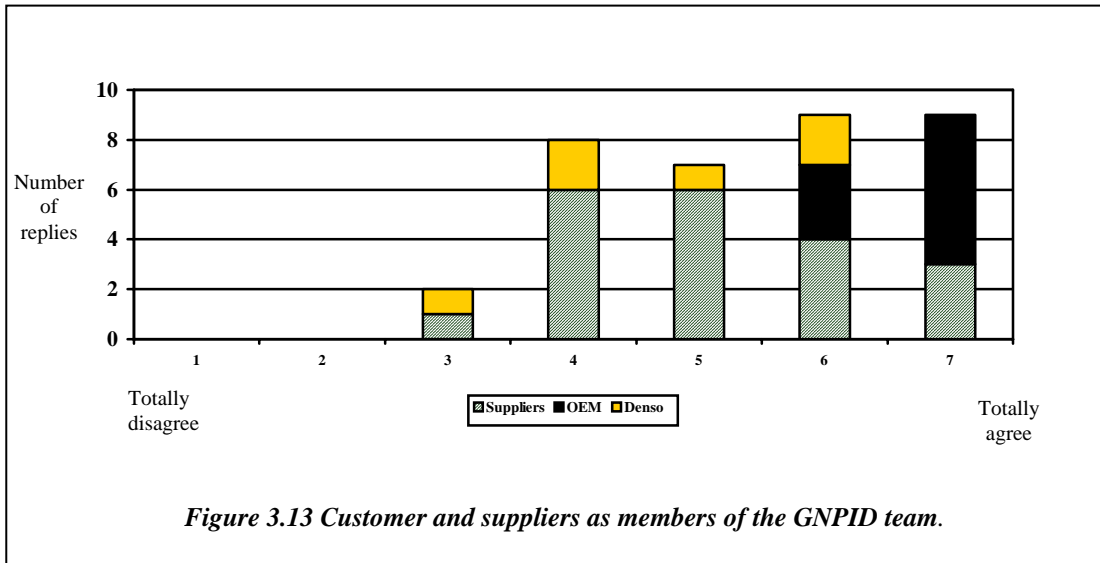
Figure 3.12 Companies who promote global teams

A variety of other problems raised by the survey shown in table 3.2 clearly detail the difficulties of operating globally extended teams. The table shows the benefits of physical collocation over those of the virtual collocation teams around general characteristics like culture, technology and resources.

| Physical collocation | Characteristics | Virtual collocation |
|------------------------------------------------------------|--------------------------------|-------------------------------------------------------------------|
| Close | Physical proximity | Remote |
| Small/medium sized companies with one or a few sites | Typical use | Multi-national and international organisation with different site |
| Limited variety as team members come from one site | Cultures | Different people from different countries, variety of experiences |
| Opportunity for sharing formal and informal information | Information exchange | Limited opportunity to share informal information |
| Ample opportunity for face to face communication | Relationships | Limited opportunity to interact and build relationships |
| An evolving common sense of purpose | Purpose | A directed common sense purpose |
| Ample opportunity for sharing resources | Resources | Limited access to similar non-technical & technical resources |
| Fewer hiccups due to possible sharing of technical systems | Technology | Possible problems due to variation in technical systems |
| A higher sense of belonging within the team | Working environment | Isolation and frustration, absence of a sense of belonging |
| Availability of information at any time for all members | Access information | Limitation in time and space for accessing information |
| Greater visibility of activities | Transparency of activity | Lack of visibility of work being completed |
| Similarity of work methods and employment | Education/ training background | Differences in education, language training, time orientation |
| A lower degree of empowerment and closer supervision | Empowerment team management | Limited opportunity to interact and build relationships |

Table 3.2 Problems and challenges faced by GNPID virtual collocation teams.

A best practice identified by the literature review was supplier and customer integration. There was a mixed response to this from suppliers. Often (Q 12) “supplier or customer as a working member of the team” was seen as an intrusion, an additional opportunity for the customer to make demands on process controls, as seen in figure 3.13. One supplier stated that a lot of time was wasted preparing unnecessary documentation for customer visits rather than actually doing the work. The OEMs however saw meetings with the customers as opportunities to improve their understanding of what is finally required. Most of the suppliers interviewed infrequently encouraged participation in the working groups by their own suppliers. Some only included suppliers in the cost reduction activity, and few included them at all during the DFMA/M process.



One organisation raised the importance of involving the suppliers in the NPID process, especially in the current climate of finding suppliers from Eastern Europe, virtually and literally stretching the supply chain. This causes problems in areas where communications are not as advanced as in the rest of the market. Others found that involving the suppliers was time consuming with little actual gain, while some suggested that supplier involvement caused problems due to their newly acquired extra knowledge about the project.

3.6.5. The Company uses cross-functional teams (including shop floor operatives)

One area of agreement between all suppliers was the use of cross-functional teams. In one suppliers case these teams came together from their individual departments for the duration of the project, whilst another had dedicated new project teams who introduce the new models. The author found that cross-functional teaming was more important, in terms of reducing development cycle time and that a structured, formal development process helps reduce development cycle time more when developing complex products. All the suppliers considered motivating teams and ensuring that members retain their enthusiasm a key activity of their project manager.

3.6.6. The company has clearly defined gateway reviews involving the extended team

All of the suppliers had a similar system of phases and gateways derived from their delivery commitments to the customer, with a sign off by senior management signalling the end of a phase (Figure 3.14). Many saw problems caused by this with an over the wall type approach to these gateways, especially if the following phase was handed to a new project manager.

One supplier has developed a global bookshelf system, where each completed project is stored and is accessible to other branches of the company. Many companies consider it almost impossible to plan a project in its entirety from start to finish as there are simply too many variables. By using defined project stages it is possible to plan the next stage in detail with the remaining stages planned in summary. There is at present no definition of the activities and time line for the phases and gateway reviews, an area of future research will be to identify what manufacturers who operate the phase and gateway system are expecting from each of the phases and gates in an GNPID project.

| TRW | Lear | TI Auto | SEW-S | SIA | Mecaplast |
|----------------------|-------------------|----------------------|-------------------|-------------------|-------------------------------|
| Customer development | Customer enquiry | | Offer | Feasibility study | Quotation stage |
| System design | Feasibility study | System design | Project Develop | Pre-development | Design Design verification |
| Design verification | Project leader | Tooling verification | | Proto type | Tooling verification |
| Product validation | Select Team | Process design | Production layout | Production prep | Process verification |
| Product launch | Intro to plant | Product validation | | | Mfg trials |
| Production | SOP | Production | SOP | Production tuning | SOP |

Figure 3.14 Phases and gateways used by the benchmarking partners

3.6.7. Your company's global NPID defines, specific activities and follows a standard project management process

This question was designed to promote discussion on the role of the project manager, probing the role of the project manager within the global team. The suppliers agreed that project managers on the whole spent most of their time fire fighting within a crisis situation rather than managing in the true sense of the word. The suppliers all pointed towards compression of lead-time, cost reduction and exaggerated Quality demands from the OEMs for this situation.

The approach to project management in the case of many suppliers began with the team being assigned the task of completing the project. Teams consisted generally of engineers, technicians, specialists and production shop floor personnel. Several suppliers and OEMs assigned a project manager to oversee all aspects of the project from conception to installation and field support, ensuring at all times that the customer's requirements were met and that safety and environmental compliance issues are satisfied. The contemporary attitude to project management by numerous companies differed widely both from each other and from the best practices identified in the literature. The author plans to define the project managers' role in globally dispersed teams and using the final project model to simplify the activities of the PM.

One benchmarking partner stated that the project manager was appointed temporarily from any department and then returned to his regular position once the project was completed. Others stated that as a project progresses through the development cycle, other team members could assume the role of project manager and complete a phase of the project that is directly related to their normal position. All those interviewed agreed that the outcome of the NPID process could be heavily influenced by the project manager's technical background and past PM experience.

| Project managers | Programme controller |
|----------------------------------------------------------------|-----------------------------------------------|
| σ Prefers to work in teams | σ Prefers to work individually |
| σ Committed to their managerial and technical responsibilities | σ Committed to technology |
| σ Manage people | σ Manage events |
| σ Committed to corporation | σ Committed to profession |
| σ Committed to and pursue material values | σ Committed to and pursue intellectual values |
| σ Seek to achieve objectives | σ Seek to exceed objective |
| σ Think in short term spans | σ Think in long term spans |
| σ Willing to take risks | σ Unwilling to take risks |
| σ Seek what is possible | σ Seek perfection |

Table 3.3 Comparison between project manager and controller

An individual supplier explained that they were moving from a project manager to programme controller, the main difference is total involvement in the process, incorporating customer and supplier. Other differences between the project manager and a programme controller are shown in table 3.3. The company’s observation was that the programme manager’s role is as yet undefined and the lack of total knowledge had caused problems. It is the author’s opinion that due to the requirements of managing a GNPID project, the project controller role is becoming more common.

3.6.8. There are regular communications with the extended team

During the survey communications both internally and externally were discussed through questions 32 through to 37 (refer to appendix 2). Predominantly “there are regular scheduled video conferences etc” and “the main form of communication by team members is the E mail system”. The frequency and how different levels and responsibilities interact with each other was raised during the site visits. The resulting table is shown in figure 3.15. The table illustrates the tendency was towards frequent working team meetings and less frequent executive level updates.

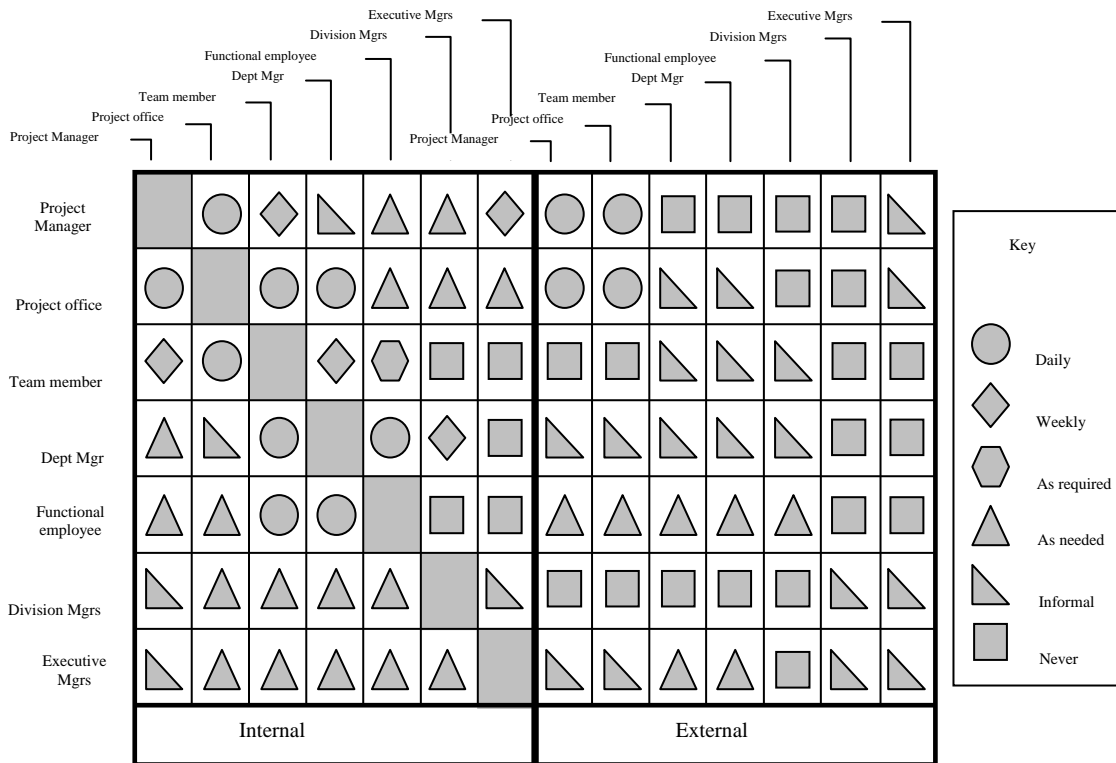


Figure 3.15 Communication relationships and frequency grid

This was further supported by a supplier stating that project success also depends on controlling the NPID process via excellent communications, project management, and ensuring team cohesion with group rewards. Another company emphasised their key points for project managers, to measure, manage, reward and motivate the team. An area for further research is to investigate if sharing lessons-learned between projects can positively influence cycle time improvement in the NPID process.

Frequently the companies interviewed stated that projects routinely use shared resources. This draws the project manager and the functional line managers into continual negotiations over the performance of work. The current trend to downsizing and flattening of organisations for many of the companies had only heightened the tension and led both project and function managers to compete with each other for power and authority.

The companies interviewed agreed that good project management techniques and controls as prerequisites to effecting change in their companies, each company's positive and negative points are shown in table 3.4. A German based supplier had a programme for project management guidance, training and support for all staff related to projects, including senior managers. One area for discussion in chapter 4 will be to identify the core control techniques including planning and managing risk, issues, scope, changes, schedule, costs and review.

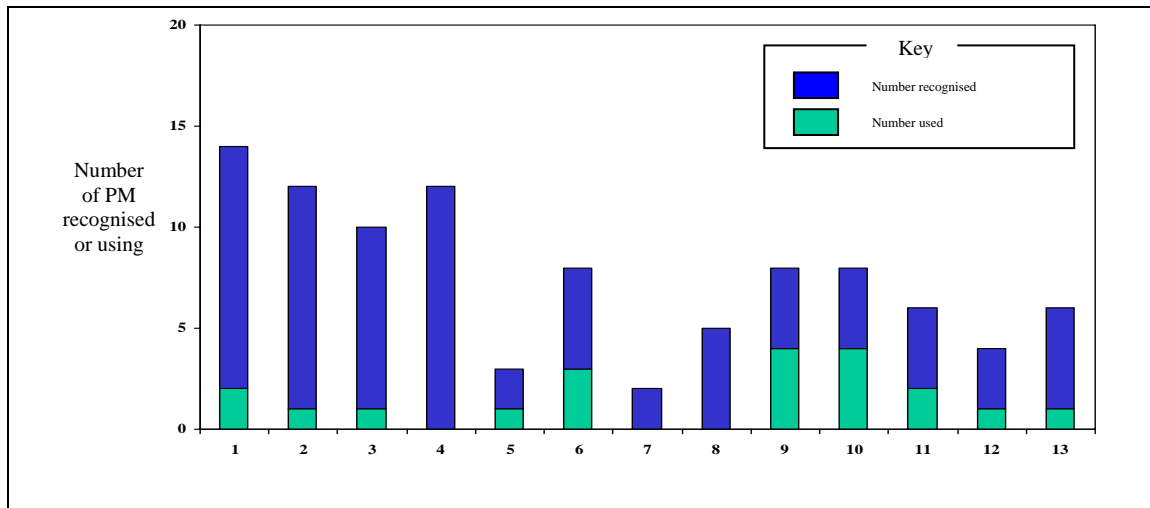
| | Pros | Cons |
|------------------|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Lear | Project leader Micro soft manager Multi skilled teams Customer involvement | Don't follow system Isolated work Unable to maintain team Limited validation |
| Benteler | High level mgr involved Defined system Multi skilled teams Customer involvement | Part time manager Unable to maintain team No project training Poor management tools |
| Mecaplast | Phase sign off Defined system Multi skilled teams Full time project manager | Too much paper work No power for project mgr Project not visual |
| TRW | Project manager Defined system& updates Multi skilled teams Risk analysis at phase exits | Gateway none specific Limited support project mgr |
| SEW-S | Simple system Operation manual Team orientated | No milestones No stage sign off No development objectives No feed back cycle |
| Denso | Project info centre Multi skilled teams Customer involvement | No project manager Unable to maintain team Info filtered by sales comp Difficult "Denso" system |

Table 3.4 Positive and negative aspects of the benchmarking partners systems

3.6.9. Control, tracking and reviews within the global NPID team

The next subdivision of questions was designed to investigate the NPID tracking and reviews within the assorted companies. As a means of obtaining the best technical solution possible, all of the companies had established NPID project progress reviews for individual projects. The project review meeting consists of members from upper management, and two or three of project team whose backgrounds are related to the stage and task. The review is seen as a source of technical guidance and expertise readily available to the project team. The project review has the responsibilities of ensuring that

the best possible technical solution was being implemented and to give support and resources if required. The actual content of the reviews will be an area of discussion in chapter 4 so that a formalised procedure can be obtained within the final project model.



| | Description |
|----|------------------------------------------------------------------------|
| 1 | PROMPT, Project Resource Organisation Management & Planning Techniques |
| 2 | PRINCE, Projects IN Controlled Environments: |
| 3 | IDEAL, Initiation, Diagnostics, Establishing, Action, Learning |
| 4 | BPMM, Project Management Methodology |
| 5 | BATES Activity, tasks, enterprises Methodology |
| 6 | 5 STEPS, a structured methodology designed to assist teams to deliver |
| 7 | SUPRA, The framework for SUPRA is similar to PRINCE |
| 8 | AIS, Administrative Information System |
| 9 | SDPP, Schedule Driven Project Planning |
| 10 | RDPP, Resource Driven Project Planning |
| 11 | MITP Managing the Implementation for the Total Project |
| 12 | COST, Customer Ownership System Teamwork |
| 13 | CALS, Continuous Acquisition Life-cycle System. |

Figure 3.16 Methodologies recognised and used by project managers

General newer tools, like BATES and SUPRA, discussed in the literature were not habitually used in authentic projects. Although some PM's were acquainted with the disciplines listed, most saw little functional use in the "real world". Several expressed the view that they had limited time and some tools were theoretically sound, but in practise not feasible. The graph (figure 3.16) and key illustrates how many of the project management methodologies were recognised by the project managers and had been used in a real situation over the past year during an actual project. Figure 3.17 shows the frequency of the well-founded project management activities used during the same period. Every company identified DFMEA and SPC as being used in all situations. Surprisingly few identified VA/VE as a project tool or DFM.

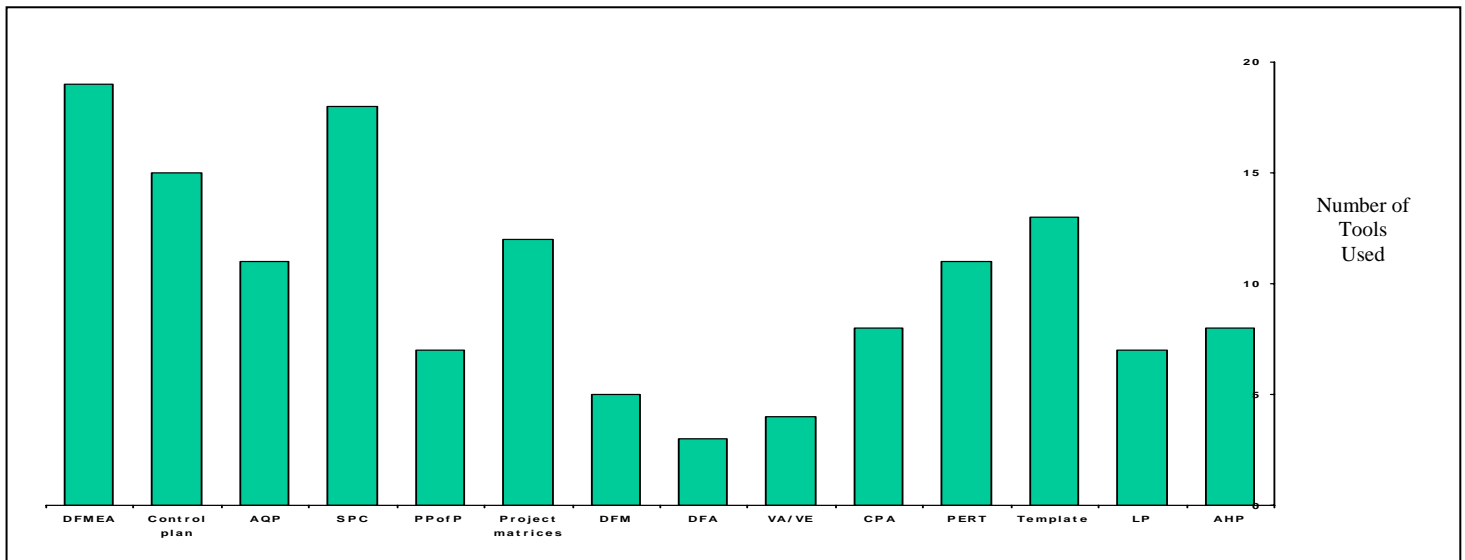


Fig 3.17 Project management activities used by the benchmarking partners during the past year

Planning as a discipline was seen as essential. MS Project was common to all companies and many had additional software that controlled or helped highlight problems and delays. One supplier often used Critical Path Analysis (CPA) and found this a constructive tool for delivering an absolute project depiction, particularly during the initial stages of the project, however very few other project managers regularly used this tool.

An area of general conformity was for project management to be successful; it must be incorporated as part of an organisation-wide implementation plan. Some of the manufacturers realised that the NPID process is an important contributor to profitability just like the production process. They saw a direct link in three ways between profitability and the successful execution of their NPID:

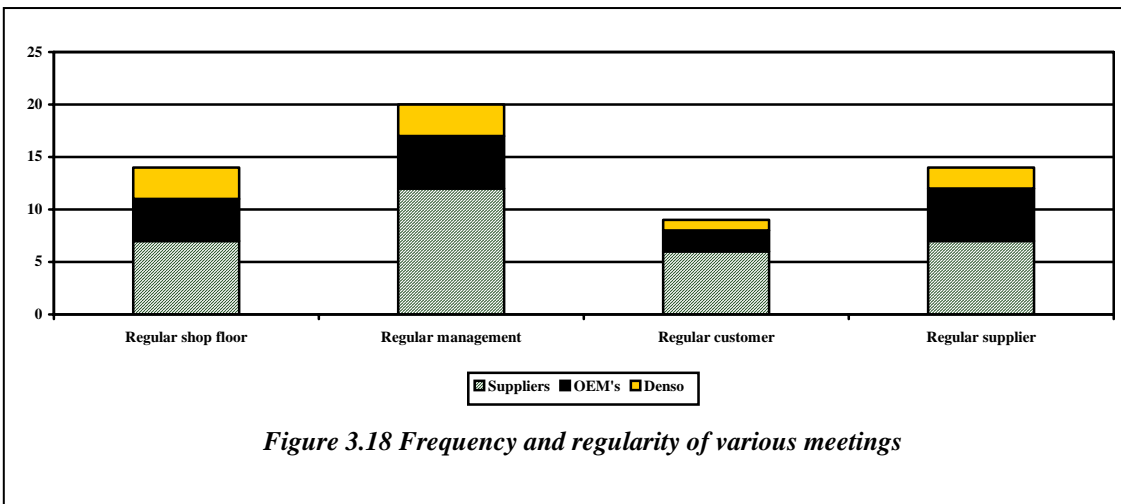
1. A planned and executed NPID provides superior control over development costs.
2. The manufacturer whose NPID is fastest from concept to production has a dramatic and strategic advantage in the marketplace by being first with the newest.
3. A healthily executed NPID increases product quality and market share.

Several interviewees believed that manufacturers who use project management techniques would improve the performance of their NPID process. The main point from those interviewed was that there is nothing astonishing in the concept, most were talking “about back to basics”. Which is simply, making a good plan and avoiding mistakes during its execution.

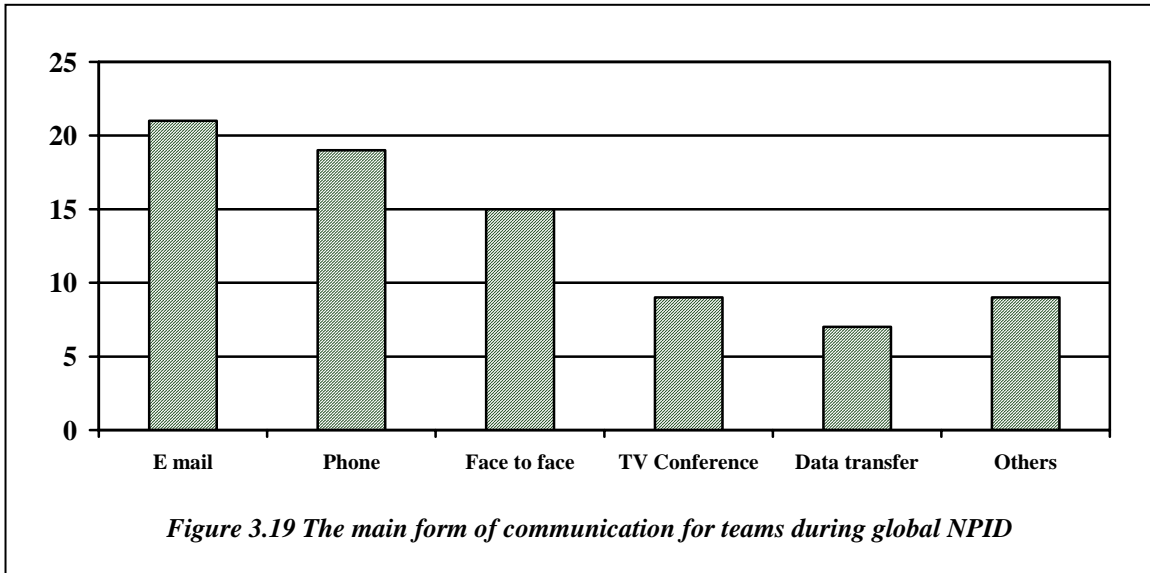
3.7. Field results and study (Q 32 – 48) reviewing the communications

The final sets of questions were designed to assess all forms of communications across the varying levels of a company. One of the OEM's believed strongly that the effectiveness of the cross-functional teams is influenced by their efficiency in conducting meetings and decisions. The proficiency with which team meetings are conducted is a precursor to the success of the team's NPID activity. There was a consensus of agreement that communications within the individual groups will also improve cross-functional communications amongst the NPID teams, functional support teams, product policy board, product strategy teams and the products committee.

The graph illustrated in Figure 3.18 examines meeting frequency and indicates that management updates and meetings are far more common than for the shop floor, particularly as pointed out by many suppliers in the early design stages. These meetings are seen as crucial for resource decisions. Lack of shop floor participation in projects was not seen as a major concern, despite the obvious experience that could be offered. The OEMs however did have management centres where information was presented and regularly updated on the shop floor.



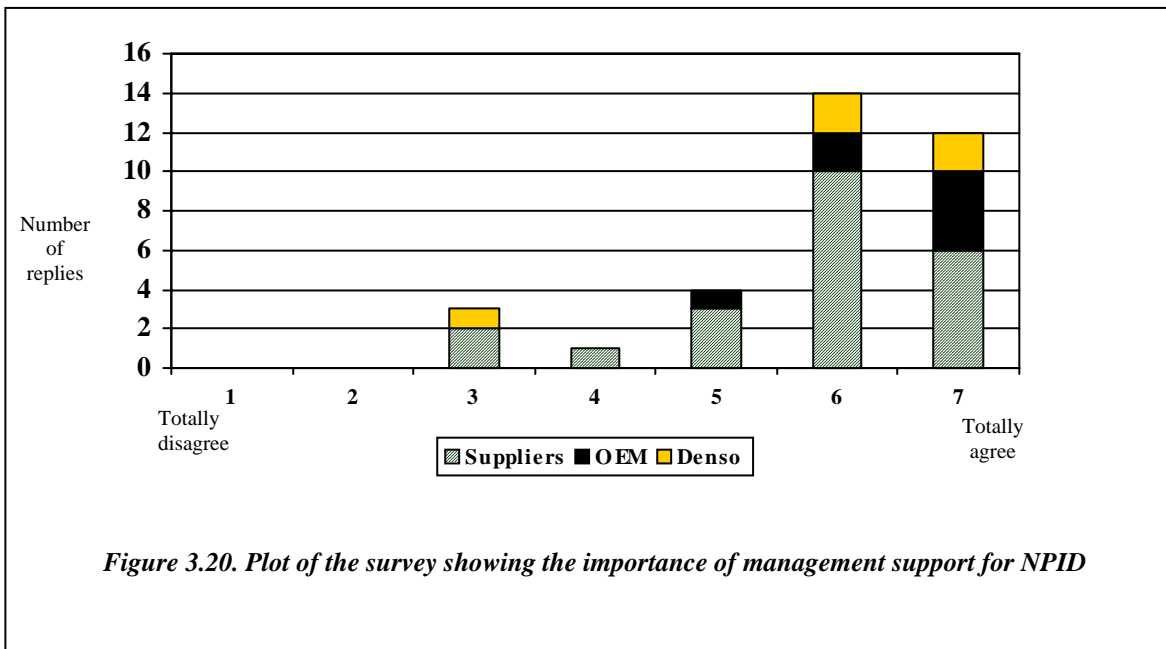
Communication was seen as a problem for some suppliers. Figure 3.19 illustrates that most communication in modern global NPID is carried out by E-mail. Most suppliers stated that this was due to time difference, whilst they were working, the design centre on the opposite side of the world was asleep, a problem encountered by many companies.



All the benchmarking partners agreed that it was crucial for the NPID team document its activities. In general, this entails documenting meetings, publishing engineering change requests or instruction (ECR/I), completing product release documents (PRD) and other items as detailed in the ISO documentation. This documentation is essential to provide for future NPID maintenance and support personnel changes within the NPID team.

3.7.1 Senior Management interface and support

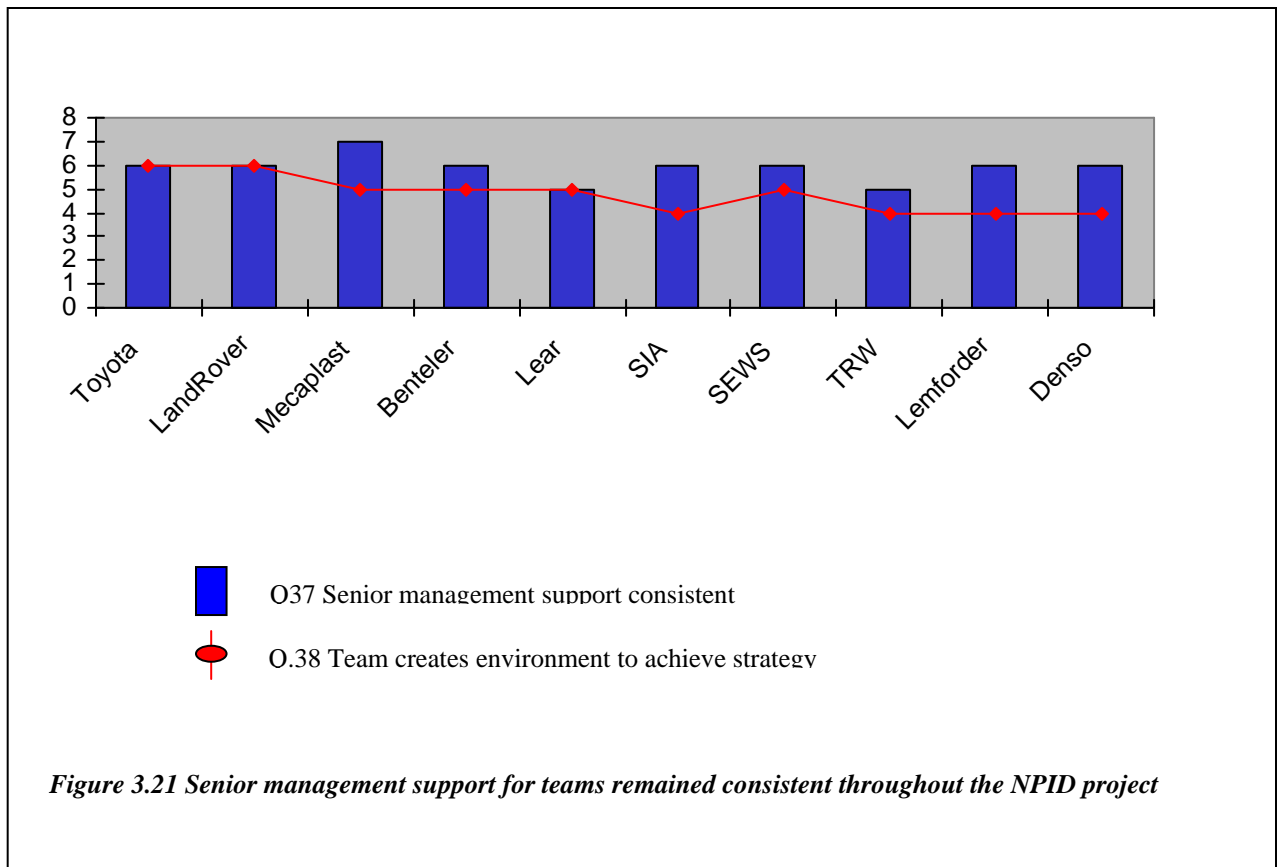
Questions 36 and 37 related to senior management support for the NPID process. The OEM's agreed that while some degree of freedom and flexibility is an essential ingredient to productive cross-functional NPID teams, upper-managers are faced with the challenge of instituting effective control mechanisms, as shown in figure 3.20. These mechanisms will head projects in the right strategic direction, monitor progress toward organisational and project goals, and allow for adjustments in the project if necessary. One supplier considered that too much or the wrong type of control may constrain the team's creativity, impede their progress and injure their ultimate performance. Whilst another company also raised the issue of management support as a negative aspect of the team building process and only the project manager discussed the project directly with senior management, acting as a filter back to the working group.



Many of the benchmarking partners discussed early and interactive decision-making on control mechanisms as important for effective projects. In particular, early team member and upper-management involvement in the setting of operational controls, such as goals and procedures for monitoring and evaluating the project, as positively associated with project performance.

3.7.2. Empowerment of the NPID team

Empowerment was the direction for the penultimate set of questions and the resulting graph is shown in figure 3.21. Many of the companies considered involvement of NPID teams early in the product development cycle as critical. One company stated that each of their expertise must be leveraged during the product development phase. For example, customers best understand their equipment needs and team members and suppliers best understand their respective technologies.

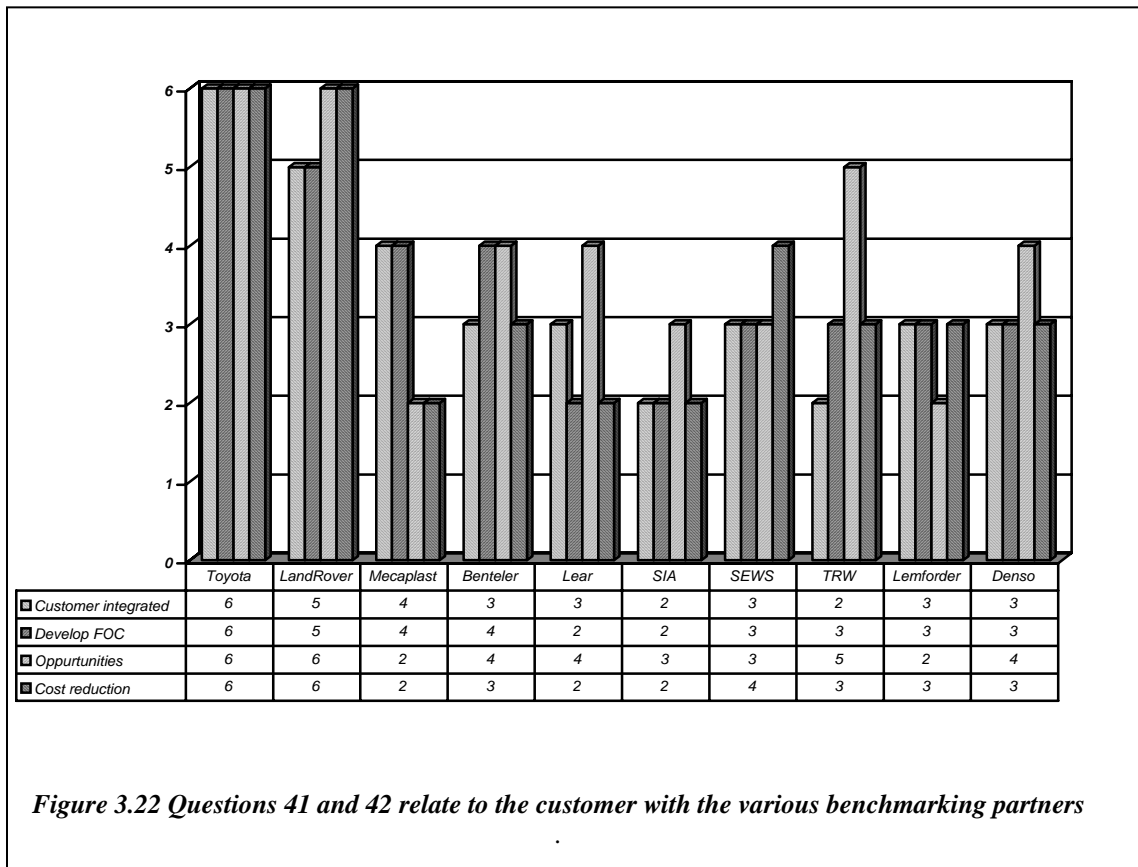


Toyota states that an empowered NPID team should be formed to manage the product development process. The cross-functional NPID team is responsible for co-ordinating and communicating all aspects of the company wide programme through the functional organisations. The NPID team refines the product opportunity assessment by assessing customer needs, documenting those needs in a marketing requirement specification and developing an appropriate product requirement specification. The team develops a formal business plan and presents its alternatives, schedules, and cost analyses and risk assessments. Using various design review meetings and field verification techniques, the team validates that product design goals have been met.

3.7.3. Customer interface

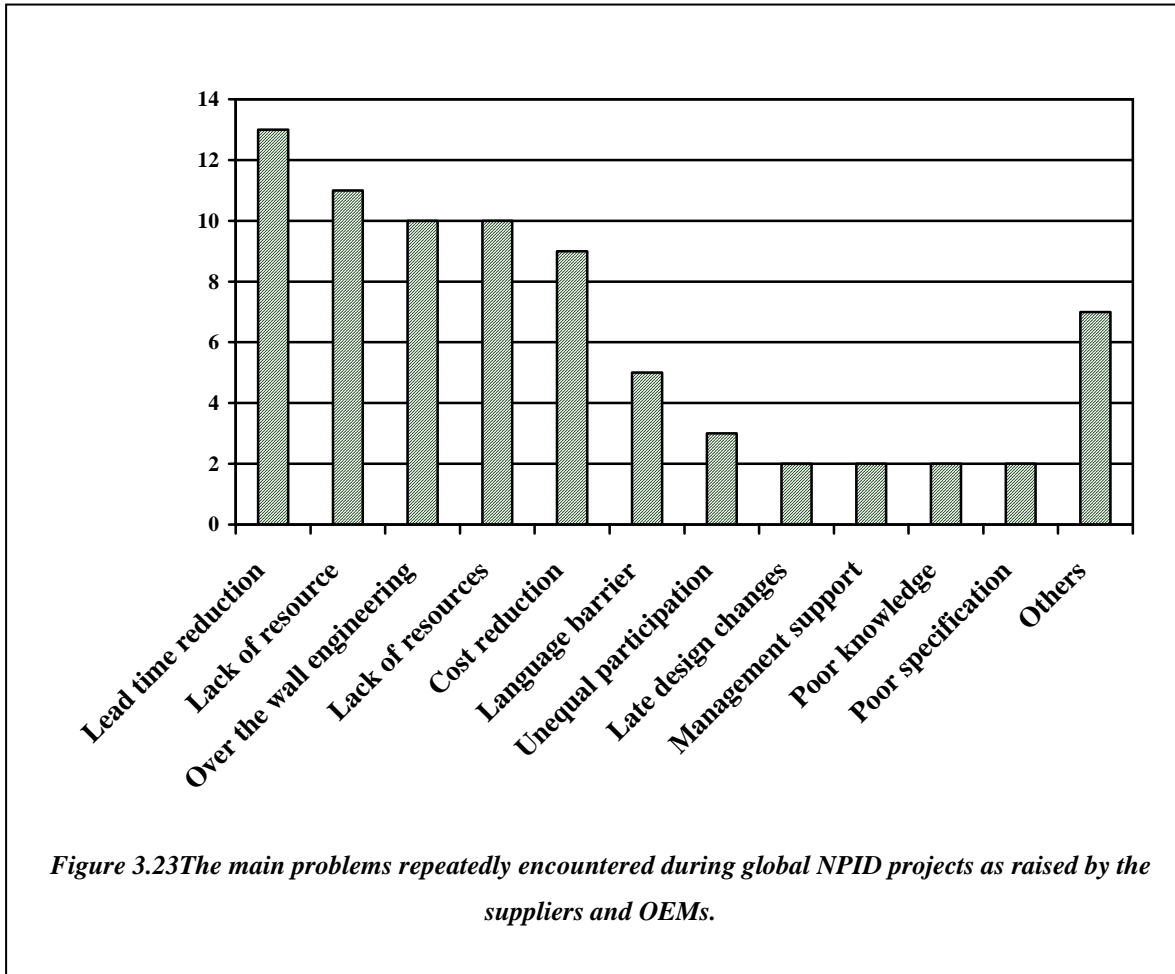
The last questions and resultant graph (figure 3.22) relate to questions 41 and 42 about the customer interface and customer focus in a highly competitive industry like the automotive industry. Here a buyer's market exists and is achieved by integrating the customer into the process of design and development. All of the suppliers and the OEM's have four objectives.

1. Develop a good understanding of customer wants and needs, what they value and how they would make judgments about things like price or performance compromises.
2. To generate new opportunities by exploring with customers the potential of new technologies and by identifying future customer needs.
3. To explore how goods and services can be combined to increase the value of product offerings.
4. To enhance innovation by making use of customers' own ideas about how to improve a product or overcome problems. The techniques of co-creation provide a means of addressing the needs of diverse global markets and customers.



3.8. Major problems raised by the benchmarking for Global NPID

During numerous discussions throughout the benchmarking survey, problems encountered during Global NPID were continuously discussed. Many suppliers raised the same concerns (shown in figure 3.23). The most frequent complaint was compression of the schedule and lack of resources to complete the project on time. One supplier complained that the lead-time from concept to customer has been reduced by 50%, compressing the process and forcing the “corners to be cut” with a direct effect on the product quality.



Many project managers and engineers discussed an “over the wall” approach within their company. Team members passing over problems, particularly those operating a phase and stage gate process of project management. A number of people commented that concurrent engineering was a good idea but was impractical in reality. Project managers talked of chasing people to complete tasks and passing on complete and quality work rather than chasing problems down through the stages.

Many also saw cost reduction during GNPID as a concern. Often the GNPID was started with cost reduction activity with all companies participating in some form of Design for Assembly or Manufacturing (DFA/M), which all saw as a crucial tool in the early stages of GNPID. However many companies stated that this activity continued throughout the

project, often resulting in late design changes, supplier problems and an increase in tooling modification costs.

3.9. Summary of benchmarking

The benchmarking partners all discussed the OEM's demands for their suppliers to operate on a global scale and that they now require manufacturing facilities around the world to meet these demands. The factors creating this global manufacturing requirement are the need for a shorter distance between supplier and customer or local content regulations. In some instances, this may be due to the requirement for lower labour rates. This creates a need to consider design systems that can handle globally based product and process design and manufacturing.

The global markets are now a fact that companies have to deal with due to alliances like the single European market and NAFTA. Companies find themselves under enormous pressures to improve their performance, changing their corporation's organisational structure to suit the new demands. Although the literature review found it important to have a Global NPID process, the benchmarking study reveals that within industry there is no such established model. Many of the suppliers in the benchmarking survey are trying to develop a model for the integration of the GNPID process to meet the demands of global expansion. To do this they are developing a systematic approach and tracking method to drive globalisation of NPID.

In summary, all of the companies involved agreed that:

1. Approved Project Management techniques could be very effective in improving GNPID performance.
2. Project management that demands detailed, analytical planning takes priority over the NPID process stage starting.
3. Disciplined control of information.

4. Best practices associated with the strategic implementation of GNPID like actual project selection, goals, technological leadership, product strategy, and customer involvement
5. Accurate records in the form of GNPID control, process control, metrics, documentation, change control.
6. Developing strong product concepts and ensuring organisational focus on those concepts through project selection.
7. Project success depends on excellent team cohesion with group rewards.
8. Sharing past history between projects could positively influence cycle time improvement in the GNPID process.
9. Use of cross-functional teams
10. Structured, formal development process helps reduce development time more when developing complex products.
11. A systems approach to implementation and the transfer of knowledge and experience.

While there is a trend to involve suppliers more in the product development process, many companies were undecided as to whether such involvement is actually beneficial. Some of the companies interviewed found supplier involvement had adversely affected a project. Some companies stated that supplier involvement had actually increased the NPID time.

Many of the automotive suppliers interviewed all had experiences where customers' involvement in design had beneficial effects. They found that involving customers directly in the design process could help establish buy-in; it helps generate knowledge of the user's environment so that product usage can be better understood and it is an effective and realistic way to test prototype products.

Chapter 4. Identifying the challenges for a Global NPID

4.1. Introduction

In chapter 2 processes involved in the introduction and development of new products were studied and a number of methodologies assessed. The work in chapter 3 identified the principle strengths and weaknesses contained within structured NPID processes in use within industry today. These methodologies have been credited with a degree of success in improving the productivity and quality of the NPID process. This section will discuss the challenges and issues that need to be addressed for global NPID.

4.2. The issues raised during the benchmarking and literature study

The literature relating to Global New Product Introduction and Development (GNPID) compared to NPID within a single company is relatively small. To a great extent the literature in the field relates to project management and communication issues that are raised during GNPID projects. The author found very little research into the cultural differences and their effect on the GNPID process, extended supply chain and extended enterprise in a global context. In general a great deal of the previous research was theoretical and untried through case study and this was further supported by the findings in the benchmarking survey. The next sub sections will outline the challenges identified in both the literature and benchmarking survey, using the criteria developed in the earlier chapters.

4.2.1. The flexibility of the GNPID model

Any model that is to be developed for GNPID in a modern organisation needs to be flexible enough to operate in the automotive business. Japanese manufacturers have gained a significant market share in the West in part through their reputation for quality and reliability, supported by their ability to introduce and update popular models more efficiently than their western competitors. A number of European car manufacturer are now catching up with companies like Toyota, but not before many others have folded or been sold off. This kind of response to the customer's demands is elemental for any automotive supplier. The suppliers need to develop a collaboration with the OEMs' in an effort to create innovation, improve quality, control costs and develop greater speed-to-market.

4.2.2. The regularity of reviews and updates

Many of benchmarking partners found (section 3.4.2) that using the stage and phase gate model could lead to disconnection between design, manufacturing and finally the customer. Stage and phase gate models can also lead to elongated project time. Unless the project management is unvarying the model can lead to over the wall engineering. The response to the challenges between the two systems is to develop the GNPID model based on concurrent engineering but with regulated management reviews or gates to provide GNPID progress updates.

Figure 4.1 shows that the main concentration of work for GNPID occurs early in the project process. This diagram shows that the model has to include early engineering involvement with suppliers and customers in the design, proto type builds, manufacturing release, supply based management and the initial stages of production the ultimate aim is to provide the final customer with a production process that is capable of mass production volumes whilst maintaining quality and cost.

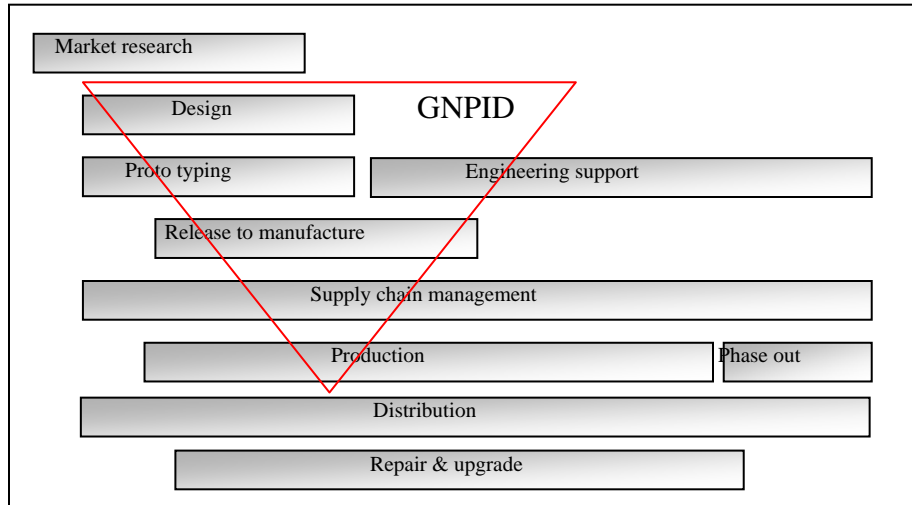


Figure 4.1 The main concentration of work for the GNPID model is in the early stage of the project.

4.2.3. A structured GNPID model with regional variance

The GNPID model needs to be a structured process, which is constantly used and continuously updated. Earlier studies (Griffin 2000, Ernst 2002) identified key differences between NPID projects that have succeeded, and those that failed. A recurring theme within this work is the importance of a formal GNPID management process. The structured GNPID process must allow a product development project to be split up into logical phases rather than functional steps, and therefore enable decision points or gates to be inserted at appropriate points in the project. This provides senior management with the opportunity to review a projects progress against an agreed set of deliverables and to be involved in the project at appropriate points in the programme.

4.2.4. The nine potential weaknesses that a GNPID model needs to address

The use of a structured model is not a guarantee of GNPID success and the concept of a model has some potential weaknesses that need to be addressed as discussed earlier in chapter 3. The following 9 potential weaknesses have been extracted from the benchmarking study and from the authors own experience in the automotive industry

- 1) Increased overlapping of the development processes means the volume of information that is exchanged has significantly increased.
- 2) The procedures need to be in the form of guidelines. If an overly formal set of rules is applied to GNPID, responsibility may be diverted away from the team.
- 3) Many projects have a unique and intuitive character that is difficult to capture in the traditional models. A new GNPID model would have to be rigid enough to follow, but flexible enough to be adaptable to local situations.
- 4) Some concurrency of activities needs to be addressed to prevent the extension of dead lines.
- 5) The problems raised at the gateways need to be addressed before progressing into the next phase to prevent an “over the wall” mentality within the GNPID process.
- 6) Review periods need to be well defined and progress reporting strictly adhered to, however the activities need to be managed so that the completed results are presented at the reviews rather than potential outcomes.
- 7) The model can also lead to late design changes due to the simultaneous nature of the activities, in other words activities can be started without a conclusion from the preceding verification activity, the periodic reviews are therefore crucial.
- 8) The model has to have some reliance on the suppliers and customers as active team members.
- 9) To benefit from experience and knowledge within the team, cross functional teams need to be involved totally in the GNPID from the concept, with the possible added expense on resources and personnel.

4.3. An outline of the generic GNPID model

Addressing the nine weakness points just raised and drawing from both the literature and benchmarking surveys an outline of the generic GNPID model was developed (as shown in figure 4.2). The model is a combination of the stage and gate and concurrent engineering. Application of the model should reduce lead time, avoid costly reworks and late designs, certify the project is completed to APQP standards and ensure the company has a good record of the project for future understanding and knowledge. The overall project is broken into six phases, planning, product design and development, followed by process design and development, then product and process validation, followed by pre-production and finally mass production. Each of the phases has some minimum requirement for engineering tools followed by key words for the GNPID team.

| Phase | Actual steps | Engineering tools | Outcome | |
|------------------------------|------------------------------------|------------------------------------------------------------------------|------------------------|------------------------------------------------|
| Planning | Basic study | Brainstorming VA/VE | Benchmarking | C R E A T I V I T Y |
| | Goal setting | | | |
| | R & D planning | | | |
| Product design Development | Product development | QFD, VA/VE Design FMEA, FTA | Concurrent Engineering | |
| | Basic specification determined | | | |
| Process Design | Process development | DFA,DFM Simulation | Design verification | |
| | Basic concept production system | | | |
| | Production system design | | | |
| Product & Process Validation | Equipment procurement | Process-FMEA Process control plan MRP Visual control (Kanban) | Process verification | C O N C E N S U S |
| | Implementation planning | | | |
| | Equipment design | | | |
| | Equipment build | | | |
| Pre-production | Process flow | Process flow diagram SPC | Confirmation | |
| | Initial production | | | |
| Mass production | Daily controls | Continuous Improvement | Maintain | |
| | Total production Maintenance (TPM) | | | |

Figure 4.2 The generic phases and activity associated with NPID.

a) Planning phase - During the planning phase the actual outcome has to be benchmarking, always reviewing the competition and considering the voice of the customer (VOC), working with suppliers, completing market research, whilst doing a fundamental study of what is required. Setting targets and goals must be completed early in the project to ensure eventual success. There also needs to be substantial design and research planning to avoid over complication, schedule delays and costly over runs.

It is important that that during this phase the evaluation of the concept has been passed and the initial product specification fixed. If subsequent changes are made, the required redesign work will significantly escalate the time to market. Successful companies have a comprehensible plan for product specification and cost at this juncture. They will already have investigated the marketing issues surrounding the new product and its competitive advantages will also have been defined. The firm will also have an unambiguous understanding of the risks and potential reward involved with the project.

b) Product design development - Concurrent engineering is the outcome to reflect on during the product design development phase, where the basic specification needs to be agreed. Both of these two phases can be considered the creative section of the project and activities like Design for Assembly and Manufacture (DFA/M) and prototype simulations need to be incorporated into a design verification phase, where the design ideas become reality.

c) Process design phase - During the production design process, the activities of Predictive Failure Mode effect Analysis (PFMEA), Process control plans (PCP) and visual control systems need to be incorporated into a process verification phase, where the production process can be validated and the product assessed.

d) Product and process validation - Following the production of the prototypes, the product and process needs to be tested to validate that it corresponds with the specification and that it can be consistently manufactured. Test marketing should be carried out in partnership with a small number of strategic customers. It is erroneous to

presuppose that this progression will escalate the time to market. In fact, eliminating test marketing and customer trials may increase time to volume manufacture, since any minor problems will have to be rectified whilst the sales force is endeavouring to arrange deliveries. The subsequent lost business may never be recovered. This stage also allows the company to ensure that sales and support, both financial and service, are in place and ready.

e) Pre production phase - The pre production phase is basically the preparation for mass production and it requires the process flow and initial production trials to be evaluated. Engineering tools like statistical process controls (SPC) need to be employed to maintain the quality during production and the process flow to ensure standardised work. The key outcome for the GNPID team during this phase is to monitor and confirm the process is capable.

f) Mass production phase - The final phase distinguishes between the NPID project and the continuous production operation or mass production, where the activities are principally daily management of the process and maintenance in the form of total productive maintenance (TPM). The system should be supported by continuous improvement, with the outcome being to maintain the improvement activity as well as the status quo. After the product has been passed to mass production and launched into the market place, the company should continue to monitor the product. This will ensure that the actual performance in the field can be compared with the business plan and that lessons are fed back to subsequent new product development projects. It will allow the firm to assess the possibility for enhanced or derivative products.

4.3.1. Developing the GNPID strategy

The proposed GNPID model must respect the need for enhanced senior management involvement in the project at the right time and at the right level. The executive level of the company needs to lead the GNPID project by developing the strategic direction and ensuring that all projects are aligned with the company's business strategy, senior management should not be involved in micro managing every small element of the project. Gate reviews will give management an excellent opportunity to carry out this role and to consider the project in the light of the company's entire NPID portfolio. This provides encouragement for the project team to concentrate on the initial planning stages of the project, so that downstream engineering changes are kept to an absolute minimum. The latter is a very important part of the management of GNPID projects, since it has been shown that detailed and early product definition is a key determinant of NPID success.

Other key elements extracted from the literature review, the benchmarking study and the author's own experience that need to be included in the GNPID strategy are:

- 1) The use of a formal life-cycle management process to significantly reduce time to market and to enable continuous learning from each GNPID project.
- 2) A cross-functional approach to the process of GNPID is also obligatory, so that the need for downstream changes to a product are reduced or possibly eliminated.
- 3) Successful companies also have clear strategies for business and technology planning; the first test of any GNPID has to be its strategic fit.
- 4) The strategy must also ensure that its technical and business strengths can be leveraged to give a GNPID a clear competitive advantage.
- 5) Early involvement of GNPID with the customer and suppliers in the product development cycle is critical, as the customers may best understand their equipment needs whilst the supplier will best understand their respective technologies. It is therefore critical to give great importance to obtaining the

customers input and therefore clearly understanding their requirements at the beginning of and during the GNPID process.

4.3.2. Developing the GNPID activities

Developing the new GNPID should improve a company's ability to manage the required complexity of GNPID activities in a profitable way by mastering within the organisation excellent customer, product and supply chain-related business processes. Also by mastering across multiple organisations excellent synchronisation of those processes across the organisation and its customers and suppliers. From the authors research and own personnel experience the following activities will have to consider:

- 1) The methods for managing dispersed GNPID project by cross-functional teams.
- 2) Managing the complexity and inefficiency involved in controlling the global manufacturing supply chains.
- 3) Engagement in some form of customer-collaboration and the intensity of integration and interaction within the global team.
- 4) Maintaining product Quality despite global dispersion of the supply chain activities, which greatly increases the risk of deteriorating quality, through sourcing components from low-cost locations and venues.
- 5) Outsourcing production, engineering or logistics to third parties can end up lengthening lead times, increasing risk and reducing flexibility.
- 6) The implementation across customer, product and supply chain operations, including Product Lifecycle Management (PLM) and Advanced Planning Systems (APS) that focus on long-term planning and forecasting, in addition to more tactical technology, including warehousing management systems (WMS) and transportation management systems (TMS).
- 7) Ways to explore possible methods to develop and advance knowledge and expertise in virtual long-distance cross-disciplinary and cross-cultural product development projects.

- 8) The adoption of agile manufacturing principles that incorporate virtual product development teams.
- 9) The introduction of new technologies, which are significantly more efficient at delivering the services and resources required in GNPID projects.
- 10) The activities required to respond to global trends and stakeholder expectations.
- 11) Develop cohesive dispersed senior management teams that effectively establish and communicate strategies throughout the GNPID project.
- 12) Development methodology, define a consistent structured development process with clear decision criteria for all projects
- 13) Conducting reviews at event-driven points in the process and hold interim reviews when significant changes occur during development
- 14) Project organisation through the use of small cross-functional development teams empowered to make decisions
- 15) The installation and the project start of a single team leader managing the project from the concept to market launch
- 16) The development of project performance measures as a team and individually
- 17) The use of e-mail and other IT support tools to improve communication and team accountability.

4.3.4. Requirement for developing the proposed GNPID model.

The GNPID model as seen previously in figure 4.2 will need to consider a systematic approach to the integrated and concurrent development activities for products and related processes that accentuate customer satisfaction and exemplify team values of co-operation, trust and sharing, such that all elements of the product life cycle are considered. The GNPID model should empower, cross-functional teams to carry out the required activities, minimise redundancy and eliminate non-applicable requirements while managing resources and risk. The rationale of GNPID is to substantially reduce development costs and time-to-market cycles, while providing high-quality, durable and efficient products to the marketplace.

The GNPID model proposed needs to contain a degree of flexibility, so that projects are not delayed at a review point waiting for one task to be completed. The phases and review points have a blurred division between them, so that phases can overlap one another as in the concurrent engineering approach taken by Toyota. The role of senior management is to decide whether the risk of proceeding to the next phase is less or greater than the commercial risk to the company of delaying the project, and may therefore issue a decision to proceed conditionally upon any remaining tasks being completed at a future date. The use of cross-functional teams can help to quantify any risk involved here and assess its acceptability, since the team will possess the expertise to predict the chances of delivering the incomplete task within an acceptable time scale.

Chapter 5. A rationale for a GNPID model

5.1. Introduction

The preceding section (chapter 4) outlined the criteria and constraints involved in the construction of the proposed GNPID model as seen in figure 4.2. Using the literature review criteria (refer to section 2.4) and the benchmarking study conclusions (refer to section 3.9) it has been possible to develop the GNPID model (figure 5.7). The subsequent section will discuss the individual strategies and activities that require completion within the individual phases of the GNPID model.

5.2. Basic concepts for the planning phase strategy within the GNPID model

Table 5.1 illustrates the planning phase of the GNPID model. Four tables (Table 5.1 to 5.4) have been drawn up from “best practice” extracted from both the literature survey (chapter 2) and the benchmarking (chapter 3). The planning phase must:

- start with the Extended Enterprise (EE) and involve the strategic partners from the inauguration of the project. This should be a function that the project manager (PM) executes at the start of the GNPID. The PM should also be appointed at the project conception and remain with the newly formed GNPID team until the product is launched.
- conduct market research in order to identify key customer characteristics and develop the Voice of the Customer (VOC). At this point it is critical to analyse the company’s competitors and ascertain the company’s strengths and weaknesses.
- set the business objectives and deliberate over the current product lines. This will enable the setting of targets and goals, as well as other considerations for standardising with existing product lines. Reviewing the operation at this time will also enable costs to be calculated as well as the capacity, personnel and investment requirements to be considered.

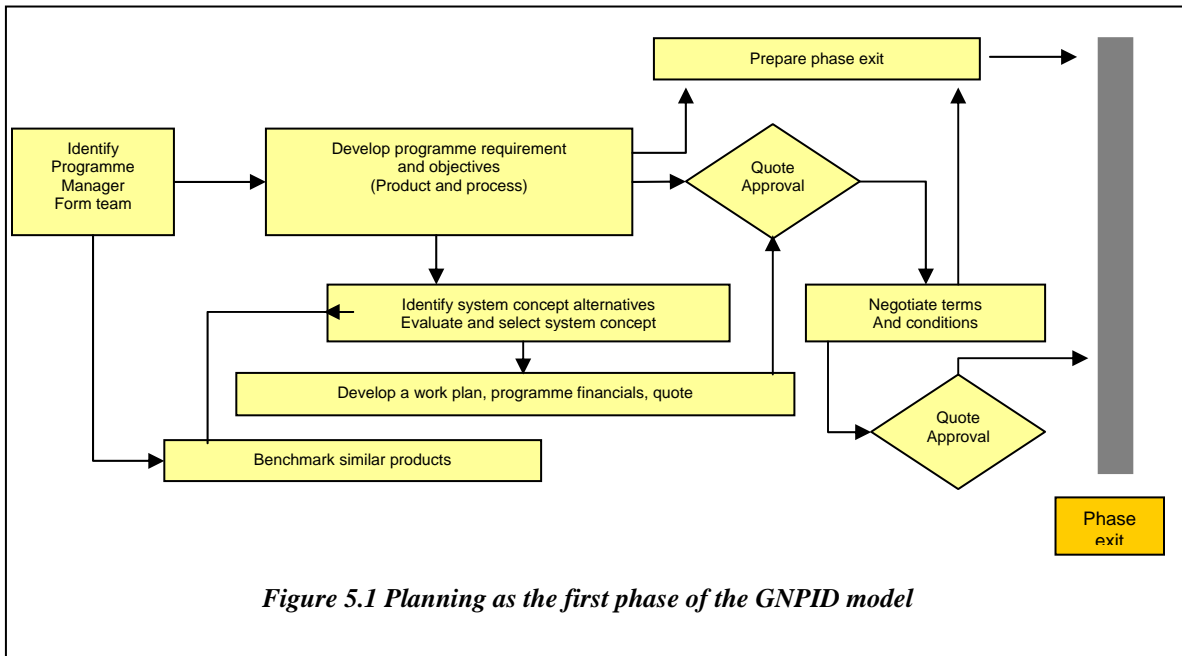
| Concept | Activity |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Involve strategic partners • Conduct market research • Analyse competitors • Asses current product lines • Set business objectives • Review operations • Evaluate procurement • Investigate technology trends • Review legal and environmental issues • Evaluate product distribution • Address staffing issues • Make strategic decisions • Communicate stratev | <ul style="list-style-type: none"> • Product manager should form strategy focus team • Identify key customer characteristics • SWOT analysis on competitors • Evaluate current models for standardisation • Determine targets and goals • Review cost, capacity, investment and personnel • Evaluate the supplier base • Review the component programme • Safety, emissions, re-cycling • Asses production distribution channels • Estimate staff required • Identifv customer and market requirements |

Table 5.1 The planning phase of the GNPID process, the concepts and activities to be employed.

- evaluate the procurement and the capability of the supplier base.
- investigate into recent technology trends and reviewing the component programme are key considerations at the earliest point possible.
- review legal and environmental issues, such as the considerations of emissions, safety and recycling.
- ensure that logistics and product distribution have to be included in the initial investigations so that the distribution channels can be assessed.
- ensure that packaging and truck utilisation as well as delivery frequency and structure are investigated.
- agree on staffing and recruitment requirements, together with a communication strategy.
- identify the customer and the market requirements and based on that requirement make the strategic decisions.

The activities detailed above should be completed in full and then reported at the gate review to senior management. The control and successful completion of the front end of the project was seen as crucial in both the literature study (section 2.4) and the

benchmarking survey (section 3.9). The product planning phase model illustrated diagrammatically in figure 5.1 shows the requirement for identifying team members and a project leader. Ideally the team leader and team members should be appointed directly to the team and removed from their individual regular work.



5.2.1. Product design and development strategy phase of the GNPID model

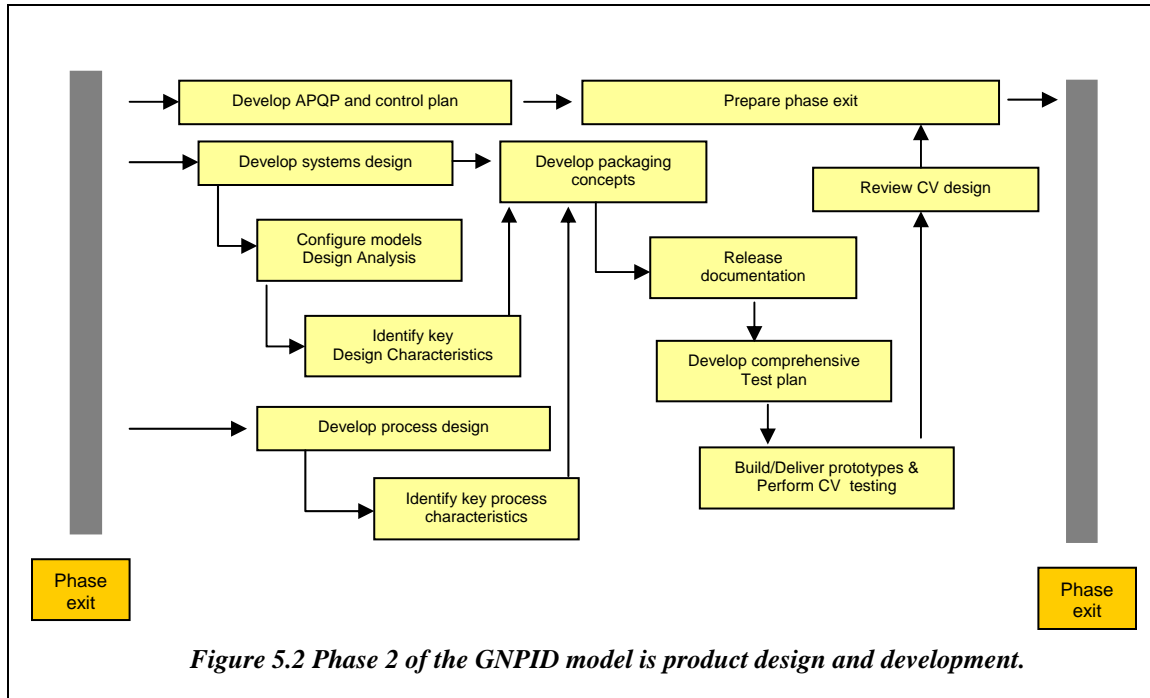
Table 5.2, illustrates the activities for the GNPID model during the design and development strategy phase. This phase must:

- have in place a formalised GNPID project team in all locations, meeting on a regular basis using a documented NPID procedure. This team needs to review and comprehend the project objectives and concur with the objectives presented to management at the previous gate review.
- understanding the customer's requirements and the development of the voice of the customer (VOC) into the project scope. Within the project team environment key suppliers should be seen as partners in the team.

- utilise Design for Assembly and Manufacture (DFM/A) techniques product and process concepts should be identified to reduce costs, production and processing time as well as improve Quality.
- ensure that the technology specification and concepts can also be finalised at this time.
- confirm that the team assemble a business plan and validate the hypothesis.
- ensure that the decision to source internally or externally should be analysed, in addition to quality targets, budget and financial plans. In this way the team is responsible for setting and then achieving their own success criteria, targets and goals.
- that ultimately a review of the project at this point should consider either proceeding to the reality phase, or termination as the indicators substantiate the project will eventually fail. The phase model is shown in 5.2, or as the complete model in 5.7.
- that if required this is the phase where proto typing either directly within their plant or indirectly, as part of a collocated team needs to be started.
- that concept validation should be reviewed and confirmed prior to the phase sign off or gateway.

| Concept | Activity |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Involve teams • Review strategy and project goals • Determine customer requirement • Identify product and process concepts • Identify and involve external suppliers • Evaluate alternatives products and processes • Finalise technology specification • Assemble a business plan | <ul style="list-style-type: none"> • Formalise NPID teams at all locations • Secure commitments to goals • QFD, VOC • Develop concept design, apply DFA • Asses potential suppliers • Develop manufacturing process, apply FMEA • Finalise product systems and concepts • Develop product and process design, validation • plan, manufacturing procurement plan, in/ out • classification, reliability and Quality plan. market |

Table 5.2 Concepts and activities involved during the product design and development phase



5.2.2. The process validation strategy phase of the GNPID model

Within the process validation strategy phase (as illustrated in table 5.3) the critical activities are:

- communication of the project approval to the project team, confirming the goals and objectives to be achieved.
- that the project manager monitoring the project costs reporting progress to senior management and implementing a product support plan confirming that marketing communication plan is secure.
- that the product design is completed using solid modelling geometry and creating a design to meet technical specification.
- that the design is analysed and a design FMEA (DFMEA) completed in addition to a Fault Tree Analysis (FTA).
- materials and assets for proto typing need to be procured.

- that the proto types is produced verifying and documenting the conformance to the original specifications.
- that the proto types production is audited validating the production process.
- ensure that once the proto typing is completed and assessed the procurement of actual production assets can commence, ordering parts for the initial trial build. Numerous suppliers during the benchmarking (chapter 3) emphasised the importance of fully utilising the proto type stage to ensure tooling and procurement does not start on an inconsistent or flawed design.
- that the first production trials should be used to verify production and the process. Initial trials should confirm process controls and subsequent builds to confirm capacity and capability.
- that the GNPID team should initially perform auditing of the production trials; management should audit later trial builds.
- that once the product has been completed as the “off tool off process” evaluation in the field, it is essential that the feedback from the customer be communicated back to the GNPID team.

Finally confirmation in the form of a recognised hand over from the GNPID team to manufacturing is mandatory, with a responsibility phase in phase out period to ensure the project management is maintained. Senior management sign off from development into production should be conducted prior to start of production (SOP) with enough time to complete final audit items before mass production. The longest, most intricate and difficult part of the GNPID process is the development phase illustrated diagrammatically in figure 5.3 and as part of the complete model in figure 5.7.

| Concept | Activity |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> ▪ Communicate approved project ▪ Complete product and process design | <ul style="list-style-type: none"> ▪ Provide detailed project management information ▪ Solid modelling to define geometry, create design to meet technical specification, analyse and validate design, conduct DFMEA and FTA |
| <ul style="list-style-type: none"> ▪ Manage cost and investment ▪ Implement product support and market plan ▪ Procure assets and proto type materials ▪ Build proto types ▪ Audit, update and evaluate prototypes ▪ Update product and process design ▪ Procure assets and materials for production ▪ Commence first production trials ▪ Audit and evaluate production trials ▪ Conduct field trials ▪ Confirm launch readiness | <ul style="list-style-type: none"> ▪ Monitor project cost to achieve financial plan ▪ Confirm marketing communication plan is secure ▪ Procure production intent assets ▪ Verify and document conformance ▪ Audit process, validate test information ▪ Update design to reflect proto type evaluation ▪ Order material for first trial builds, procure and install assets ▪ Build products, verify process are in control ▪ Conduct and document audit results ▪ Obtain external feedback, conduct fitting trials ▪ Implement phase in/out plan, confirm parts availability |

Table 5.3 Concepts and activities involved in the process design phase

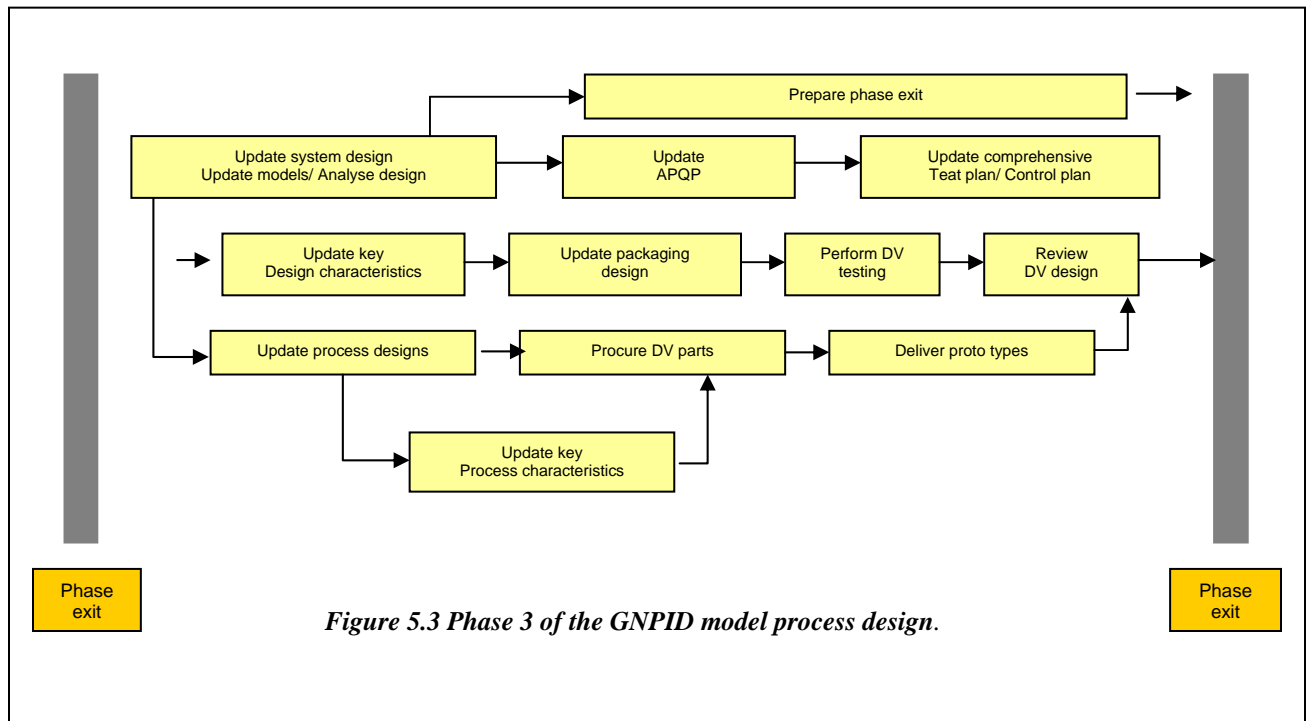


Figure 5.3 Phase 3 of the GNPID model process design.

5.2.3. Product and process validation phase of the GNPID model

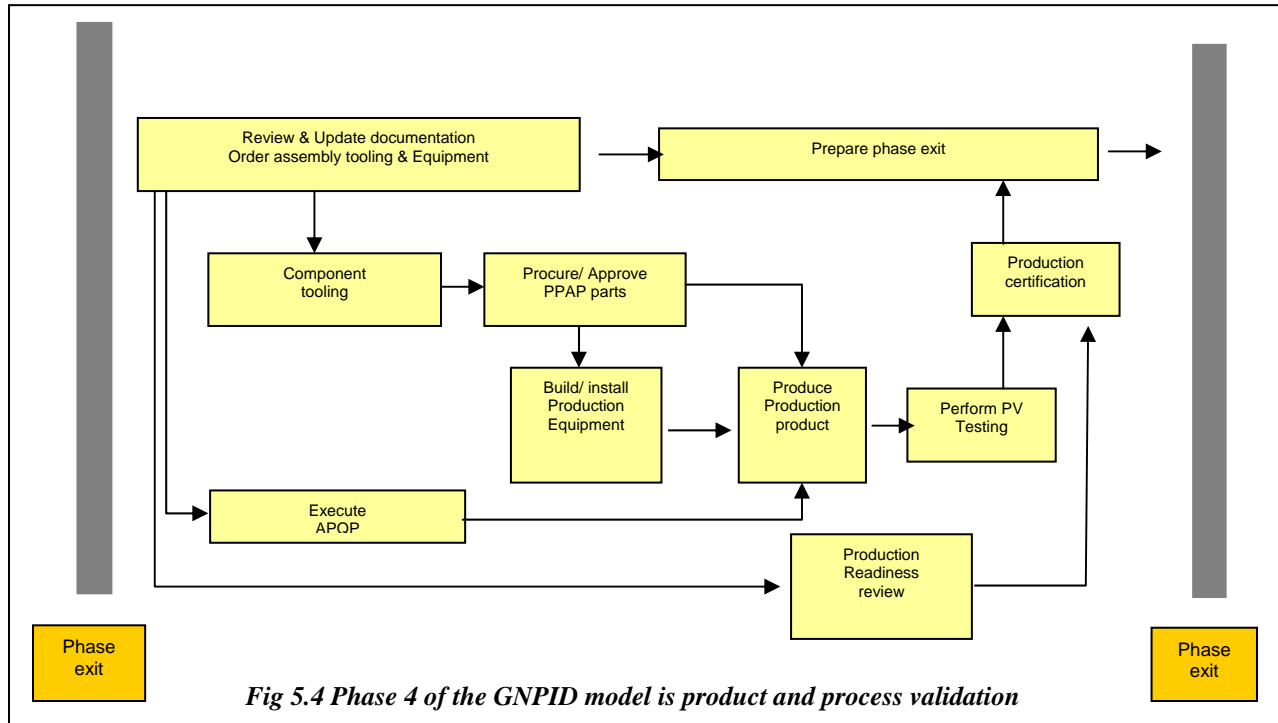
The ramp up in volume and achieving the production plan, as well as accomplishing delivery times, quantity and quality is the requirement for the mass production phase as table 5.4 indicates. The activities to be complete in this phase include:

- implementation of the delivery plan for production units to achieve the ramp up in volumes should be assessed, as should continuous feed back from the customer.
- internal and external feedback should be obtained and evaluated to confirm the project effectiveness against the original specified goals.

| Concept | Activity |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Ramp up production • Delivery plan • Maintain customer feedback • Obtain internal/ external feedback • Conduct product review | <ul style="list-style-type: none"> • Implement production achievement plan • Implement plan for delivery of production units • Gather information on customer feedback • Evaluate project effectiveness • Assess project against criteria established during project • Maintain a record of the project |

Table 5.4 The concepts and activities involved during the product and process validation phase

During this period of the project, the validation of the company’s production capabilities needs to be completed (refer to figure 5.4). The product specification and special characteristics requires confirmation, as correct to drawing and the initial sample inspection report (ISIR) testing completed. Production equipment is built and installed and pre production testing carried out.



5.2.4. Preparation for production of the GNPID model

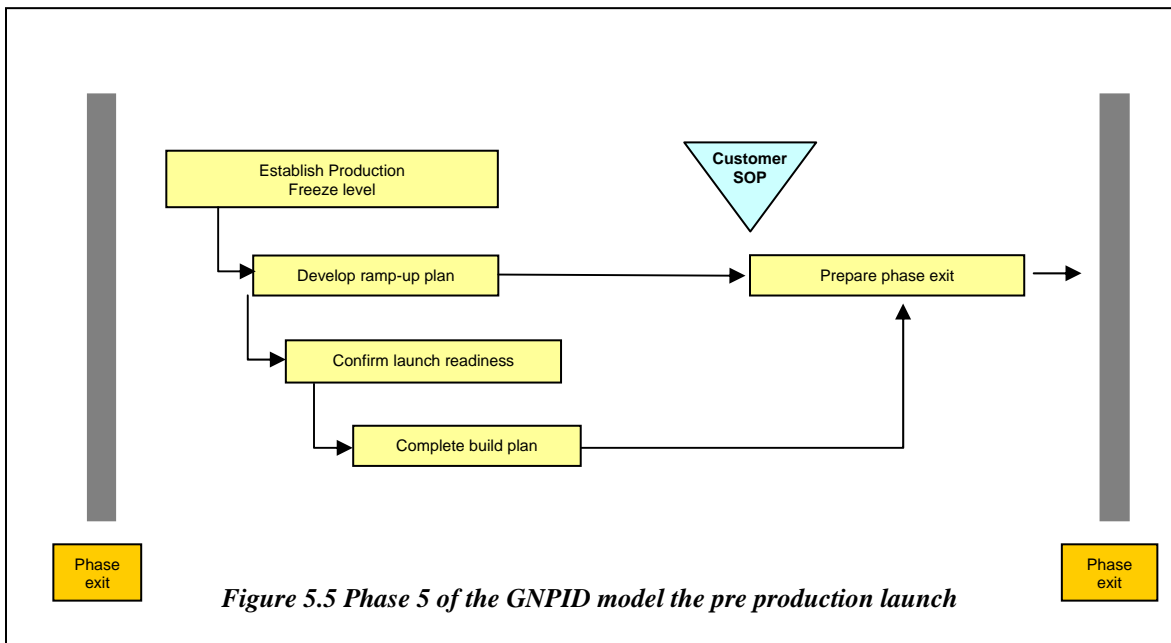
The production phase (refer to figure 5.5 and table 5.5) starts when:

- design review verifies that the product meets the specification following the field evaluation period.
- the verification of the programme goals has been performed, the new product is handled by the company functions, which are responsible for their respective areas of the product.
- assembly, testing and shipping of the first trial products are completed, the local GNPID team activities begin to enter a transition phase.
- product improvement, problem resolution and change requests can originate in the responsible areas such as customer services; manufacturing, design, package engineering or purchasing.

- the resolution of each change to the product as it was accepted during the NPID programme is handled through the completion by the manufacturing area effecting the change.

| Concept | Activity |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> •Verification of specifications •Verification of programme goals • Testing of final product •Improvement and problem resolution | <ul style="list-style-type: none"> •Field evaluation and trial •In house verification trials and brainstorming •Shipping, handling and packaging trials, production at takt trials •Problem resolution in all areas of the project |

Table 5.5 Pre- production concepts and activities during phase 5 of the model



5.2.5. Mass production stage of the GNPID model

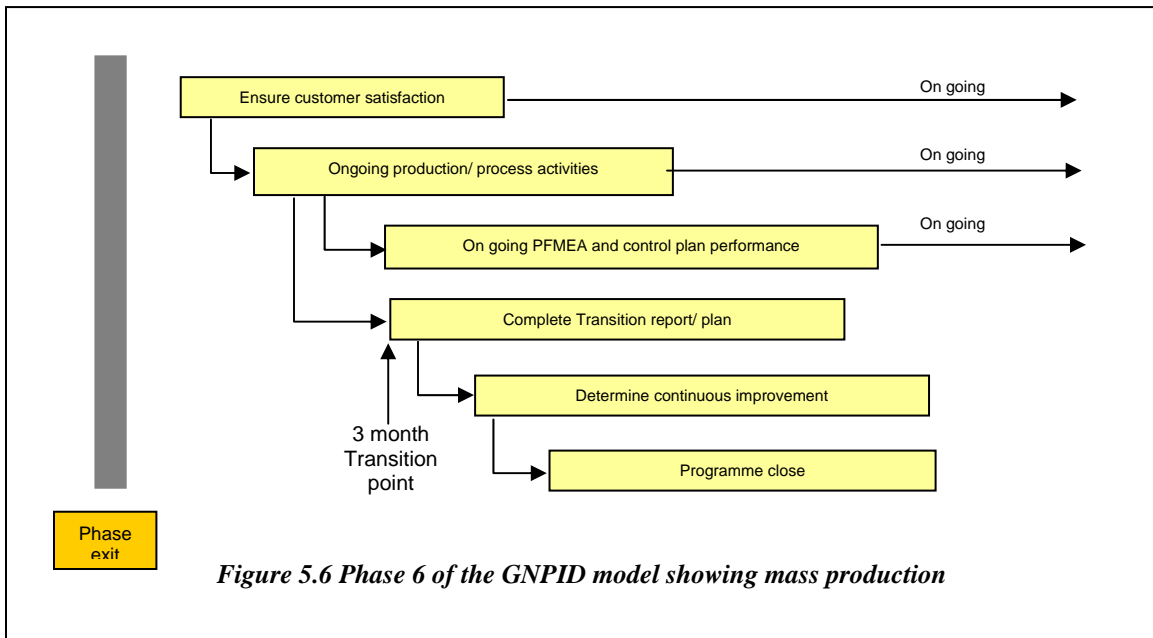
The concluding stage of the GNPID process (refer to figure 5.6 and table 5.6) is mass production, during this phase activities must include:

- to ensure productivity (profitability) and customer satisfaction (Quality) and continuous improvement (control plan and PFMEA) are all essential manufacturing requirements.
- achieve production of a final transition report to ensure knowledge is retained within the company.
- aim that a final programme close is a formal sign off from senior management signifying the project is now into mainstream or mass production.

A further check three months into mass production should be completed to ensure the product and process are behaving as planned and countermeasure to problems can be undertaken. This three month period could also have some very late design changes due to problems found in the final customers mass production process.

| Concept | Activity |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> •Ensure the VOC is complete •Knowledge retention •Formal gate Project to mass production | <ul style="list-style-type: none"> •Quality improvement activity, •Final transition report •Formal sign off of project. hand to line management |

Table 5.6 Mass production phase of the GNPID model



5.3. The application of cross functional teams during GNPID projects

The use of GNPID teams in the local plants is the logical extension of concurrent product development. GNPID teams need to be a multi-functional group charged with bringing a new product from concept through field operation. This requires various disciplines to be employed together, giving each team member a broader perspective of the entire GNPID process. The team approach should result in meeting customer requirements with higher quality outputs, shorter concept-to-market cycles and reduced and controlled development costs.

5.4. Performance measurements during GNPID projects

It is critical that new products meet customer expectations and business plan objectives. To ensure that each GNPID project meets its critical objectives, several measurements should be taken to provide visibility and to monitor the progress of various aspects of the project. These measurements should be addressed in four categories:

- Process Measurements.
- Program Measurements.
- Team Effectiveness Measurements.
- Individual Participation Assessments.

5.5. Communications and team effectiveness during GNPID projects

The effectiveness of the cross-functional teams is strongly influenced by their efficiency in conducting meetings and decision making. GNPID teams need to practice good meeting principles such as agreeing to and following agendas, attending meetings and starting on time, keeping to the schedule, recording and monitoring action items. The proficiency, with which team meetings are conducted, will be a precursor of the success of the team's new product introduction activity. Effective, documented communications within the group will also improve cross-functional communications among the GNPID team members.

5.6. Requirement for the GNPID documentation and procedural controls

The GNPID team should document all activities as specified in the ISO 9000 standards. In general, this entails documenting meetings, publishing engineering change requests (ECR), completing product release documents (PRD), and other items as detailed in the ISO documentation. This documentation is essential to provide for future product continuation and to support personnel changes.

5.7 Research concept for the development of a GNPID model

Using the information gained during the benchmarking visits and from a review of the current literature on the subject, a comparison of the GNPID processes has been developed. The majority of global companies are trying to develop a formal GNPID management process for all new product projects and this highlights the importance attached to the continuous improvement of this process, both in terms of time to market and quality of execution. A diagram outlining a model for the GNPID team to follow can be seen in appendix 3. It is not intended to be prescriptive and flexibility will be built into the process, and the ability to learn from previous projects and therefore to improve the process consequently it is a self optimising model.

The final detailed thirty-nine stages for GNPID made up from 34 activities and 5 gates, is shown graphically in appendix 4 and as a written procedure in appendix 5. The table shows the activities in chronological order starting with the project initialisation and ending with the confirmation of customer satisfaction. The six phases of GNPID are shown across the top of the table, product planning, product concept development, product design, production and process design, pre production and mass production. Between each of these phases are the reviews, zero NPID through to the fourth NPID finally on the right of the table remarks and activities have been shown. The thirty-nine stage model details the reasons and activities as well as the section or department responsible for documenting the outcome of that stage.

5.8. Summary of the proposal for the GNPID model

The importance of continuous improvement and revision to the GNPID process cannot be overstated. By bringing a continuous stream of superior and innovative new products to market a firm has an opportunity to sustain growth. This sustained growth will also depend upon a clear mission, supported by complimentary business and technology strategies that are also continuously revisited and revised.

The uses of stage and phase gate methodologies have been found to have a beneficial effect on the productivity and quality of execution of GNPID programmes for the companies studied (section 3.6.6). The experience gained through product development projects is built upon, concurrent engineering is encouraged and time to market reduced. Companies are likely to produce superior products with fewer defects through the use of structured life cycle management processes, since cross-functional teams enable early product definition, and limit downstream engineering changes. Product life cycle revenues are increased as products come to market earlier and a larger market share established.

Chapter 6. The thirty-nine step Global New Product Introduction and Development Model

6.1. Introduction and purpose

This Global New Product Introduction and Development (GNPIP) model for automotive suppliers is a structured method of defining the activities and has been designed based on the criteria built up from the literature survey (chapter 2) and the benchmarking exercise (chapter 3). This procedure applies to the introduction of new projects including new business and model changes, from planning through to the production stage. The format for the individual phases is shown in figure 6.0. The steps are defined and numbered; the responsible department is shown in parenthesis. The purpose and recording method are stated (as record) as well as the section responsible for maintaining and storing the records. Also identified are the phase gate reviews, timings and the expected meeting content. The full thirty-nine stage process can be seen as Appendix 5, the following sub section will give a brief appraisal of each stage together with roles and responsibilities.

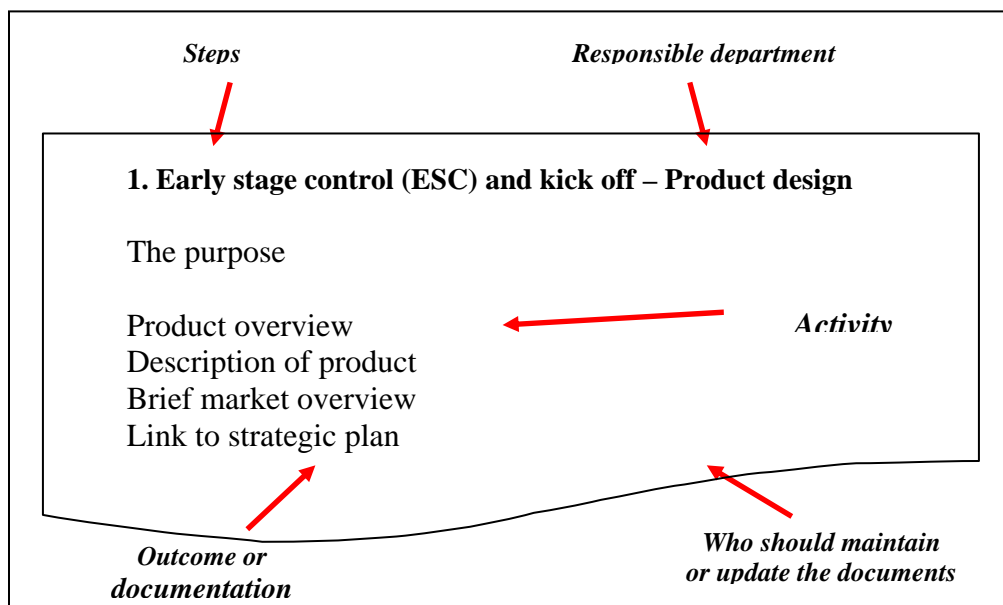


Figure 6.0 illustrates the layout of the thirty-nine step procedure (refer to appendix 5).

6.2. Outline of the thirty-nine step GNPID model

The following section will discuss briefly the individual stages of the thirty-nine step GNPID model as developed by the author for GNPID

1) Early stage control initiation and kick off

The kick off meeting is held to determine the activity level of all departments involved in the project and to develop the project overview linked to the company's strategic plan. During this phase market analysis would be completed and customer/ supplier consultation sessions would begin. The eventual project plan would be produced, and the relevant risks assessed and evaluated. The preliminary project team would be engaged as would the project manager.

2) Zero GNPID gate meeting

The purpose of this gate meeting at this very early stage of the project is to develop a general list of internal and external customer requirements for testing, the outcome would be the eventual test and specification plan.

3) Determine product specification

This activity determines the specification and requirements for the product, working with suppliers and customer to determine fitness for use and review prototype drawings for concerns and then finally distribute information as needed.

4) In or out sourced classification

This activity will determine what will be manufactured or assembled internally (in house) or externally by suppliers (out sourced). The activity should generate an approved supplier list for purchasing.

5) 1st GNPID gate meeting

All departments present their schedules, strategy and key points to meet the customer expectations in cost, quality and delivery. This gate review meeting should be held a month prior to “OK-to-Tool” drawing issuance.

6) Design change review meeting

The purpose of this activity is to keep up-to-date on implemented and pending design changes. The review involves prototype drawings and designs changes for concerns and then finally distributes information as needed.

7) Drawing review

This stage reviews the design drawings for potential failure modes and to determine suitable countermeasures. This should be completed with consideration to product safety and special focus should be on the differences and the change points from the current processes, as well as the potentials of mixing products.

8) Design FMEA

Feedback is given to the design office from value added value engineering (VA/VE) meeting or special requests.

9) Order dies or schedule die modification

The purpose of this activity is to ensure new dies are ordered or modifications are scheduled.

10) Order or schedule equipment modification

New equipment is ordered or modifications are scheduled in a timely fashion.

11) VA / VE meeting

Develop cost reduction ideas and clarify potential assembly problems. Samples and drawings should be displayed and discussed to develop cost reduction ideas, potential assembly problems, and solutions developed.

12) GNPID working group meetings

The purpose of this team is to clearly learn, understand, document and make plans to confirm, all changes and important points from design to manufacture.

13) Shipping quality assurance

This activity creates, documents, evaluates and improves in house and suppliers process reliability for GNPID projects.

14) Issue OK to tool drawings

The research and development office provides "OK-to-tool" drawings to any department on request.

15) Issue parts drawings

Provide drawings to be used for product build, jig designs, and layout. Product design issue drawing based on standard procedure print review.

16) Order jig or schedule modifications

The purpose of this activity is to ensure new jigs are ordered or modifications are and that engineering will have scheduled the design work internally or with outside suppliers as required.

17) Product and process quality systems review

The GNPID team reviews the quality manuals, systems and updates as needed.

18) Prepare or review and modify process flow

The GNPID team provide a basis to develop assembly method, assembly manuals, control charts, and FMEA's .

19) Prepare or review and modify process FMEA

Analysis of potential failures and determine required preventive actions.

20) Pre – launch control plan

Planning for the dimensional, measurements, material and performance test that will occur after prototype and before normal production.

21) Purchase raw material review

Order quantities and cost estimates for in-house materials.

22) Prepare or review package design

Packaging is used to protect the product and to meet in house and customer requirements.

23) Prepare quality test plan

The purpose of this activity is to ensure product meets customer's requirements in terms of fit for use, functionality and durability based on the quality specification developed by the Quality Assurance and reliability team.

24) Measurement system evaluation plan

Development of a plan to accomplish the required measurement system analysis.

25) 2nd GNPID gate meeting

Focus primarily on production and quality readiness both in your own process and at the supplier. The gate review should be held one month prior to off-tool and off-process trial.

26) Process control plan

Describe the systems to control parts and processes.

27) Machine trials

Ensure new or modified equipment will produce product that satisfies the customer's requirements.

28) Prepare or review receiving quality inspection standards

Ensure that products both received and shipped meet customer's demands.

29) Rough draft of production manuals

Departments like engineering should support development of manuals and working standards, the activity and the manuals should be employed during production trials. Manuals should be evaluated after trials for improvements ideas.

30) Measurement systems evaluation

The purpose of this activity is to subject the measurement system to analysis prior to or during the production trial run.

31) Product trials

Determine if a product can be assembled correctly and with confirmed quality. Operations will schedule training of staff and operators with sections like design, engineers and Quality assurance supporting.

32) Finalise manuals (operational and maintenance work instructions)

To ensure manuals and training of operators and engineers is complete and all records approved and complete.

33) Parts assembly evaluation

Evaluations to verify the parts meet customer Quality requirements based on the test plan and that an actual evaluations have been completed inside the plant and at suppliers and customers plants. Problems reported by the supplier Quality Assurance team (SQA) should be followed up and completed.

34) Capability studies

The purpose of this activity is to ensure that the products' critical characteristics will meet customer's and company's requirements, and that the minimum requirements are based on Statistical Process Control (SPC), manual or customer-specifications.

35) Customer trial shipments

Ensure shipments are made to the customer on time, at the expected level of design and are accompanied by the correct customer paperwork.

36) Quality parts evaluation

Confirmation of the customer's assembly methods, the products functionality as well as the ability to manufacture the products correctly. A static car check will evaluate the customer's assembly method and an engine running check will evaluate performance.

37) Mass production review

Clarification of the manufacturer's preparations in readiness for mass production. Review line audit details and key control points as well as pre-production problems and the status of manuals, documentation and training. The timing for this meeting is immediately after the final line assembly trials.

38) Management audit

Managers physically review the workplace for mass production readiness. Areas such as packaging, product, identification tags, key processes and work instructions would all need to be reviewed

39) 3rd GNPID Gate meeting

Ensuring product meets customer and in house requirements of quality and delivery.

Chapter 7. Discussion, conclusion and further work

7.1. Introduction

This report has discussed the research undertaken to develop a model for Global New Product Introduction and Development (GNPID) and has concentrated on the strategies and activities behind GNPID.

7.2. Discussion

Competitive pressures, cost challenges and increased customer expectations are driving companies to improve their New Product Introduction and Development (NPID) processes. The objective of this research was to investigate a cross-functional business-focused Global NPID process in a way that brings new products to market more effectively. While models like Stage-Gate, concurrent engineering and others are helping companies formalise and improve this critical process, they do not consider fully the global constraints for NPID projects as discussed in chapter 2 and 3. The missing element is a solution that enables all constituents to streamline the process, expose performance bottlenecks, drive consistent execution and continuous improvement and provide management visibility into the product development pipeline.

The proposed GNPID model employs a set of activities that if followed will simplify and expedite many business processes to streamline execution and repeatability while removing distance barriers. The next step will be to implement the model to ensure it is a configurable and reusable model and a process templates guide for GNPID teams and to include best practice and benchmark-based project plans, standard document templates, teams, roles and gate review deliverables.

7.3. Conclusion

- The automotive industry has gradually evolved and become a global enterprise, project teams are becoming increasingly more detached, maintaining communication channels is complex, monitoring team progress and achieving targets and goals as a distanced team is a reality that GNPID teams have to overcome.
- Numerous studies have shown that a standard GNPID model, working for all industries, organisational structures and companies does not currently exist. The available literature on the subject of NPID has not fully addressed the global aspects of GNPID and very little of the theoretical proposals have been supported by actual case studies.
- The difference between what is seen to be “best practice” in the literature survey and the actual reality of working in the automotive industry are very far apart. This may have been caused by the benchmarking partners not having been the best practitioners or because the current models have not changed to the current high-speed demands of the automotive industry.
- Compression of the development time is forcing a far more agile or reactive GNPID process from suppliers. Reduction of development time has been seen by many suppliers to be a direct causal factor of poor quality, late design changes and lower profit margins.
- Cost reduction activity continues throughout the project and on into mass production forcing design changes throughout the project. The GNPID system needs to be agile enough to react to late design changes should they be required, adaptable for change due to local traditions or customs but rigid enough to maintain the original project goals and objectives.

7.4. Suggested plan for further work

Suggestions for additional research and work as described within this report are,

- Continue to benchmark a wider supplier base and further original equipment manufacturers (OEM) to broaden the basic understanding of the problems and evolving issues.
- Validate the model in a project environment using an actual Global New Product Introduction and Development (GNPID) project.
- Continue to monitor and modify the model based on the problems encountered throughout the project.
- Extend the scope of the benchmarking to firms operating outside of the automotive field to compare the challenges and responses to non-automotive problems, as well as to evaluate the model within an overseas company.
- Test and evaluate the model and compare directly to project completed prior to the introduction of the GNPID model.
- Expansion of lean thinking into the GNPID and the value of creating knowledge based environment.

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Chapter 5

Ernst H (2002) “*Success factors of new product development: a review of the empirical literature*” International Journal of management Reviews, Volume 4, Issue 4, pp 1 – 40.

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Appendix 1 The postal Questionnaire

Name:

Company name:

Position:

Date:

Please answer as many of the questions as possible. Your company has a strong and well defined:

1) Control of the NPID product strategy and model and the use of dispersed multifunctional teams.

Strongly disagree Strongly agree

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

2) Parallel product planning and process management development in globally dispersed teams

Strongly disagree Strongly agree

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

3) Suppliers as partners in an extended supply chain particularly when introducing processes or new technology

Strongly disagree Strongly agree

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

4) Global project management, coordination and development lead-time, is in real time control of teams and maintaining team dynamic

Strongly disagree Strongly agree

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

5) Full integration of the abilities of both upstream (design) and downstream (manufacturing) processes.

Strongly disagree Strongly agree

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

6) Knowledge integration or sharing within teams.

Strongly disagree Strongly agree

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

7) Effective and efficient communication of projects and organisation structure for product development and introduction.

Strongly disagree Strongly agree

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

Strongly disagree Strongly agree

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

27) QFD, FMEA, PCP etc are living documents.

28) Your manufacturing capabilities, including systems and process would be considered world class.

| | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Strongly disagree | | | | | Strongly agree |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 1 | 2 | 3 | 4 | 5 | |

**Please return in the envelope provided to,
David Atkinson,
Denso Mfg,
Queensway Campus,
Hortonwood, Telford, TF4 2BZ.**

Would further benchmarking and a possible site visit be possible **YES / NO**

Appendix 2 The benchmarking questionnaire

| | | | | | | | | | | | | | | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---|---------------|---|---|---|---|------------------|--|---------|--|---------------|--|--|
| <p>New Product Introduction and Development</p> <h1 style="margin: 0;">NPID</h1> <p>Questionnaire</p> | <p>Ranking please answer all questions</p> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin: 10px 0;"> <table style="border-collapse: collapse;"> <tr> <td style="border: 1px solid black; padding: 2px 5px;">1</td> <td style="border: 1px solid black; padding: 2px 5px;">2</td> <td style="border: 1px solid black; padding: 2px 5px;">3</td> <td style="border: 1px solid black; padding: 2px 5px;">4</td> <td style="border: 1px solid black; padding: 2px 5px;">5</td> <td style="border: 1px solid black; padding: 2px 5px;">6</td> <td style="border: 1px solid black; padding: 2px 5px;">7</td> </tr> <tr> <td colspan="2" style="text-align: center; font-size: small;">Totally Disagree</td> <td colspan="2" style="text-align: center; font-size: small;">Neutral</td> <td colspan="3" style="text-align: center; font-size: small;">Totally Agree</td> </tr> </table> </div> | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Totally Disagree | | Neutral | | Totally Agree | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | | | | | | | |
| Totally Disagree | | Neutral | | Totally Agree | | | | | | | | | | | |
| <p>Name.....</p> <p>Company.....</p> <p>No of employees at your plant</p> <p>Your plant has facilities and is responsible for</p> <p><input type="checkbox"/> Design</p> <p><input type="checkbox"/> Development</p> <p><input type="checkbox"/> Proto typing</p> <p><input type="checkbox"/> Business planning</p> | <p>Date</p> <p>Position</p> <p>Head office location</p> <p><input type="checkbox"/> Manufacturing</p> <p><input type="checkbox"/> Warranty</p> <p><input type="checkbox"/> Purchasing</p> <p><input type="checkbox"/> Sales and aftermarket</p> | | | | | | | | | | | | | | |
| <p>Section one (Q 1-6) reviewing the NPID models used. How that NPID model is translated into the companies' organisation and methodology and how that methodology is documented and maintained.</p> | | | | | | | | | | | | | | | |

- 1) *The company has a clearly defined and documented new product introduction and development strategy.*

| | | | | | | |
|-----------------|---|---------|---|---------------|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally Disagre | | Neutral | | Totally Agree | | |
- 2) *There is a clearly defined framework that each project follows*

| | | | | | | |
|-----------------|---|---------|---|---------------|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally Disagre | | Neutral | | Totally Agree | | |
- 3) *There is a worldwide charter clearly specifying the objectives, responsibilities and expected contributions from each member.*

| | | | | | | |
|-----------------|---|---------|---|---------------|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally Disagre | | Neutral | | Totally Agree | | |
- 4) *The company uses a centralised approach to formulate a new product introduction as opposed to developing strategies at a local level.*

| | | | | | | |
|-----------------|---|---------|---|---------------|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally Disagre | | Neutral | | Totally Agree | | |
- 5) *An important strategy for the global new product introduction and development is to develop global products with minor adaptation for local conditions.*

| | | | | | | |
|-----------------|---|---------|---|---------------|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally Disagre | | Neutral | | Totally Agree | | |
- 6) *The APQP procedure sets out the following input demands that have to be completed before the planning of the development process can start. Does your company strategy cover*

 - a) *Voice of the Customer*

| | | | | | | |
|------------------|---|---------|---|---------------|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | Totally Agree | | |

b) *Market Research*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

c) *Historical Warranty and Quality Information*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

d) *Team Experience*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

e) *Business Plan/Marketing Strategy*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

f) *Product/Process Assumptions*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

g) *Product Reliability Studies*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

h) *Customer Inputs*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

Section two (Q7- 16) reviewing the companies strategy within the NPID model and the role of the management in projects, how GNPID is monitored, progressed, and how the projects are maintained.

7) *The project team are accountable for the end result, for ensuring the projects meet the company targets and objectives*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

8) *The company promotes truly global teams encouraging contributions from team members located in different countries*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

9) *The team leader or project manager are responsible for carrying the project team through from idea launch not just the later trial stages*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

10) *There is a global NPID process that successfully incorporates the customers input*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

11) *Global project teams are*

a) *Multi-disciplinary*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

b) *Have cross functional co-operation*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

c) *Encouraged to communicate through all forms of available technology rather than face-to-face meetings.*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

d) *Encourage where ever possible to meet with distanced team members*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

12) *There is a defined strategy regarding suppliers that*

a) *Encourages suppliers involvement in the design and development*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

b) *Regards suppliers as part of the working group team*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

c) *There is an open and frank working partnership with key suppliers*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

13) *Your company's global new product introduction and development process defines, specific activities and follows a standardised process.*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

14) *The project manager has clearly defined go/no go decision points that are regularly reviewed.*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

15) *The project manager is totally involved in the initial stages of the project through until the start of production.*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

16) *The project managers role is*

a) *Merely that of a co-ordinator with no real authority*

1 2 3 4 5 6 7
Totally disagree Neutral Totally Agree

b) *The main interface with the customer*

c) *Planning, organisation, directing and controlling the company resources*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

Section three (Q17- 31) reviewing the employment of the NPID activities including the IT support and the knowledge management, how GNPID is monitored and progressed.

17) *Collocating people and programmes are achieved within the company by networking.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

18) *The virtual collocation is maintained by allowing all user access to programmes, people, and data across the network.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

19) *Integrating tools and services with frameworks is a means of allowing designers to use different tools with ease.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

20) *Project management tools, CAE tools, and Analysing tools are regularly used as standard in GNPID projects*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

21) *The GNPID strategy includes*

a) *Reducing the internal variety to the point where products can be built flexibly without the cost and time delays of set up changes.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

b) *Standardising on parts, features, materials, and processes in the design stage.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

22) *The global new product and development process depends on*

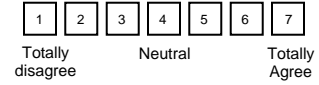
a) *Developing versatile product family architecture that optimises versatile modularity,*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

b) *Utilization of standard modules and parts,*

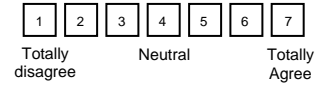
| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

c) *Maximum use of off-the-shelf hardware, design by suppliers, and easy-to-modify parametric CAD templates*

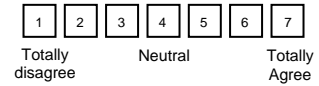


23) *These activities are seen as a key tool within the NPID strategy*

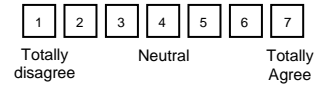
a) *Quality Function Deployment*



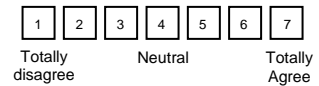
b) *Design for manufacture or assembly*



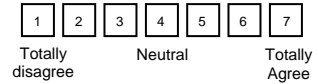
c) *Design for dimensional control*



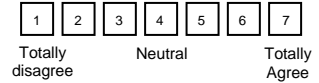
d) *FMEA*



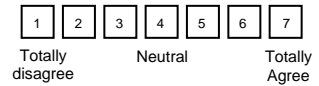
e) *VA/VE*



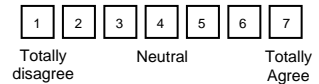
f) *Knowledge Based Engineering (KBE)*



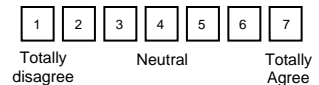
g) *Finite Element Analysis (FEA)*



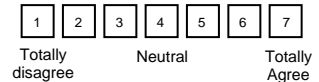
h) *Computer Aided Product Planning (CAPP)*



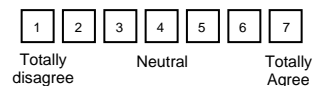
i) *Rapid prototyping (RP)*



j) *Concurrent Engineering (CE)*



24) *External information such as market, customer, competitors which is usually created and accessed by staff.*



25) *There is an single product database which is the source of data for several disciplines*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

26) *Computer based tools like CAD are widely used by everyone.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

27) *Capturing projects history is a means of keeping track of design decisions and the reasons for them.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

28) *There is a central database or an electronic design notebook, or some other means of recording project decisions.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

29) *Strategic information, which is critical to competitiveness and is generally stored in people's heads and taken with them when they leave.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

30) *New products are introduced and developed using processes that are explicitly documented.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

31) *There is an active strategy strongly emphasising knowledge sharing.*

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

Section four (Q 32 – 48) reviewing the communications, internally and externally, with reference to the customer and supplier interface in GNPID projects, as well as communication and controls.

32) *Every GNPID team meetings*

a) *Run strictly to a preset agenda*

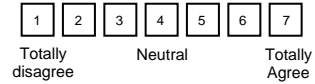
| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

b) *Is well documented as per ISO 9000 standards, the minutes circulated, or recorded in a central data base*

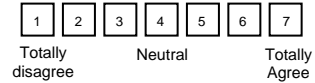
| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

33) *There are regular scheduled meetings*

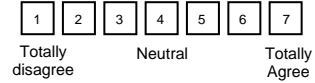
a) *Using video conferencing*



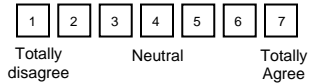
b) *Face to face with members in other locations*



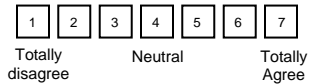
c) *With the shop floor and manufacturing operators*



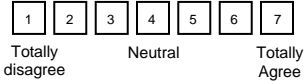
d) *Pro-actively with the customer as part of the team,
and not as a reaction to problems that have
occurred*



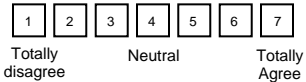
e) *With suppliers as members of the working group.*



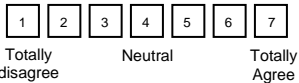
34) *The main form of communication between the distanced
team members is by E- mail.*



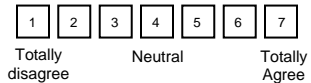
35) *Cross continent communication is not seen as a major
concern within the project.*



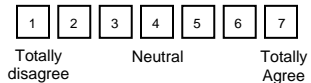
36) *There are clearly defined reviews for senior management
at regular periods throughout a project.*



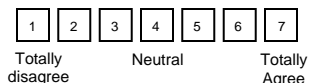
37) *Senior management support for the project is consistent
throughout all phases of the project.*



38) *The NPI Team is accountable for the entire development
program.*



39) *The team creates the necessary environment and
structures to successfully carry out the product*



development program consistent with the company's product and business strategy.

40) Team members are empowered to represent their functional areas, bringing their individual perspectives to the team, while co-ordinating activities such that there are no surprises to either the team or the functional area.

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

41) The customer is fully integrated into the GNPID process and is considered a member of the team.

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

42) There is strategy of co-creating with customers to

a) To develop an understanding of the customers needs.

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

b) To explore the potential for new opportunities.

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

c) To investigate cost reduction opportunities.

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

d) To use the customers knowledge as a source of innovation.

| | | | | | | |
|------------------|---|---------|---|---|---------------|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Totally disagree | | Neutral | | | Totally Agree | |

43) The three main obstacles to you NPID

- a)
- b)
- c)

44) In your opinion who has the best NPID process and why

.....
.....
.....

45) *How much knowledge is transferred and shared between remote teams*

.....
.....
.....

46) *How was most of the communications handled between the remote teams?*

.....
.....
.....

47) *How do you manage security within the remote teams?*

.....
.....
.....

48) *What are the main cultural differences and problems during GNPID projects?*

.....
.....
.....

Thank you for taking the time to fill in this questionnaire, please return the completed form to

David Atkinson
Denso Manufacturing
Queensway campus
Hortonwood
Telford
Shropshire
TF1 2BU
d.atkinson@denso.mfg.co.uk
Tel: 01952 655355

Appendix 5 The 39 step global New product Introduction and Development Model

1) Planning phase - (Product design)

The purpose is to determine the activity level of all departments involved in the project.

- ❑ Product Overview
- ❑ Description of products
- ❑ Brief market overview
- ❑ Link to strategic plan
- ❑ Market Analysis
- ❑ Market size, growth and applications
- ❑ Competitive analysis
- ❑ Product positioning and differentiation
- ❑ Features and benefits summary
- ❑ Target Specifications
- ❑ Appearance and user interface
- ❑ Performance and environmental specifications
- ❑ Compliance to standards and regulatory agencies
- ❑ Product development plan
- ❑ Project schedule and preliminary project team
- ❑ Product cost and price margins and targets
- ❑ Service and documentation requirements
- ❑ Quality plan

Records: ESC designation form (Product design)

2) 0 GNPID Gate Meeting - (GNPID team/ project manager)

Prepare the Quality specifications and plan - (Quality assurance)

The purpose is to develop a general list of internal and external customer requirements.

- Prepare a general list of test items

Records: Test plan (Quality Assurance)

3) Determine product specification – (Design)

The purpose is to determine the specification and requirements for the product, working with suppliers and customer to determine fitness for use.

- Prepare a specification list

Records: Product specification (Design)

4) In or out sourced classification – (Purchasing)

The purpose is to determine the internal (in house) or external (out sourced) components.

- Review what parts or dies should be obtained from local sources
- Determine for what trials approvals are required
- Determine the date of drawing issuance to meet all targets
- Review timing and trails for local parts
- Distribute source list for approval signatures

Timing: One month prior to 1st GNPID meeting

Records: Approved supplier list (Purchasing)

5) 1st GNPID Gate Meeting - (Project manager)

The purpose is to present to all departments the schedule, strategy and key points to meet the customer expectations in cost, quality and delivery.

Sales dept

- ❑ Vehicle outline
- ❑ Ordered products
- ❑ Mass production volume and cost reduction target
- ❑ Changing point from previous meetings
- ❑ Define customer survey schedule

Product design

- ❑ Product outline
- ❑ Design failure mode effect analysis (DFMEA) summary
- ❑ Component strategy
- ❑ Drawing issuance sheet

Project manager

- ❑ Present the critical path, trial schedule and production quantities
- ❑ General status of project (drawings, dies, jigs, machines etc)
- ❑ Milestone or phase gate meeting schedule
- ❑ Packaging strategy of final assemblies and components

Purchasing

- ❑ Present plans for brand new supplier components and processes

Manufacturing

- ❑ New design influences which affect the assembly or process
- ❑ Rough line layout and equipment schedule
- ❑ Key process changes and impacts
- ❑ Required die and quantity
- ❑ Unique die characteristics or structure
- ❑ Rough die schedule
- ❑ In or out strategy

Quality Assurance.

- ❑ Test plan (for all assemblies)
- ❑ New equipment needs and plans (as appropriate)
- ❑ Review any customer-specific requirements (testing, etc.)
- ❑ Supplier (parts) Quality Assurance (SQA) plan
- ❑ Project plan (in house and supplier)
- ❑ Staffing and space impacts (as appropriate)

Production control

- ❑ Packaging strategy

Timing: 1 Month prior to “OK-to-Tool” drawing issuance

Records: Meeting minutes (Project manager)

6) Design change review meeting - (Product design)

The purpose is to keep up-to-date on implemented and pending design changes.

- ❑ Review prototype drawings and design changes for concerns
- ❑ Distribute information as needed
- ❑ Distribute information needed to plan localisation

Records: Engineering Change Instruction (ECI) (Product design)

7) Design review - (GNPID)

The purpose is to review design for potential failure modes and determine countermeasures.

This is done with consideration to product safety. Special focus should be on differences and changed points as well as the potentials of mixing products.

8) Design FMEA's (Product design)

Feedback given to design office from value added value engineering (VA/VE) meeting or special requests

Records: Copy of VA/VE and DFMEA (Engineering)

9) Order dies or schedule die modification - (Engineering)

The purpose is to ensure new dies are ordered or modifications are scheduled.

- ❑ Order or schedule modification for part dies for in-house and outside
- ❑ Order or schedule modification for stamping dies for in-house stamping
- ❑ Dies include, moulding dies, stamping dies, etc. (Ensure part-mixing mistake-proofs are addressed and incorporated as necessary)

Records: Die prints (Engineering)

10) Order or schedule equipment modification - (Engineering)

The purpose is to ensure new equipment is ordered or modifications are scheduled.

- ❑ Order or schedule modification for equipment needed for manufacturing and assembly
- ❑ Kick-off meeting
- ❑ Review floor plan for acceptability of inspection points, space requirements for proper flow, storage areas, lighting and utility needs
- ❑ Schedule modifications or additions if necessary

Records: Equipment requisitions and floor plan with revisions as appropriate.

11) VA / VE Meeting - (Engineering)

The purpose is to develop cost reduction ideas and clarify potential assembly problems.

- ❑ Samples and drawings are shown and discussed to develop cost reduction ideas
- ❑ Potential and actual assembly problems are discussed and potential solutions developed
- ❑ Part mixing potentials are addressed, recommended and decided upon
- ❑ VA/VE meetings will be repeated as necessary after trials and drawing issuances
- ❑ Records: Meeting minutes (Engineering)

12) GNPID working group meetings – (GNPID team/ project manager)

The purpose is to clearly learn, understand, document and make plans to confirm, all changed and important points from design to manufacturing perspective.

- ❑ Parts tracking
- ❑ Quality Control (QC) designation drawing and design review
- ❑ Quality audit material (as available) is reviewed
- ❑ Control plans
- ❑ Supplier Quality assurance (SQA) sheets
- ❑ Confirmation and control activities
- ❑ Confirmation of meeting GNPID milestone

Records: Meeting minutes (Project manager)

13) Shipping Quality assurance/ POA Sheets (Parts Quality assurance)

The purpose is to document, evaluate and improve in house and suppliers process reliability for GNPID projects.

- Share final status by senior management.
- Supplier Quality Assurance (SQA) team is responsible.

Timing is to be able to share information by the working group meeting.

Records: SQA sheets and Part Quality Assurance (PQA) Sheets

14) Issue OK to tool drawings - (Engineering)

The purpose is to provide "OK-to-tool" drawings to any department on request

- "OK-to-tool" drawings are issued to each requesting department
- "OK-to-tool" drawings used for advance ordering of tools, jigs, equipment etc

Records: Part prints (Engineering)

15) Issue parts drawings - (Engineering)

The purpose is to provide drawings to be used for product builds, jig designs, layout, etc.

- Product design will issue drawing based on their standard procedure
- Operations groups, production engineering, purchasing and QA are responsible for reviewing prints

Records: Part prints (Engineering)

16) Order jig or schedule modifications (Engineering)

The purpose is to ensure new jigs are ordered or modifications are scheduled.

- Engineering will do design work or suppliers as needed
- Poka yoke (fool proofing) explanation

Records: Jig prints (Engineering)

17) Product and process Quality systems review - (Quality Assurance)

The purpose is to review the Quality manual, systems and update as needed.

Records: Revisions to Quality manual and Quality systems are documented

18) Prepare or review and modify process flow - (GNPID team/ project manager)

The purpose is to provide a basis to develop assembly method, assembly manuals, control charts, FMEA's etc.

- Order of parts processing
- Order of parts assembly
- Line balance
- Mould settings for trials

Records: Process flow charts (Engineering)

19) Prepare for review and modify process FMEA - (Engineering)

The purpose is to analyse possible failures and determine required preventive actions.

- ❑ Consideration to product safety.
- ❑ Cross-functional team analysis
- ❑ Past problems, FMEA's and history analysed

Records: PFMEA's (Engineering)

20) Pre – launch control plan - (Engineering)

The purpose is to describe the dimensional, measurements, material and performance test that will occur after prototype and before normal production.

- ❑ Pre-launch control plans are developed based on the APQP manual
- ❑ Preliminary process capability requirements are determined

Records: Pre-Launch control plans (Engineering)

21) Product raw material data -(Purchasing)

The purpose is to provide order quantities and cost estimates for in-house materials.

- ❑ Product Design provide part number and names on source sheets
- ❑ Purchasing will pull part number information from source sheets and issue to engineering
- ❑ Engineering complete weights and specific material dimensions
- ❑ Business Planning verifies input to the computer and develops cost

Records: Part lists and prints (Engineering), tracking sheets (Production Control),

22) Prepare or review package design - (Production Control)

The purpose is to ensure packaging is available that will protect the product and meet in house and customer needs

- ❑ Package engineering receives input from customers, suppliers, QA, purchasing, operations groups, and material distribution
- ❑ Packaging will be tested per customer and management requirements
- ❑ Customer, supplier and senior management approval

Records: Packaging specifications (Production control)

23) Prepare Quality test plan - (Quality Assurance)

The purpose is to ensure product will meet the customer's needs for fit, function and durability

- ❑ Based on the Quality specification developed by QA (include QC designation drawing requirements)

Supported by QA, design, Sales dept

Records: Test Plans (Quality Assurance and reliability)

24) Measurement system evaluation plan- (Quality Assurance)

The purpose is to develop a plan to accomplish the required measurement system analysis.

- ❑ Measurement Quality manual

Records: Measurement system evaluation plans (Quality Assurance)

25) 2nd GNPID Gate Meeting - (GNPID)

The purpose is similar to 1st GNPID meeting, but more focus on production and Quality readiness both in house and at the supplier.

Sales dept:

- ❑ Vehicle outline
- ❑ Ordered products
- ❑ Mass-volume and cost reduction target
- ❑ Change points from previous meeting
- ❑ Review sales' open items form problem study log

Product design:

- ❑ Product outline
- ❑ Change points from previous meeting
- ❑ Review significant issues from customer vehicle trials
- ❑ ECI and VA/VE status
- ❑ Review open items from problem study log

Production control (P.C.):

- ❑ Review 1st GNPID Mtg. minutes (follow up on open issues)
- ❑ Update general status of project and define discussion points
- ❑ Update critical path
- ❑ Confirm Vehicle Parts Trials (VPT) requirements and date,
- ❑ Packaging status
- ❑ Assembly and components to customer;
- ❑ Components to manufacturing
- ❑ Review PC open items from working group minutes

Purchasing:

- ❑ Review schedule and plan against actual
- ❑ Itemise problem areas and countermeasures
- ❑ Review new or unique processes to suppliers
- ❑ Review purchasing open items from working group minutes

Engineering

- ❑ Review design influences that affect the assembly or process
- ❑ Detailed layout equipment schedule (with poka yoke status)
- ❑ Key process changes with assembly technique
- ❑ Problem study sheet status (open issue summary)
- ❑ Process capability results (preliminary capability of processes)
- ❑ Process control plans (PCP) and PFMEA results
- ❑ Required die and quantities
- ❑ Explain unique die characteristics, structure or process, with preliminary capability of process die schedule and status,
- ❑ In or out plan
- ❑ ECI influence
- ❑ Review engineering's open items from the GNPID group minutes

Quality assurance (Q.A.):

- ❑ Project Plan status (In house and supplier)
- ❑ Test Plan Review (test results or concerns)
- ❑ SQA status
- ❑ Review supplier part approval plan and status
- ❑ Customer audit schedule for in house and supplier's
- ❑ Share vehicle evaluation results and update
- ❑ Receiving and shipping inspection
- ❑ Parts mixing and miss assembly results
- ❑ Review any QA open items from the working group minutes

Operations:

- ❑ Present status of GNPID schedule (timeline)
- ❑ Staffing impacts
- ❑ Status of special activities to support key or unique processes (to include strategy for special focus on work instruction development and training provided on key difference and changed points, new poka yoke, etc.)
- ❑ Trial results and concerns
- ❑ Training status for operators, confirm need for training trials

- ❑ Review production's open items from the working group minutes
- ❑ Finalise total number of samples needed

Timing: 1 Month prior to off-tool and off-process trial

Records: Meeting minutes (Project manager)

26) Process control plan (Engineering)

The purpose is to describe the systems for controlling parts and processes.

- ❑ Process control plans are developed based on the Quality manual

Records: Control Plans (Engineering)

27) Machine trials - (Engineering)

The purpose is to ensure new or modified equipment will produce product that will satisfy the customer's requirements.

- ❑ Test out new machines for running capability (poke yoke reliability)
- ❑ Test conducted by production engineering and manufacturing

Records: Results of machine trials (Engineering)

28) Prepare or review receiving inspection standards (Quality)

The purpose is to ensure product received and shipped meets the customer's demands.

- Obtain critical information from purchasing, design, QA, engineering
- Receiving inspection standards

Records: QA inspection standards and manuals

29) Rough draft of production manuals - (GNPID team/ project manager)

The purpose is to develop manuals to use during trial productions.

Engineering will provide support

- Manuals will be evaluated after trials for improvements

Records: Manuals (GNPID)

30) Measurement systems evaluation - (QA)

The purpose is to subject the measurement system to analysis prior to or during the production trial run.

- Measurement system manual

Records: Master file for measurements

31) Product trials- (Operations and GNPID team/ project manager GNPID)

The purpose is to determine if a product can be assembled and produce QA test samples.

- ❑ Ops groups will schedule training of staff and operators
- ❑ Design, engineers and Quality assurance will support
- ❑ Document process problems and corrective actions
- ❑ Purchasing may require support depending on circumstance

Records: Problem study sheet (Engineering)

32) Finalise manuals and training - (Operations / Maintenance/ GNPID team)

The purpose is to ensure manuals and training is complete.

- ❑ Manuals must be approved
- ❑ Training must be documented
- ❑ Engineering will provide support

Records: Training records, manuals (Operations groups/GNPID)

33) Evaluate parts (Suppliers QA)

The purpose is to verify the parts meet customer requirements based on the Quality test plan.

- ❑ Actual evaluations will be done in the plant, at the suppliers etc
- ❑ Problems will be reported by SQA and they will be responsible for following up on corrective actions

Records: Test reports and layout data (SQA)

34) Capability studies - (Engineering)

The purpose is to ensure that the products' critical characteristics will meet customers and the company's requirements.

- ❑ Fundamental SPC manual or customer specified methods would be used
- ❑ Minimum requirements are based on Statistical Process Control (SPC), manual or customer-specified requirements
- ❑ Suppliers must follow in house manuals and purchase order requirements

Records: Capability studies (Engineering)

35) Customer trial shipments - (Production Control)

The purpose is to ensure trial shipments are made to the customer on time, at proper design change level and with proper customer paperwork/tags.

- ❑ Receive order from sales (PC)
- ❑ Assign shipping date (PC)
- ❑ Issue special shipping notice (PC)
- ❑ Schedule production (PC)
- ❑ Issue customer's Quality paperwork to material distribution (QA)
- ❑ Issue customer's shipping paperwork to material distribution (PC)
- ❑ Stage parts (PC)
- ❑ Apply tags and paperwork (PC)
- ❑ Review parts, tags and paperwork (QA)
- ❑ Ship product (warehouse)

Records: Shipping trial records

36) Quality parts evaluation (QA / sales)

The purpose is to confirm customer fit, function and ability to assemble products.

- ❑ QA and sales coordinate activities
- ❑ GNPID, design, engineering, operations group optional in attendance
- ❑ Customers assembly will be evaluated
- ❑ Static Car check will be performed
- ❑ Engine running check will be performed
- ❑ Customer use points will be confirmed as possible
- ❑ Car evaluations will be with all level of parts if allowed by customer

Records: Car evaluation results (Quality Assurance)

37) Mass production review - (GNPID team/ project manager)

The purpose is to clarify manufacturing's preparations for mass production.

- ❑ Review line audit details
- ❑ Review of key control points
- ❑ Review of pre-production problems
- ❑ Review status of manuals, documentation and training

Timing this meeting is conducted immediately after the final line assembly trials

Records: Meeting Minutes (GNPID)

38) Management audit (GNPID team/ project manager)

The purpose is for managers and above to physically review the workplace for mass production readiness.

- Packaging, product, identification tags, key processes and work instructions should all be reviewed

Conducted in conjunction with, and is part of review and approval for 2nd QA

39) 3rd GNPID gate meeting (GNPID team/ project manager)

The purpose is to ensure product meets customer and in house requirements of Quality and delivery

Product design:

- Product outline
- Changing point from previous meeting
- Review significant issue from customer vehicle trial
- Engineering change instruction (ECI) and VA / VE status

Production Control (P.C.):

- Packaging result and readiness, final assemblies and components to customer and manufacturing
- Review warehouse and shipping
- Warehouse staging status (close to similar product and part numbers)
- Product handling status
- Shipping schedule and first shipment date
- Weekly ramp-up chart until full production

Operations group/ engineering:

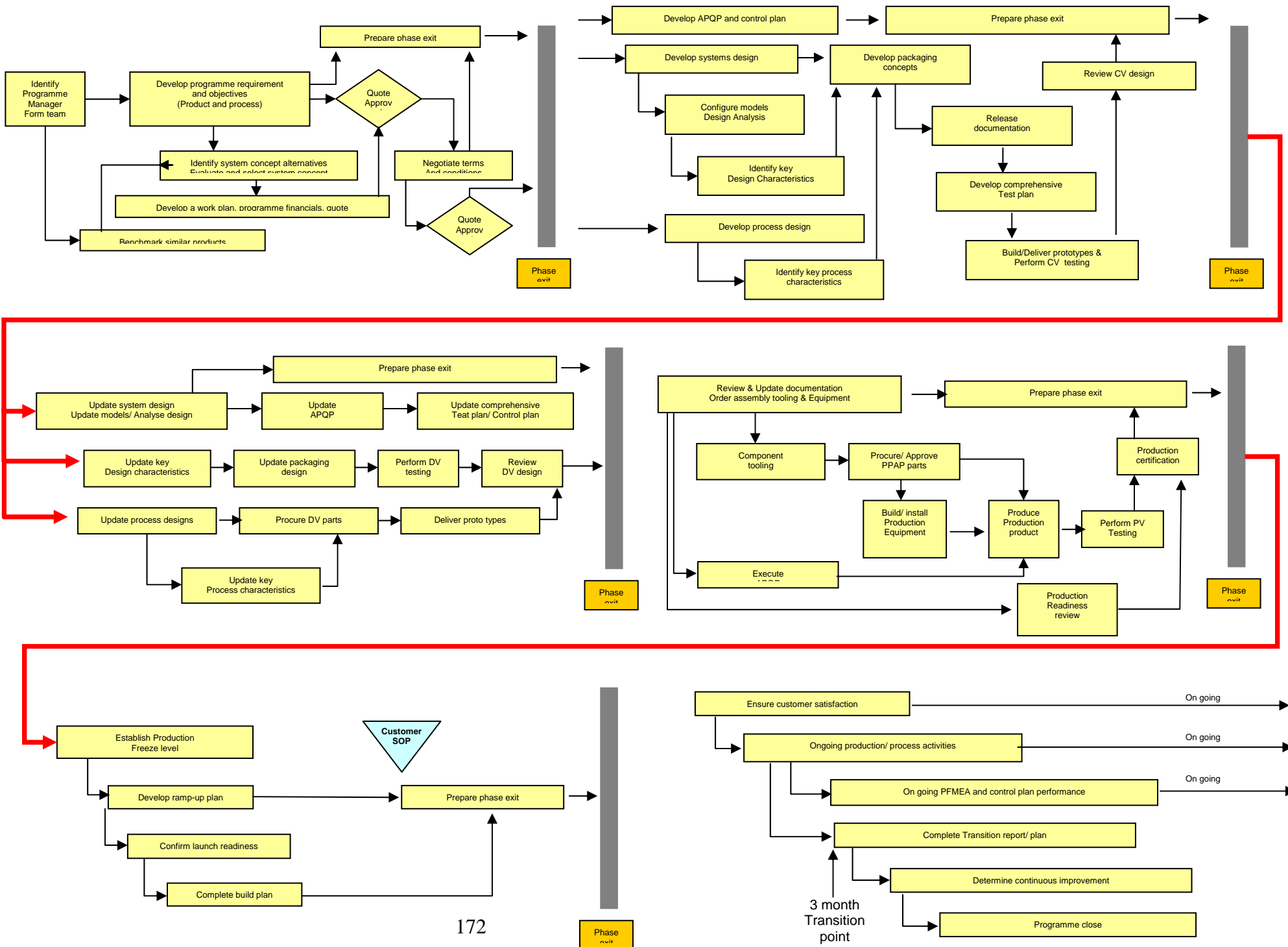
- ❑ Review design influence results that affected the assembly or process
- ❑ Detailed (final) line layout and equipment schedule (including 'poka yoke' results)
- ❑ Key process changes with assembly technique results
- ❑ Run @ rate results (as applicable)
- ❑ Problem follow up sheet status (open issue summary)
- ❑ Outstanding items from management line audit
- ❑ Present timeline against schedule for GNPID
- ❑ Present trial results (Quality and seconds per piece against target),
- ❑ Training against plan and staffing status
- ❑ Results of special activities to support key processes
- ❑ Explain key issues and countermeasures
- ❑ Present summary from manager process review
- ❑ Present production's readiness
- ❑ Present performance and Quality targets
- ❑ Process capability sheet review, with control methods explained
- ❑ Explain unique die characteristics or structure and final results
- ❑ Final process capability with process control method explained

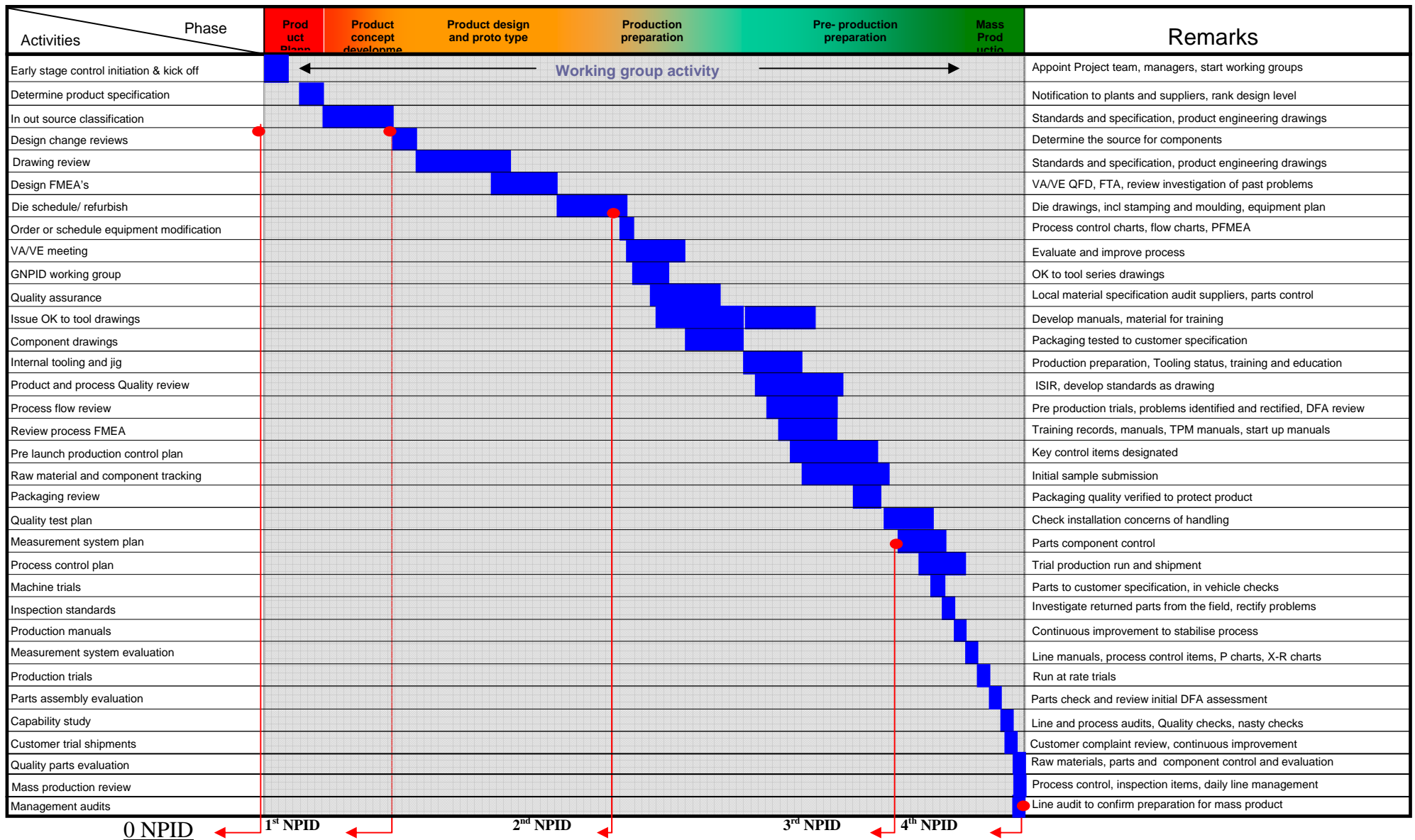
QA

- ❑ Test results and open issue summary
- ❑ Supplier part approval results
- ❑ Vehicle evaluation summary
- ❑ Supplier Quality Assurance (SQA) summary
- ❑ Customer satisfaction assessment
- ❑ Receiving and shipping inspection project and activities summary
- ❑ Shipping approval will be requested
- ❑

Timing: 4 week prior to SOP

Records: Meeting minutes (Quality assurance), signed approval must be given by managing director.





Appendix 4 The 39 step process, 34 activities and 5 gates that make up the GNPID model

