

CRANFIELD UNIVERSITY

MR ANDREW PALMER



THE CONCEPT OF RIGHT FIRST TIME (RFT) DESIGN

**SCHOOL OF
INDUSTRIAL AND MANUFACTURING SCIENCE**

PhD THESIS

CRANFIELD UNIVERSITY

**SCHOOL OF
INDUSTRIAL AND MANUFACTURING SCIENCE**

PhD THESIS

MR ANDREW PALMER

THE CONCEPT OF RIGHT FIRST TIME (RTF) DESIGN

Supervisor: Professor Stephen Evans

March 2004

This thesis is submitted in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

© Cranfield University 2001. All rights reserved. No part of this publication may be reproduced
without the permission of the copyright holder

Cranfield University

Abstract

THE CONCEPT OF RIGHT FIRST
TIME (RFT) DESIGN

by Mr Andrew Palmer

Supervisor: Professor Steven Evans

Customer demands and intense competition have resulted in the need for shorter development lead times. The problems with shorter lead times have been well documented. Mistakes are costly and the need for a sustainable and efficient new product development process has become paramount to a successful product.

Vehicle Manufacturers (VM's) have had their choice of a variety of tools and philosophies to assist in reducing lead times. Amongst others, the use of Quality Functional Deployment (QFD), CAD/CAE, cross-functional teams and simultaneous engineering have each been mooted as being the panacea for efficient design and development.

The author argues the need for a Right First Time (RFT) design policy and states that this can be delivered through the "Hoshin Kanri" method of policy deployment. The resultant strategies are achieved through the tactical use of the most appropriate tools, integrated into the new development process.

Performance is measured against agreed target in a Case Company (Nissan) and the strategy is tested for Strengths and Weaknesses. The result is achievement of an 80% reduction in Design Change compared with previous programs. The approach is explained in the Thesis, as are the Quantitative and Qualitative results, which are finally analysed using an adapted T-Matrix.

In conclusion, the author uses the experience to draw 14 Rules for undertaking Right First Time Design and "proves" them in two alternative companies to ensure that the principles are robust.

TABLE OF CONTENTS

Chapter 1: An Introduction to a Right First Time Approach to Passenger Vehicle Development Process	1
Chapter 2: Literature Review.....	10
Chapter 3: The Research Methodology.....	40
Chapter 4: The Concept of Right First Time Design (RFT Design)	45
Chapter 5: A Novel Application Of Hoshin Kanri Combining Historical Analysis of Design Change Causal Factors and Associated Costs.....	68
Chapter 6: The Results at Start of Production.....	110
Chapter 7: Qualitative Findings	138
Chapter 8: Conclusions from the Research in the Case Company and Applicability to Other Companies.....	155
Chapter 9: Overall Conclusions.....	184
References	191
Appendix 1: Glossary of Terms	
Appendix 2: 32 nd ISATA Proceedings	
Appendix 3: Almera (HS) Sales Brochure	
Appendix 4: An Example of a “Design Guide”	
Appendix 5: Verbatim Interviews with Nissan Managers	
Appendix 6: Nissan in the UK – A Brief History	
Appendix 7: Nissan Press Releases	
Appendix 8: Nissan Definition of HS Platform	
Appendix 9: HS Supplier Explanation Presentation	
Appendix 10: Extracts from a Typical Planning Drawing Analysis	
Appendix 11: Output from Recent Intranet Based “Engineers Handbook”	
Appendix 12: IQPC Presentation Material Extract	
Appendix 13: FASTD Explanation Table & Relationship Diagram	
Appendix 14: Financial Times – World Automotive Manufacturing Article	
Appendix 15: Collaborative Automotive Design and Product Development	
Appendix 16: July 2002 Automotive News Europe – Latest Lead-times	
Appendix 17: NMUK TQ Story	

ACKNOWLEDGMENTS

The author wishes to take this opportunity to thank the following people, without whom this Thesis could not have been possible.

Firstly to Nissan and NTCE in particular, for giving me unprecedented access to data and facts about their development process. Special words of mention to Mr Ken Foxley and Mr Saotome, who guided me at the most difficult times.

To John Temple, who supported me throughout the project with wise words of advice. To John Austin, who validated the project results from a Qualitative point of view. To Prof Steve Evans, for patiently guiding me through the academic rigours of the project.

Finally, my deepest thanks go to my future wife Hitomi, my three Children, Zoë, Zara and Zack and my Parents, for their moral and practical support during the write up.

I thank you all

Andy Palmer

March 2004.

CHAPTER 1

An Introduction to a Right First Time Approach to Passenger Car Development

The author introduces the concept of Right First Time Design (referred to throughout the project as RFT Design) in the context of Passenger Vehicle development and against its history. The explanations aim to explain to the reader why faster Product Development Lead-Times are desirable and why RFT Design might help. In this context, the Author sets out the Research Objectives and the way in which the Thesis will be structured in-order to deliver these objectives.

1.1 Context

Passenger car design is a mature process. It has changed very little in principle, since the early days of Henry Ford, Alfred Sloan, etc, where the iterative principles of "Design", "Build", "Test", "Refine", were utilised.

As the Millennium begins, the automotive industry faces significant difficulties, which impact upon the design processes of cars. Severe competition caused by over-capacity (circa 20%), linked with increasing regulatory and environmental pressures are all catalysts to change. Vehicle Manufacturers (VM's) have responded by making their vehicles more attractive through increased body types, specification improvements, utilisation of enabling technologies such as electronics and price-down actions. Inevitably, these actions have consequential effects on the "bottom-line" performance of all Vehicle Manufacturers (See Figure 1.1 below).

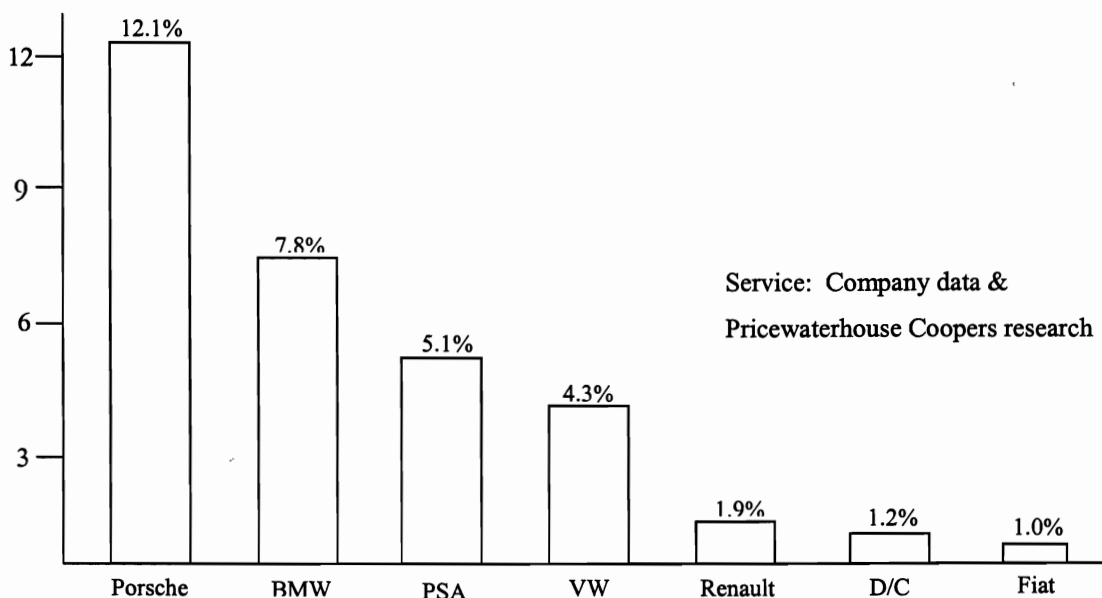


Figure 1.1- 2001 Earnings Before Tax & Interest, As % of Revenue [Ref: 1.1]

CHAPTER 1

For the Design Engineer, these external pressures force a paradigm shift in the way cars are developed. This challenges the typical 'fifty-month' development lead-times and forces a skills shift from 'Scientist' to 'Business Engineer'. Most corporations have responded to cost-down pressures by increasing their economies of scale. At a macro level, Mergers and Acquisitions have resulted, (although not always successfully in terms of profitability) allowing individual marques to commonise 'platforms' with other marques and share parts from their 'corporate parts bins' e.g. VW Golf IV shares its platform and many parts with Audi A3, Seat Toledo, Skoda Octavia, VW Beetle, VW Bora & Audi TT. This strategy allows Platforms and Parts to enjoy the economics of huge volumes whilst (arguably) allowing each marque to have its own visual personality. As a result, volume manufacturers are able to appeal to niches and satisfy/create new fashions e.g. Renault Scenic small MPV, Ford Ka [Ref 1.2, Cothier, G. INSEAD 1999].

Marketeers in most Vehicle Manufacturers, unable to fully predict competitor 'push' and consumer 'pull' trends [Ref 1.4, Weinstein, D. INSEAD 2004], demand ever-shorter vehicle development lead-times, whilst the corporation requires lower development costs.

Engineers have responded with a plethora of initiatives ranging from team based simultaneous engineering organisations to the utilisation of CAD/CAE (Computer Aided Design, Computer Aided Engineering) technologies. Whilst most Vehicle Manufacturers have embraced these tactics, few have reconsidered the total overview and challenged the "Design", "Build", "Test", iterative paradigm on a strategic level.

This project proposes a strategic approach to improving the new vehicle development process, utilising new and existing technologies and processes in a structured manner, to achieve sustainable shortened development schedules. This strategic approach is called Right First Time Design (RFT) and utilises TQM (Total Quality Management) as its guiding principle to reduce development expenses by 40%. The first two Research Objectives were therefore set as follows:-

- i) To Test the hypothesis that a Policy of Right First Time Design will increase Product Development Efficiency.
- ii) That this could lead to a 40% reduction in development expense, combined with a 30% reduction in development lead-time (and incidentally a 30% reduction in manufactured cost)

CHAPTER 1

Through a policy of RFT Design, defined as "Zero design changes after the initial production release", (but later re-defined as an 80% reduction in design change), strategies and tactics are deployed in a novel Hoshin Kanri approach. Each tactic is evolved from a strategy, which in turn is connected to the basic RFT policy. Therefore the third Research Objective is defined as:-

- iii) That Front Loading development can result in an 80% reduction in design change and that the tactics to allow this to be achieved can be derived through Historical Analysis of previous projects and deployed through a modified Hoshin Kanri

All are measurable against the "number of design changes avoided" unit of currency and thus a calculated reduction in development cost. This defines the fourth Research Objective as:-

- iv) To establish the cost of design change

The approach is tested through implementation in a real vehicle programme and comparison to two recent similar programmes. The value of each unit is determined by a detailed analysis of design change causal factors on a number of previous programs in both Japan and predominantly Europe. The theories are tested on a new vehicle development program (HS-Almera – See Appendix 3) at Nissan's European Technology Centre, Cranfield, UK. Therefore, the fifth Research is defined as:-

- v) To validate the authors hypothesis through a real project, using Action Learning Research principles and actually measure the results in a Qualitative and Quantitative manner

The deployed strategies/tactics and their subsequent strengths/weaknesses are discussed and analysed at milestones throughout the process and ultimately against a target of 80% reduction in post production release design change at the end of the program. A novel application of the [Ref 1.3 Prof. Kano Noriaku, University of Tokyo, 1998] 'T' Matrix is then utilised to derive areas of improvement. These include efficient dissemination of the 'customers voice' into the engineering target setting process and the application of leading edge CAE technologies such as CAPE, Virtual Reality, etc.

CHAPTER 1

In conclusion, the successful generic building blocks to a RFT approach to Vehicle Product Development are defined in a 14 step process, which is “tested” at a macro level in two alternative companies in different sectors of Engineering. This therefore defines the last Research Objective as:-

- vi) To establish rules for the dissemination of RFT Design Principles and “Test” them in alternative industries.

Thus in summary the 6 Research Objectives are as follows:-

1.2 Research Objectives

- 1) To Test the hypothesis that a Policy of Right First Time Design will increase Product Development Efficiency.
- 2) That this could lead to a 40% reduction in development expense, combined with a 30% reduction in development lead-time (and incidentally a 30% reduction in manufactured cost).
- 3) That Front Loading development can result in an 80% reduction in design change and that the tactics to allow this to be achieved can be derived through Historical Analysis of previous projects and deployed through a modified Hoshin Kanri.
- 4) To establish the cost of design change.
- 5) To validate the authors hypothesis through a real project, using Action Learning Research principles and actually measure the results in a Qualitative and Quantitative manner.
- 6) To establish rules for the dissemination of RFT Design Principles and “Test” them in alternative industries.

CHAPTER 1

1.3 Thesis Structure

These Objectives are delivered and described in each of the following Chapter and are summarised below:-

1. An Introduction to a Right First Time Approach to Passenger Car Development and Determination of Research Objectives

The author introduces the concept of Right First Time Design (Referred to throughout the project as RFT Design) in the context of Passenger Vehicle development and against its history. The explanations aim to explain to the reader why faster Product Development Lead-Times are desirable and why RFT Design might help. In this context, the Author sets out the Research Objectives and the way in which the Thesis will be structured in-order to deliver these objectives.

2. Literature Review: The Competitive Need for Speed

From the outset, it is necessary to understand the standing literature with respect to Product Engineering lead-time reduction and the tactics that might or have been reviewed in the past.

Much literature exists and one can easily find agreement to the principle that doing the engineering design “right first time” is a good thing. However, little literature exists explaining how to make engineering designs “Right First Time”.

The available literature is reviewed and discussed and was pivotal to setting the direction for the project and evaluating risks in areas of novelty. The literature review is also pulled up to date, thus putting into context lead-times in 1996 (reference for this Thesis) and those of 2002.

3. The Research Methodology

The research methodology used in this Thesis is principally “Action Based”. Chapter 3 describes why this is relevant in this case and the theory and research which validates its use.

CHAPTER 1

4. The concept of right first time (RFT Design)

The intention of this chapter is to discuss the concept of Right First Time Design & Development against a background of historical & contemporary references. From that discussion and a business requirement to reduce R&D expenditure on any given vehicle development program, a definition is asserted, arguing that a reduction in Design change, by 80% post production Design release, will result in a 40% reduction in development cost within the Case Company.

5. A Novel Application Of Hoshin Kanri Combining Historical Analysis of Design Change Causal Factors and Associated Costs.

A Japanese technique for “Policy Deployment” is adapted to be applicable as the key tools of the “Change Agent”. The use of this tool, combined with the 11 step maturation process derived by the Nissan “Total Quality Story”, seeks to remove tactical development risks, mitigating “the leap of faith” often seen as a barrier to up-front investment in the development process. This chapter explains the Hoshin Kanri, its strategy, its tactics and the expected outcome of deployment.

The Hoshin Kanri defines the means of deployment of strategies & tactics to achieve the aims of Chapter 5. Later on, the Chapter provides the historical data by which forecasts are made within the Hoshin Kanri. This Chapter defines the source of factual data and ultimately the expected output / success (failure) of the tactics deployed through the Hoshin Kanri.

There is clearly a cost associated with changing a Design. The direct cost of obvious – the “Cash-out” of the company to pay the supplier or toolmaker to undertake the necessary modification. However, there is also an indirect cost within the company. The cost of employees spending time designing, introducing and adapting the change. The cost of one design change within Nissan is defined as [Ref 8.1 Financial Times World Automotive Manufacturing 1999] £ 13,000. Costs in other companies vary, but the principle remains the same. The latter part of this chapter explains how the figure of £ 13,000 was calculated and why it is important in the implementation of a RFT Design.

CHAPTER 1

6. The Results at the Start of Production

The Initiative to reduce Design Change by 80% was wrapped up in a Program called FASTD. FASTD became the central focus of NTCE for a period 1996 to 1999 and figured highly in the annual corporate objectives. It represented the focal point for winning the D+D contract for the HS vehicle and seeing the commitments achieved.

Almost all Technical Staffs of NTCE were involved in some way, either through tactical development or in the post analysis and countermeasure phase of the project. All those staff directly involved were awarded with a FastD “badge of Honour”.

FASTD (an acronym for Fast Development and “Find Away to Streamline Development”) was also designed as a Knowledge Management initiative. From Figure 5.6, one can see a list of Designer Guides. These represent the capture of the processes developed through the Hoshin Kanri and validated through this project. They are indexed to the Generic Master Schedule of a 31 Month vehicle development schedule. They represent the core knowledge of Nissan in achieving a 31 Month vehicle development with less than 200 design changes. This information is highly sensitive and can only be referred to in this thesis.

The Designer Guides were contained in an Engineers Handbook – the concept was one of a Filafax, containing the Engineers Diary. The thinking being that Engineers will use their Diary daily, but a Central Procedures Manual would simply “gather dust”.

In 2003, the Engineers Handbook has been succeeded by an Intranet based Knowledge Management System, but nevertheless, linked to the Engineers Microsoft Scheduler and other Corporate Standards.

The Design Guides are still published, because the activities planned through this research were successful and achieved their aims, both in terms of an 80% reduction in Design Change, but also in terms of a 40% reduction in Development budget. As can be seen in the following Chapter, some of the Secondary measures did not achieve their targets, but were compensated by over-achievements in other areas. This chapter explains and elaborates on the practical results from the implementation of RFT Design.

CHAPTER 1

7. Qualitative Findings

The research until now has relied heavily in analytical analysis, using statistics from previous history and quantitative records from the project. From the quantitative point of view, the targets were achieved, but it is also interesting to look from the qualitative perspective to discover how the people performing the project view the successes and to see whether the quantitative data is truly a reflection of success.

This analysis has been undertaken by a review with the Managers in the organisation and using a technique adapted by the author from Kano's T Matrix. In this instance, the author asked the Managers what they perceived as issues through the HS project and to analyse their issues on the T Matrix. Because the author had heavily influenced the direction of the project, a consultant (Mr John Austin) was used (under the management of the author) to conduct the interviews and whiteboard analysis – parts of his report are re-printed here with his kind permission.

Transcripts of extracts from the Interviews are contained in the Appendix 5. To the author's best knowledge, the use of the adapted T Matrix for post project analysis is quite unique, but it is certainly useful in communicating results and has now been used to disseminate the project outcomes in several public forums to validate novelty.

8. Conclusions from the Research in the Case Company and Applicability to Other Companies

The purpose of this Chapter is to consider the Quantitative and Qualitative results from the Case Project with a particular emphasis of areas for improvement by critical analysis. The author will then put forward 14 Rules for Right First Time Design and Development, which could arguably be applied to any Product Development project.

In support of this hypothesis, the 14 Rules will be tested in two alternative organisations and significant engineering reputation, outside of the Automotive Industry.

The first company (ABC Co Ltd), is a global developer of Electro-Mechanical devices, deployed on the high streets around the world and required by their nature to be highly reliable and durable.

CHAPTER 1

The second company (XYZ Co Ltd), is a famous Engineering company employed in the development and manufacture of aero-engines. By their nature, these aero-engine components, must be highly reliable and durable, but also competitive.

9. Overall Conclusions

This is the concluding Chapter of this Thesis and aims to sum up the overall context of the research and its achievements. The author also aims to provide an insight into the up to date situation in design change reduction. The Chapter ends with the prediction that Right First Time practitioners will eventually reduce vehicle development lead-times down from the HS case of 31 Months to (an un-believable) 6 Months. Time reduction and the management of its implementation can become a huge competitive advantage for those that can do it.

CHAPTER 2

Literature Review: The Competitive Need for Speed

From the outset, it is necessary to understand the standing literature with respect to Product Engineering lead-time reduction and the tactics that might or have been reviewed in the past.

Much literature exists and one can easily find agreement to the principle that doing the engineering design “right first time” is a good thing. However, little literature exists explaining how to make engineering designs “Right First Time”.

The available literature is reviewed and discussed and was pivotal to setting the direction for the project and evaluating risks in areas of novelty. The literature review is also pulled up to date, thus putting into context lead-times in 1996 (reference for this Thesis) and those of 2002.

CHAPTER 2

2.0 Introduction

The purpose of this literature review is to generate a study of previously published work and to provide a frame of reference for the analysis of *Right First Time*. By way of an introduction, the first section outlines the competitive environment of the motor industry. It presents a setting in which the later analysis of strategic change and time-based competition can be put into context.

2.1 The Motor Industry

'The Automobile industry...the industry of industries.'

[Ref 2.1 Peter Drucker, 1989]

Since Ford's introduction of the assembly line, car making has become one of the world's most important businesses. It employs upwards of 20 million people [Ref 2.2 Dicken 1998] and exerts a strong influence on the operations of other industries.

'The auto industry is even more important to us than it appears. Twice in this century it has changed our most fundamental ideas of how we make things. And how we make things dictates not only how we work but what we buy, how we think, and the way we live'

[Ref 2.3 Womack et al, 1990].

Car making is a truly global business with only 10 companies accounting for over 70% of the world's production. Their operations are spread far and wide with production facilities in over 30 countries [Ref 2.2 Dicken 1998].

Despite the industry's importance, the late 1990's have been a troubled period for the world's auto-makers. Hyper-competition has led to an over capacity in excess of 20% (See Figure 3.1), with forecasted sales sliding 11% between 2000 and 2002 [Ref 2.4 Economist, 2001].

CHAPTER 2

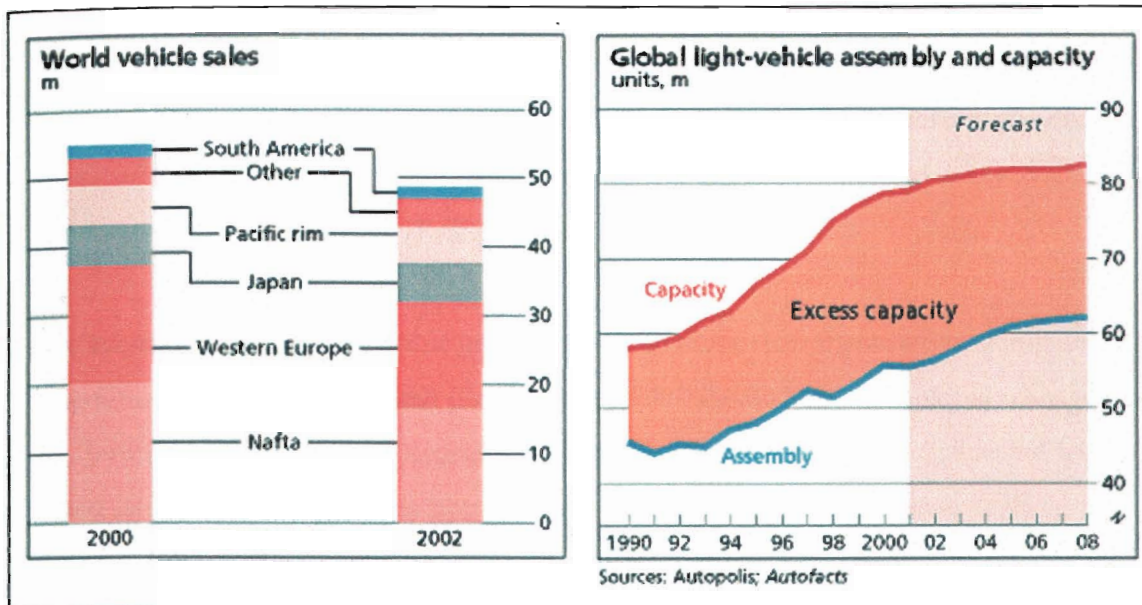


Figure 2.1 - Motor Industry Sales and Capacity (Source: Economist, 2001)

This increasingly competitive market place led the 1999 *Financial Times Auto Survey* [Ref 2.5, FT Auto Survey, 1999] to propose that in order to assure survival, car producers must fundamentally rethink their strategies for design, manufacture and marketing. This not only precipitated a series of mergers and acquisitions (including Renault-Nissan and Daimler-Chrysler), but also changes in the methods of new product development.

'Companies must be looking at new strategies and acquisitions – that will drive out costs and keep pace with the price cuts'
[Ref 2.6 Blair-Smith in Financial Times 1999].

It was in this economic environment that NTCE (Nissan Technical Centre Europe) was seeking to reduce its development costs with its *Right First Time (RFT)* philosophy.

CHAPTER 2

2.2 Organisational Strategic Change

'What is impossible to do today, but if it could be done, would fundamentally change the organisation for the better?'

[Ref 2.7 Gavin Staude, 2001].

To achieve sustainable profitable growth, it is imperative that organisations compete for the future. Hamel and Prahalad [Ref 2.8 Hamel & Prahalad 1994] implored managers to be forward looking, to look beyond current products and processes to determine ways of successfully competing for the future. Vandermuwe [Ref 2.9 Vandermuwe 1995] considered how organisations are affected in times of difficulty and how they initiate a strategic change like RFT. She proposed a transformation model that presents a dynamic picture of strategic change (See Fig 2.2).

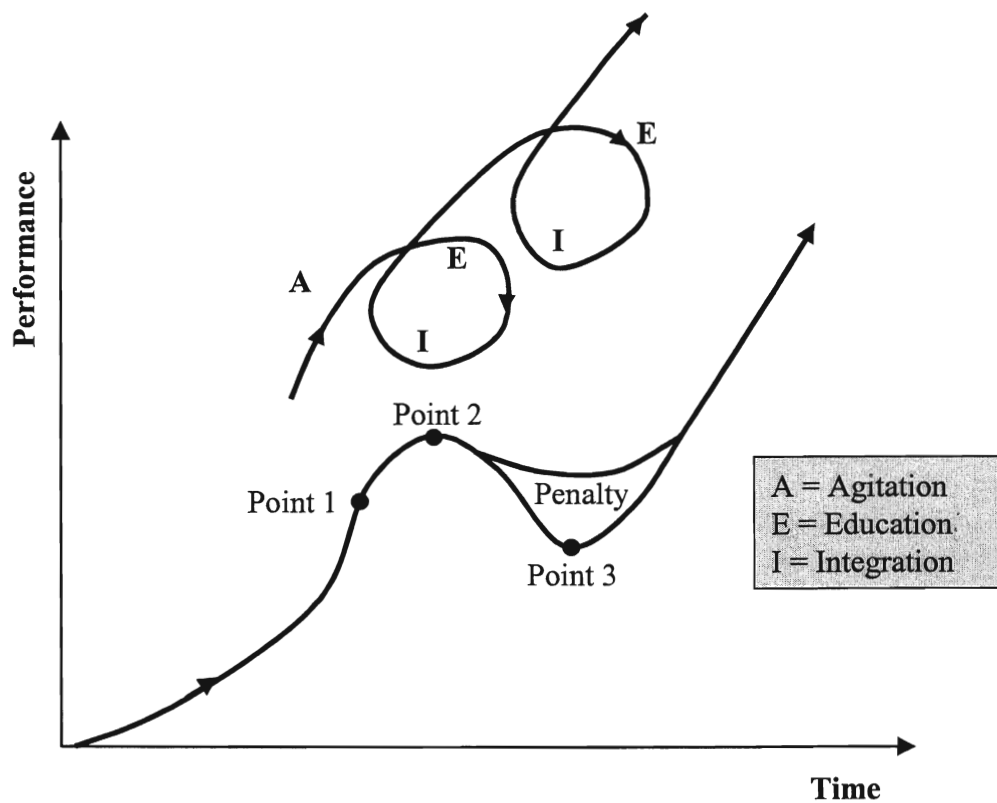


Figure 2.2 – Sigmoid Curve with Transformation Points (Vandermuwe 1995)

CHAPTER 2

Vandermerwe argued that organisational transformation should begin at point 1 to avoid a performance penalty. But she noted that it was not until point 2, where performance had levelled off, or point 3 where decline had started, that change became easy. This is arguably the condition that most of the auto industry found themselves in during the late 1990s. To promote change and reduce the penalty of lost performance she argues for *agitation* or strategic discomfort, *education* to decide how to change and *integration* to embed a day-to-day behaviour change. This is echoed by Thompson [Ref 2.10 Thompson 1997] who argues for '*creative tension*' to promote adaptive strategic change.

A vital part of the transformation process is to understand how and what to change for assured long-term profitable growth. The obsession of the 1980s and 90s were Porter's theories [Ref 2.11 Porter, Michael E, 1985] of competitive advantage, where companies tried to beat their rivals by benchmarking, differentiating and reducing costs. The car industry was a victim of this competitive trap, creating a converging series of products through incremental cost and quality improvements.

Hamel & Prahalad (1994) described management strategies as either *denominator* or *numerator management* depending on their influence on the return on investment (ROI) calculation. Denominator infers down sizing or efficiency improvements and parallels the activities of the 1990s motor industry.

'Under intense pressure for a quick ROI improvement, executives reach for the lever that will bring the fastest, surest result: the denominator.'
(Hamel & Prahalad 1994)

They describe the negative effects of denominator management and call for numerator management through growth and wealth creation strategies. Hamel later expands his description of numerator as:

'Strategy innovation...the capacity to re-conceive the existing industry model in ways that create new value for customers, wrong foot competitors and produce new wealth for stakeholders.' [Ref 2.12 Hamel 1998]

CHAPTER 2

In reality, what the effective company needs to do is combine the efficiencies of denominator management whilst using numerator management as a means of creating new markets and generating new revenue streams [Ref 2.7 Staude 2001].

2.3 Time-based Competition

Reducing the time to market or *time-based competition* is currently in vogue as such a strategic solution to this competitive problem. Time is often equated to money. So through lead-time reduction strategies, organisations can reduce costs through a more efficient use of resources denominator management. Simultaneously the company can build competencies in getting its products to market faster: numerator management.

Time-based competition has been described as the *'fourth wave of competitive marketing'* [Ref 2.7 Staude 2001] or the *'evolving competitive paradigm'* [Ref 2.13 Beholav 1996].

First Wave:	Cost	Ford
Second Wave:	Differentiation	GM
Third Wave:	Quality	Toyota
Fourth Wave:	Time/Speed	Nissan -RFT

(Source: Staude 2001)

Research by Richard Bremner [Ref 2.14 Automotive World March 2000] highlights the drive in the industry for reduced development lead times. The analysis of lead times is not always reliable (due to differing definitions company to company)

Against The Clock

In 2000, Honda president and chief executive officer Hiroyuki Yoshino [Ref 2.15, Hiroyuki Yoshino Honda, 2000- Press Announcement] announced that his company was aiming to reduce the lead-time for new vehicle development to just 12 months. Yoshino considers this essential to Honda's survival, believing that the company must "create products that offer new value to our customer, while also responding to the needs of society", and that "the company (must) be flexible enough to respond rapidly to changes in the market place". In other words, Honda will adapt itself to offer a greater variety of

CHAPTER 2

products, more swiftly. It wants to lead the “development time speed race”, says Yoshino. Which is pretty much a strategy that other companies have adopted. The difference is that Honda has travelled further down this road than some, and that no other maker had (at the time of Yoshino’s publication) publicly stated the intention of aiming for a lead-time so short. That said, it has already been beaten to the 12 month car by Toyota, whose domestic market Will Vi model, based on the Yaris/Vitz platform, was developed for sale in just a year, going on sale in Japan in 2001.

Few, however, are confident enough to announce such aims at all, and Honda is less open when it comes to defining what it means by lead-time, and what it means by a new model, viewing this as commercially sensitive information. It says that the starting point varies from one model to the next. But it will reveal that its current lead times vary from 15 months to 30 months, the start being defined as the production of the initial design concept. For many manufacturers, the lead-time begins with styling freeze; for others, such as Ford, it starts well before this, at the point when the need for a vehicle of a particular concept is identified and defined.

All of this makes it harder to see who leads Yoshino’s development time speed race. Indeed, General Motors is unwilling to talk at all about the subject. Its giant rival and occasional collaborator, Toyota, is willing to say more, defining the lead time as spanning design freeze to the start of production, and reckons on typically needing 18 months (in 2000) to get there, the time required to launch the Yaris supermini built on an all-new platform.

Like every other manufacturer, Toyota has been working hard to get to this point. Using the Kaizen principle of continuous improvement, it has chipped away at development times, which used to stand at 28.5 months in 1996 (a reference point for this Thesis). But with the launch of the Ipsum MPV (Picnic, in Europe) in May 1996, it pared the period back to just 15 months (for an Upper-body adaptation). On average, Toyota in 2000 needs 18 months to create a new model, with a three month leeway either side. The Will, however, has decisively bettered that record. Building it on the same platform helped, as did sharing parts with Daihatsu.

Shortening lead times is a trend that has gathered momentum over the past few years, driven by the needs of an increasingly fickle, hard-to-please market, and the ceaseless

CHAPTER 2

pressure on manufacturers to reduce costs. Here, revolution has come relatively late to Honda – though it has never been slow to develop new products – with the sixth and current generation Civic marking a shift towards the carry-over of a higher number of parts. The same policy had been applied to the Legend and Prelude, while increased platform and powertrain sharing has contributed as well. So has the simplification of design to employ fewer parts. This has allowed it to bring models such as the CR-V and HR-V SUV's both of which were derived from existing platforms, to market faster. It is not just parts and platform sharing that allows models to appear more quickly. Ford has introduced what it labels FPDS, or the Ford Product Development System, which explains Dave Router [Ref 2.16, Dave Router, 2000 – Press Announcement] who is a product development and strategy spokesman for the company, is a set of principles now used by Ford, Mazda, Jaguar and Aston Martin. It will eventually be used at Volvo as well. It has taken several years to implement and has come into effect over the past 3 years. Its development has been prompted by the increasingly consumer driven demand for new products and Ford's desire to operate under the same set of technical and engineering guidelines across its huge empire, making it easier to share research and development, platforms and components.

Under FPDS, explains Router, a new product must pass through a series of gateways, whose timings are set at the same point regardless of the brand or the model. This enables the company to know immediately what the critical path timings will be. The timings are different depending on whether the model is to be built on an existing or a new platform, or whether the task is a product freshening. An all-new model such as the Focus takes around 40 months to develop, while a freshening exercise involving sheet metal changes and engine calibration needs 30 months.

These periods may seem long, but unlike other manufacturers, Ford does not define the start point of this exercise as the styling freeze. “There are several milestones between Strategic Intent and the start of design”, says Router, “including the resource allocation process, base engineering, financial investigations and the definition of the package size”. This follows the initial segment and strategic marketing studies. The styling process starts 10 to 12 months after the initial research period begins, and can take between 2 and 6 months, depending on whether feedback market research leads to a redesign or not. This period is usually longest in the case of an all new-product. From that point, it takes between 24 and 36 months to develop a new car, regardless of whether it is a

CHAPTER 2

facelift, a new variant on an existing platform or an all new model, says Router. A new truck takes slightly longer owing to the greater body variations involved.

The FPDS process is also getting quicker, says Router, the object being to respond more quickly to the needs of the market. The shortening comes in “baby steps” he says. “Each time we go through the process we learn something – such as how to cut supplier lead times – and then we share this best practice across all the brands”. Part of the aim of speeding up the development process is to delay the point at which the styling is frozen, improving the chances of accurately fitting the target market, and increasing the potential longevity of the new variant. FPDS also lessens the damage of being surprised by a model like the Renault Scenic, whose emergence and success caught out many rivals. Faced with this circumstance again, Router reckons Ford could now respond in two to three years.

Besides the rigour of predefined gateways, Ford has also reduced its development lead times through the increased use of computer modelling, which has allowed it to take an entire prototype build phase out of the process. “We use the pilot vehicles to do the durability testing, rather than building costly prototypes by hand earlier in the process. We may also be able to take out more build phases in the future.

FPDS allows more options for responding to the market and it makes that response swifter, by utilising the global resources of all the brands, which is made possible by the compatible development systems. The accruing cost-savings can be spent on more programmes, or on increasing the competence of the product and its feature content. FPDS is also designed to meet Ford’s aim of producing a portfolio of products that need no additional marketing support through their lives. “Then you know you’ve responded well to the market”, says Router.

Anthony Sheriff, Fiat Auto’s director of product development [Ref 2.17, Anthony Sheriff 2000 – Press Announcement], cites the need for fewer people as one benefit of shorter lead times, along with the advantage of being more responsive to market requirements. But for Fiat, he says, the main advantage is the facility for late decision-making, allowing the product to be as fresh as possible when it appears. “The trick is to lock in things that have less impact on the customer early on”, he says, “and push back the decision about

CHAPTER 2

as many features as possible. You might have frozen the styling, but content decisions can be made later on”.

The entire process is pretty quick at Fiat. The new Punto was created in under 18 months, from the point when the design was frozen to the creation of a launch stock of around 18,000 vehicles. Looked at another way, the Punto took 38 months to emerge from the point of the first ideas to the amassing of the launch stock.

The new Punto was built on a modified carry-over platform, but Sheriff claims that the time to market for a model built on a new platform is pretty similar. The pre-platform development process is done beforehand, to ensure that it is compatible with existing products. The gestation time for a new platform is, however, “pretty foggy”, he says. “We’re thinking about ideas for the replacement platform three to four years before the start of the development of the first car off the new platform”.

As to the development of a new model itself, Sheriff sees three processes: styling, making dies and testing. The styling phase takes about a year, once the dimensions have been chosen and a proposal approved. The design freeze of the body is gradual, so that die manufacture can begin as early as possible, whilst leaving some flexibility to alter the style of panels that have an impact on the customer. The extent of the testing process will depend on the amount of carry-over components.

Sheriff says that Fiat “is not actively trying to reduce development times”. Nevertheless, the company’s new space-frame technology yields a shortening of lead times, because it is very flexible, allowing the use of a percentage of common parts that reduces the extent of testing required. It has also achieved reductions through virtual component testing, the elimination of testing phases and by doing more work in parallel.

Sheriff also believes that “acting as if you were an entrepreneur without money helps during the decision-making process. You need to be rigid about the decisions you make, and don’t go back and change things”. Fiat treats Power-trains and major components as platforms too – if the development of these is already done bar the application to a model, “it saves a lot of time. Ideally, you wouldn’t do anything new – in reality, around 10 per cent of the car should be things you haven’t done before.

CHAPTER 2

Like Fiat, Ford, Toyota and Honda, all the major manufacturers are able to claim reductions in development lead times over the past few years, and most of them cite pretty similar reasons for being able to achieve them. Platform and component sharing brings time savings, as does computer simulation, a process that in many cases allows the removal of at least one prototyping phase. Simultaneous engineering is another, as is involving suppliers earlier in the research and development process. And they are all particularly interested in being able to respond to the market faster.

But the auto markets are not identical in their circumstances or their opinion on the issue. For the Volkswagen group, the creative period of a vehicle's development is not fixed, but from styling freeze to job one takes four years on a new platform and two years on an existing base. This is a major step ahead from a decade ago, when an all-new model could take seven to ten years. But it has no plans to shorten this further.

Like Volkswagen, BMW (2000) has dramatically reduced its development times, from seven years to three for an all-new model, from the point of design and technical freeze. The actual time depends, however, on the complexity of the car in question, while niche models spun off existing platforms take significantly less time. The current 3 series was developed in 36 months, and required only two phases of prototyping rather than the previous three, thanks to simulation.

General Motors (2000) is unwilling to reveal much about its progress with development lead times, but it will say that it has cut its lead times by 50 per cent over the past three to four years, with the result that it can move a project from design freeze to production in 24 months.

At PSA (2001), the current lead-time is 156 weeks, or three years, for a vehicle developed on a new platform. The company is cagey about the point from which those 156 weeks begins, though broadly it is styling freeze. It cannot indicate the period for a model developed on an existing platform because, within three years, 75 per cent of the group's products will have been developed from new, and presumably more adaptable, platforms. The company is continuously reducing the lead-time – two years ago it was 196 weeks, and by this year it will have reduced it to 104 weeks, or two years. It considers the benefits to be “a significant reduction in development costs, offering the possibility of better price positioning”, as well as the usual improved reaction times and

CHAPTER 2

likelihood of satisfying consumer needs. The reduction in lead times has come about through the methods mentioned above, but PSA also credits the fact that each project manager leads his activities as an independent profit centre.

Mercedes (2000) plans to learn from its new partner, Chrysler, already quite a nimble player, though the German arm of Daimler Chrysler is not so slow itself, needing 32 and 36 months to develop an all-new model from design approval to launch, and as little as 12 months if the model is based on an existing platform. The company has pared six to eight months off development times in the past three years, mainly through computer simulation, and plans to use electronics to achieve more reductions.

At Renault (2002), the aim is to reduce the lead time from 39 months from design freeze to the start of series production (that was for the Megane) to 32 to 33 months for a major model with multiple versions, a figure it intends to reduce further. The overall development time for the Megane, from finalisation of the brief to series production, was 52 months. It can develop a new derivative, like the Scenic RX4 in 24 months, which does not compare well with some of its Japanese rivals.

Partners Nissan (2002) do rather better, needing 24 months from styling freeze for a new model developed in Europe, and 21 months for a Japanese model. The difference between Japan and Europe comes about because there is no need to ship the tooling for the domestic product. Nissan's record is the new Tino MPV, based on the Almera platform, which was turned out in 15 months. The lead time has fallen dramatically in the past few years as well – the current Primera needed 41 months, the new Almera 31 months, while the next generation Micra, sharing its platform with the Renault Clio, will be produced in 24 months. This may allow Renault to raise its game as well.

But it looks like Toyota is the current leader of the development time speed race. It is unlikely to have been bettered by GM, which, as we say, did not want to talk, or Daimler Chrysler, which also maintained silence. Toyota intends to continue to shorten the current 18 month period through the kaizen process, though without compromising quality, it says. For Honda's Yoshino to win the race, his company must not only hit his target, but also better it. How? Predictably, Honda is not saying, though part of the time saving will stem from its recently publicised plans to consolidate its engine and platform

CHAPTER 2

lines. Do not be surprised, however, if Honda's legendary engineering skills are brought to bear on the issue. They will need to be, if it is to win this race.

'As a strategic weapon, time is the equivalent of money, productivity, quality, even innovation.'

[Ref 2.18, George Stalk Jr, 1990]

This section of the review focuses on the relevance of time, with particular reference to the speed of new product development. Time-based competition is defined as the ability to deliver products or services faster than other competitors [Ref 2.19, Tersine & Hummingbird, 1995]. Its strategic implications were first explored in depth by Stalk and Hout, [Ref 2.20, Stalk & Hout, 1990, *Competing against time*] in the late 1980s/ early 1990's as a response to the competitive pressures from Japanese companies. They examined the performance of industry champions such as Toyota and realised that their ability to minimise cycle times throughout their operations gave them competitive advantage. It not only gave them superiority in efficiency, but also in their ability to reach the market quickly. They noted that *'fast-cycle'* companies were constantly alert to opportunities to compress time by eliminating stages or combining activities. They believed that combining this time advantage with customer value created a new recipe for corporate success.

Blackburn [Ref 2.21, Blackburn JD, 1991, *Time-based Competition*] concentrated on the process based approaches to time-based competition. He proposed that white-collar activities could be managed with the same Total Quality Management (TQM) approach that had proved so successful in the production environment. He argued that the TQM Pillars of reducing waste, providing simplicity and observing the principle of continuous improvement would give the opportunity for a time-based competitive advantage.

Robertson [Ref 2.22, Robertson T.S. 1993] argued that reducing product development lead-time was only half of the time-based picture, stating that a key issue was penetrating the market quickly. Market penetration cycle time was defined by Robertson as the amount of time it takes to reach the maximum sales potential for a new product. In effect he was saying that any advantage a company has in product development could be nullified if they are unable to get it into the market before their competitors. This means that a reduction in product development lead-time requires a corresponding marketing

CHAPTER 2

strategy shift to penetrate markets quickly. He outlines the following five guidelines for reducing market penetration lead-times:

- Reach the market first.
- Preannounce the new product before market availability.
- Innovate constantly.
- Occupy the market – multiple brands, positioning, segments and alliances.
- Track penetration by customer decision stage.

2.3.1 The Benefits of Time-based Competition

To complement Stalk and Hout's original work, a number of authors have sought to define and analyse the benefits of time-based competition. The central theme to these analyses is the use of time-based competitive strategies to create comparative advantage over rivals. Tersine & Hummingbird [Ref 2.19, Tersine & Hummingbird] related some of these time advantages to consumer value imperatives (See Figure 2.3), which relate back to Stalk and Hout's time and value competitive paradigm.

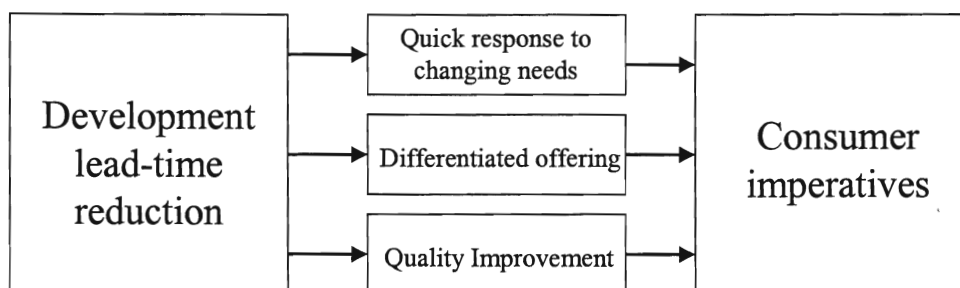


Figure 2.3 – Lead-time Reduction Match to Consumer Imperatives
(Adapted from Tersine & Hummingbird 1995)

The company that is operating with comparatively shorter development lead-times is better placed to seize a window of opportunity. [Ref 2.7,Staude 2001], [Ref 2.23,Cohen et al, 1996], [Ref 2.24, Hum & Sim, 1996]. An example from the car industry is the new market niche for mini people carriers created by the Renault Scénic. The quickest competitors to respond were at least able to claim a slice of the people carrier pie, and

CHAPTER 2

subsequent brand recognition. Those lagging behind found themselves in an overcrowded market place with an outdated product and sunk development expenses. This also demonstrates that being able to reach a market faster also infers a reduction in risk [Ref 2.7, Gavin Staude, 2001 and Ref 2.21, Blackburn JD, 1991]. Not only are the market conditions more predictable for the company, but also in addition, the time when it can start to recoup its development expenses are closer.

The adage that “time is money” is very true in a business where product lead-time corresponds to employee wages and overheads. In this way, reducing the time spent in product development has the obvious knock-on effect of reducing costs and therefore improving margins [Ref 2.7, Staude, 2001], [Ref 2.25, Kessler & Chakrabati 1996]. This relates back to Hamel & Prahalad’s [Ref 2.8, Hamel & Prahalad, 1994] need for efficiency driven denominator strategies. An additional point to consider is that lead-time reducing strategies are immediately attractive because significant improvements can be delivered with relatively little capital expenditure [Ref 2.19, Tersine & Hummingbird 1995].

A number of authors describe a side effect of time-based competition as enhanced product quality [Ref 2.25, Kessler & Chakrabati 1996], [Ref 2.26, Bower & Hout 1988]. One likely explanation of this benefit is the emphasis placed on TQM techniques by the original proponents of time-based competition, namely Japanese industry.

‘The power of a time-based strategy is that, by focusing on speed the firm develops world-class quality and process flexibility to deliver a wider variety of products and services without the burden of increased cost.’
(Blackburn 1991)

2.3.2 The Risks of Time-based Competition

As a reaction to the view of time-based competition as a panacea for business, a number of writers highlighted potential dangers with implementing such strategies. Choperena [Ref 2.27, Choperena, A.M. (1996)] highlights two risks to cycle time acceleration: Firstly, in the rush to speed up time to market, product quality may be sacrificed. This is at odds with earlier predictions, but holds true if speed is achieved through risky decision making, rather than robust processes. Secondly he argues that true innovation may be

CHAPTER 2

sacrificed, a point echoed by Cohen et al [Ref 2.23, Cohen, M.A., Eliashberg, J., Hua, T. 1996] who state that reducing the development time too far results in insufficient product improvements.

From a personnel perspective, Stalk and Webber [Ref 2.28, Stalk, G. Jr. & Webber, A.M. 1993] warn that the relentless pace of time-based competition can exhaust managers and workers. In this respect, time-based competition must have a long-term outlook, based on robust processes, rather than a call to “please work faster”. In addition, Hout [Ref 2.29, Thomas M Hout. 1996] identifies the conflicting priority between reducing development lead times and training people, and highlights this as a major reason for TQM implementation failures in US companies.

Von Braun [Ref 2.30, Von Braun, C.F. 1990] highlighted the dangers of time-based competition when competitive forces not only speed up development but also reduce product life cycles. He called it the *‘acceleration trap’*. He argued that shortening of cycles will become increasingly difficult to maintain, as markets and customers demand a minimum period of time before new goods replace old ones. In addition, there is less time to recoup development expense, in effect *‘.the company is not climbing any faster, it is just committing itself to a faster moving escalator’* [Ref 2.31, Manley, 2001].

As a final note, Kessler & Chakrabati [Ref 2.25, Kessler, K.H. & Chakrabarti A.K. 1996] considered when a strategy of lead-time reduction was advantageous or prudent. They argued that fast product development might not be universally desirable in all industries. As example, the pace may be slower in less dynamic industries characterised by few changes in technology or consumer preferences. They also suggest speed may be less desirable in industries with high-risk profiles such as pharmaceuticals.

CHAPTER 2

2.4 The Attributes of Time-based Competitors

'Time-based competitors outperform their industry.'

Thomas M. Hout [Ref.2.29 Thomas M. Hout. 1996]

Following the analysis of the advantages and risks of time-based competition, this section reviews the literature associated with company attributes. Stalk and Hout [Ref.2.20, Stalk & Hout 1990] have suggested that an organisation has to go through three phases to become a time-based competitor. The first phase is developing vision and decision; the second involves making the change; the third involves sustaining improvement. They stress the importance of management vision and commitment in this procedure, compared with Blackburn's [Ref.2.21, Blackburn JD, 1991] emphasis on process improvements. In both cases, a commitment to continuous improvement or *Kaizen* forms a central pillar within the implementation strategies. Choperena [Ref.2.27, Choperena, A.M. 1996] somewhat prophetically proposes '*ten commandments*' for the organisation that wishes to improve product development speed:

1. Make sure requirements are understood early in the process.

It is clear that in shortened programmes there is less time for mutual understanding to be built up. Choperena, along with many other authors, advocates the use of multi-functional teams with a customer focus. This follows the lead of many Japanese organisations identified by Stalk & Hout (1990). Here co-operation and information sharing among members of the marketing, manufacturing and R&D areas were perceived to be factors highly associated with new product success in the market [Ref.2.32, Song & Parry, 1997].

2. Reward simple solutions and avoid complexity.

Smith & Reinertsen [Ref.2.33, Smith, P.G. & Reinertsen, D.G. 1991] termed this '*incremental innovation*' and devoted a whole chapter to it. In essence, they argue that innovation should be focused on small steps to gain a large cumulative advantage. Concentrating in areas of customer value whilst keeping other areas the same. This reduces the '*learning time*' and avoids the '*mega-project trap*' where a '*revolutionary new product*' attitude results in an enormous learning burden. Unsurprisingly, given the era of Japanese dominance, this has its roots in the principles of continuous improvement - *Kaizen*.

CHAPTER 2

3. Promote visualisation of design.

Design mistakes are costly, particularly in terms of time, but their influence can be minimised if they are found during a simulation or visualisation phase. There are two Pillars to this visualisation: TQM methods and now IT enabled simulation techniques. One TQM tool that is particularly relevant to project simulation is Quality Function Deployment (QFD). This is a method used to identify customer attributes and create a specific link between those attributes and design parameters.

'QFD has power because it provides a common language and framework within which designers and marketers may fruitfully interact.'

[Ref 2.34, Wheelwright & Clark 1992]

The second pillar, IT enabled simulation, is increasingly seen as the enabling tool for even faster time-based competition [Ref 2.35, Daniels and Essaides 1993]. For example, in the car industry computers have been used to simulate not only the customer setting but also the factory environment using Computer Aided Production Engineering (CAPE). CAPE enables virtual products to be made in virtual factories without committing financial or time resources to prototype production [Ref 2.36, Sunday Business 1998], [Ref 2.37, Alan Copps, 1998], [Ref 2.38, Jesse Crosse, 1998], [Ref 2.39, David Williams, 1998], [Ref 2.40, Les Oliver, 1998], [Ref 2.41, Eureka, 1998].

4. Experiment around poorly understood areas.

In effect this removes the risks from the project itself. Experiments or feasibility studies can be carried out up-front or in parallel to the main project and do not become part of the critical path [Ref 2.34, Wheelwright & Clark 1992], [Ref 2.42, Pinto & Kharbanda 1996]. An important side effect is that the organisation builds competencies in these areas and may be able to integrate them into the main schedule for the next, perhaps faster cycle project.

CHAPTER 2

5. Avoid system bottlenecks.

Some of the best suggestions for speeding up product innovation have come from looking at how production people have speeded up the manufacturing process [Ref 2.20, Stalk & Hout 1990], [Ref2.21, Blackburn 1992].

'A comprehensive lead-time reduction strategy should attack all the bottlenecks in the system...any activity that consumes time but does not add value is an initial target for reduction or elimination of waste. Value-added activities should be continually improved so they take less time and thus add more value.' [Ref2.19, Tersine & Hummingbird, 1995]

6. Visualise the system integration phase.

In a similar vein to the design simulation, it is important that the process effects are visualised to ascertain organisational impacts. McCormack et al [Ref2.43, M^cCormack, S.P., Lewis, K.J., Mink, O., Batten, J.D. 1992] argue that successful implementation of fast-cycle methods requires employee wide commitment to the philosophy, coupled with a strategic framework for implementation. Commitment is particularly important for the introduction of strategic initiatives because they represent a period of discomfort and risk [Ref2.44, Burgess & Turner 2000].

'Commitment requires the internalisation of the organisation's values, norms and goals to a point where there is a strong correlation between them and the individual's belief...Building commitment in change and project management is more than just carrots and sticks. The energy, loyalty, resilience and competitive advantage offered by commitment cannot be reproduced via coercion or material rewards.'
(Burgess & Turner, 2000)

7. Identify the top five critical issues, as most activities will likely concern these.

Choperena's use of five critical issues is arbitrary, but the principle is *Pareto Analysis*. Isolating and analysing the vital few from the trivial many. Pareto Analysis is part of Joseph Juran's teachings and one of seven quality tools promoted by Kaori Ishikawa, both *fathers* of TQM [Ref2.45, Turner, 1993].

CHAPTER 2

8. Promote rapid decision-making.

Stanford Professor Kathleen Eisenhardt [Ref 2.46, Prof Kathleen Eisenhardt, 1990] describes three conventional methods of making quick decisions

Skipping analysis, but this compromises quality.

- Limiting conflict and disagreement, but she argues a degree of conflict is healthy and an opportunity to disagree encourages commitment.
- Making bold and rapid unilateral moves, but she believes *'the era of the swashbucklers is over'*.
- Keeping lots of options open, and evaluating them quickly with current factual information.

In a survey of successful fast-cycle computer firms, Eisenhardt found they wanted to keep lots of options open, and then to evaluate them quickly. This is re-iterated by

Daniels & Essaides [Ref 2.35, Daniels, N.C. & Essaides, G. 1993] who claim that effective time-based competitors aid decision-making through extensive use of information systems.

Keeping many options open in a fourth decision-making paradigm proposed by Eisenhardt and tends to convey an image of chaos, but as one of the gurus of time-based competition states:

'Today more than ever companies need to embrace complexity rather than neatly organise it.'

(Hout 1996)

9. Integrate the team and promote total system understanding.

Stalk and Hout [Ref2.20, Von Braun, C.F. 1990] argue that time-based companies create more information and share it more spontaneously with as many employees as possible. And that creating fast response among employees is necessary in order to provide fast response to external customers. This team integration also harks back to the requirement for cross-functional understanding and shared knowledge.

CHAPTER 2

10. Guide the project through its phases with a well-understood process.

Mistakes in process application can be just as expensive as design errors so it is apparent that the process must be clear and widely understood. In addition, project success is a balancing act between relatively autonomous problem solving by the project team and the discipline of a powerful project leader and strong top management [Ref2.47, Brown & Eisenhardt 1995]. This leadership and commitment focuses efforts in the same direction and will also set the tone for the organisational culture.

2.5 Time-based Competition in the Car Industry

The success of the Japanese auto industry throughout the 1980s was partially attributed to their ability to compete on time. Indeed it is companies like Toyota and Honda that were constantly referred to as '*best practice*' in the seminal works of Stalk and Hout. This was further refined to an analysis of their product development capabilities by Clark & Fujimoto's book '*Product Development Performance*' [Ref2.48 Clark, K.B. & Fujimoto, T. 1991]. They demonstrated that the average Japanese carmaker was able to design and start production of its vehicles 30% quicker than the equivalent US or European producer (See Figure 2.4).

	Japanese Volume Producer	US Volume Producer	European Volume Producer
Average Lead-time (months)	42.6	61.9	57.6
Average Engineering Hours (millions)	1.2	3.5	3.4

Figure 2.4 – Product Development Performance (Source: Clark & Fujimoto 1991)

The Japanese capability for speed was further emphasised when Rover in the UK developed a strategic alliance with Honda. During the alliance, Rover was able to implement Honda methods to shorten development lead-times by 38% and reduce development labour costs by 20% [Ref 2.33, Smith & Reinertsen 1991].

CHAPTER 2

In light of this, authors such as Clark & Fujimoto and Cusumano & Nobeoka sought to define a recipe for this speed advantage that could be transferred to western manufacturers throughout the 1990s. They highlighted concurrent engineering, selective or incremental innovation and TQM.

1. Concurrency

Concurrent or simultaneous engineering focuses on time reduction in the entire development process. In effect shortening the critical path by overlapping activities (See Figure 2.5).

'Instead of performing activities in series, it combines them into a simultaneous or parallel manner usually with the assistance of a multidiscipline project team.'
(Tersine & Hummingbird 1995)

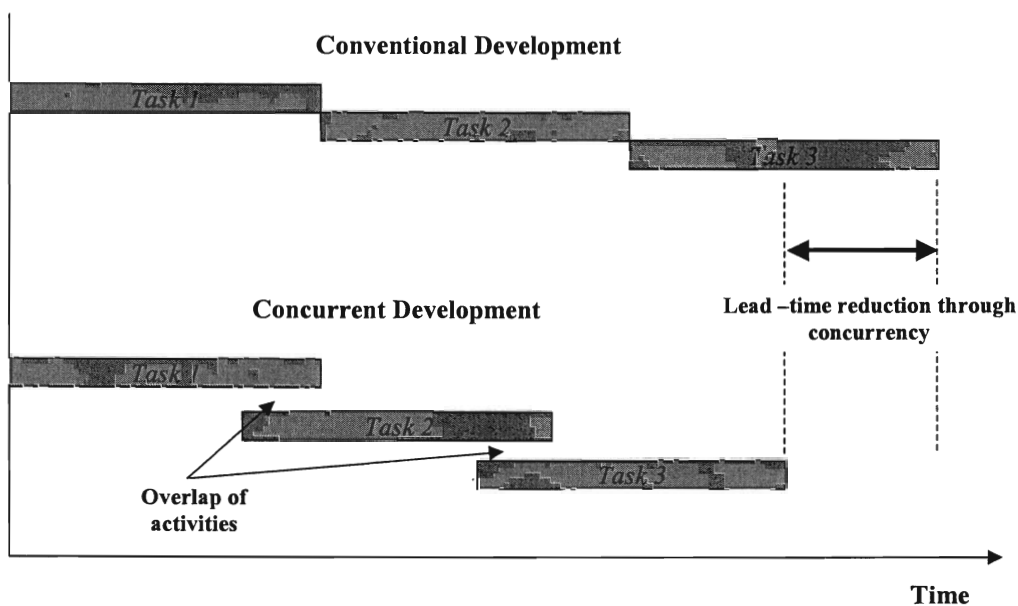


Figure 2.5 – Development Lead-time Reduction Through Concurrency

Toyota are credited with developing the concept of concurrent engineering in the late 1960s with other Japanese companies, including Nissan, following in the late 1970s. Following the work of Clark et al, concurrency has become the norm throughout automotive manufacturers in the 1990s as they seek to improve development efficiency [Ref 2.49, Ward et al, 1995].

CHAPTER 2

The difficulty for companies implementing concurrency is that by shortening beyond the critical path, the next step is initiated before design and testing is complete on the previous one. It is this inherent risk that requires careful management and in particular strict change control [Ref2.45, Turner 1993]. Hauptman & Hirji [Ref2.50, Hauptman, O. & Hirji, K.K. 1996] identified four management imperatives for successful concurrent engineering:

- Two-way communication.
- Overlapping problem solving.
- Readiness and willingness to use uncertain and ambiguous information.
- Readiness to release uncertain and ambiguous information.

Within a manufacturing environment a key facet of this concurrency is the link between the designers and the engineers implementing the product at the factory. Verespej [Ref2.51, Verespej, M.A. 1987] believes that Japanese companies have historically developed projects faster than their western counterparts, because in Japan, production engineers have a greater status, and therefore their standing within the process is that much greater.

2. Selective Innovation

Linking back to Choperana's simplicity and Smith & Reinertsen's incremental innovation, Japanese car manufacturers concentrated on keeping many components the same whilst changing key items that were of value to the consumer (Ward et al 1995). Ironically, in the 1990's the Japanese manufacturers became a victim of Von Braun's 'acceleration trap' by developing large numbers of vehicles to fit many market niches. They were shown the solution by the German manufacturers (primarily *Volkswagen*) through platform sharing. This reduces development complexity by having a significant proportion of major components common to a number of vehicles [Ref 2.52, Robertson & Ulrich 1998].

3. Total Quality Management (TQM)

During the late 1980s, TQM was hailed by western manufacturing as the secret to Japanese dominance. Its influence on white-collar processes was first discussed in detail by Blackburn [Ref 2.21, Blackburn JD, 1991] highlighting Honda and Toyota as companies that were applying manufacturing principles in the design office.

CHAPTER 2

Cusumano & Nobeoka 1998]. In effect, a product development cycle of Design - Make - Test - Fail - Re-Design (See Figure 2.6).

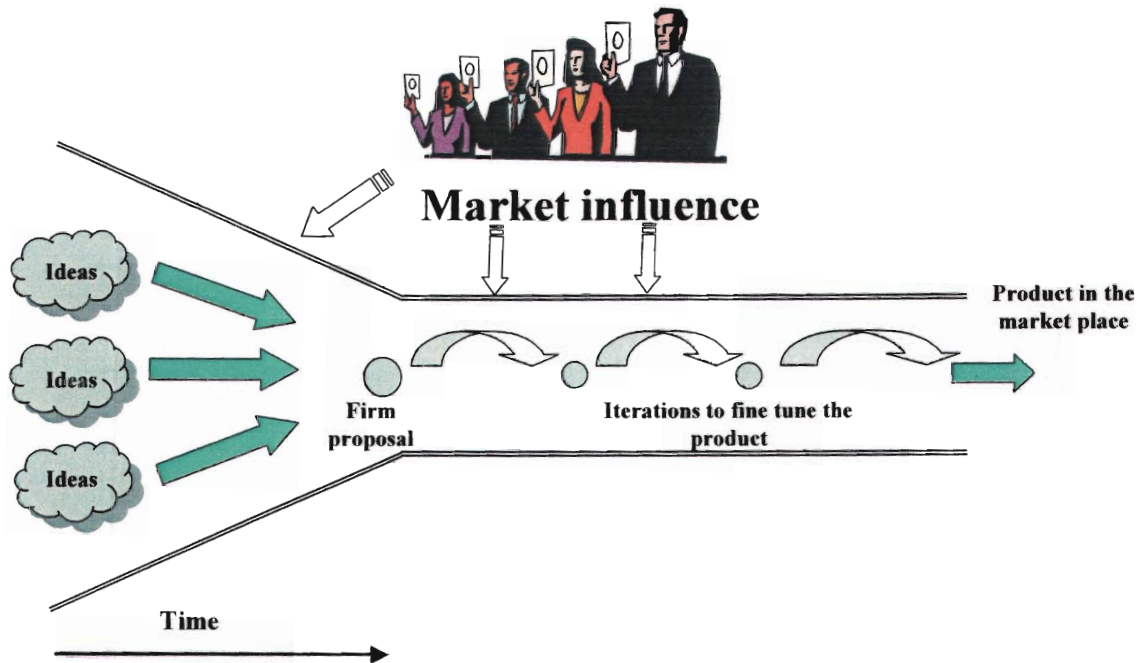


Figure 2.6 – Development Funnel (Adapted from Wheelwright & Clark 1992 and Ward et al 1995)

During the development phase, carmakers are able to include changing market influences in their prototype iterations. A limitation with this process is that repeating development loops can be costly in terms of time and development costs.

CHAPTER 2

As an alternative Toyota has developed another technique: 'Set Based Design' (Ward et al 1995 – See Figure 2.7).

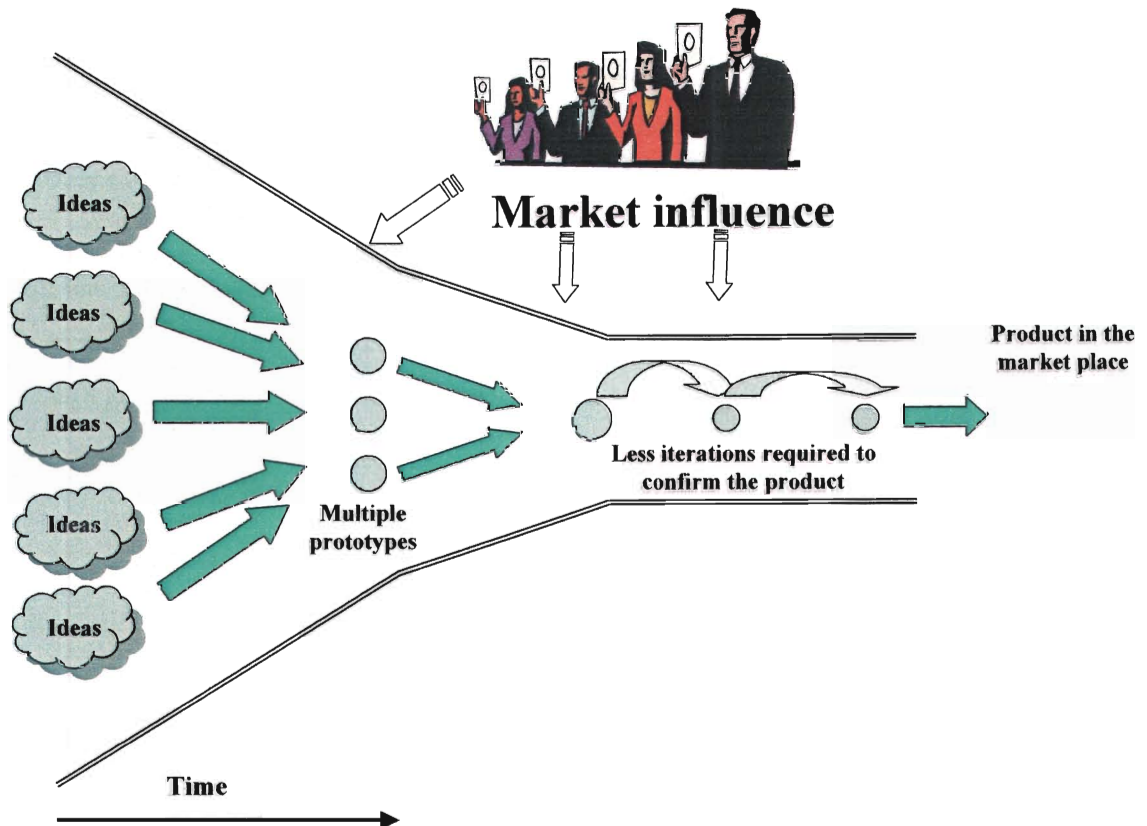


Figure 2.7 – Toyota Set Based Design Development Funnel
(Adapted from Wheelwright & Clark 1992 and Ward et al 1995)

'Set based design refers to a deliberate effort to define and explore sets of possible solutions, rather than modifying a point solution.'
(Ward et al 1995)

Toyota explores multiple ideas through the creation of a number of prototypes before choosing from those features that best suit the market. They are then able to implement the development phase more rapidly using less iterations because they have acquired significant technical and market knowledge through the concept stage.

CHAPTER 2

'Set based engineering bases the most critical, early decisions on hard data [prototype vehicles]. The earliest decisions have the largest impact on the quality and cost, but these decisions are usually made with the least data.' (Ward et al 1995)

Critics of set based development argue that multiple prototypes are very expensive leading to greater development costs. But Toyota is able to offset this to some degree by being very fast during the implementation stage [Ref2.55, Cusumano & Nobeoka, 1998].

Nissan has taken an alternative stance through its *Right First Time* development process, the subject of this research. RFT seeks to reduce lead-times by removing the iteration phase and going straight from the first prototype into production (See Figure 2.8).

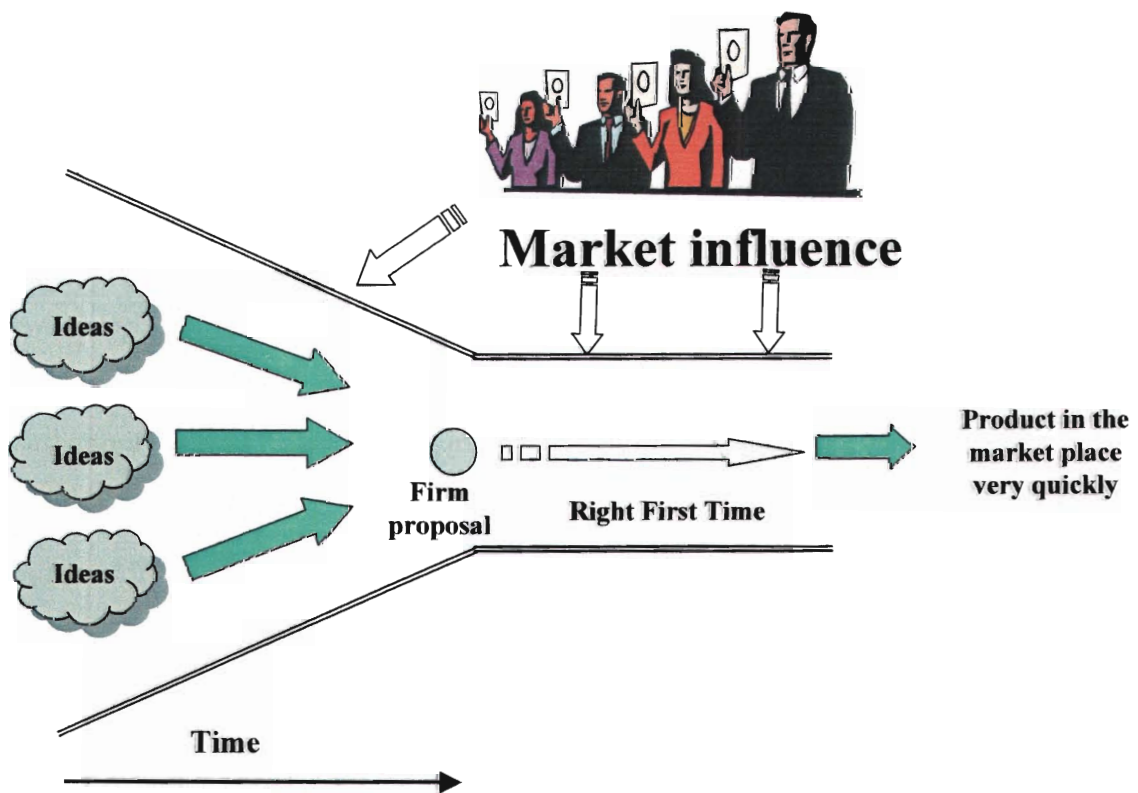


Figure 2.8 – Nissan Right First Time Development Funnel

(Adapted from Ref 2.34 Wheelwright & Clark 1992 and Ref 2.58. Palmer et al 1999)

By significantly shortening the development phase, the RFT philosophy not only reduces development costs but it also brings the product launch closer to the time when the

CHAPTER 2

product is approved. This should make the marketing information more current and therefore more accurate.

2.6 Right First Time – Time-based Competition at Nissan

‘Doing it fast forces you to do it right first time.’

[Ref2.56, B. Dumaine 1989]

The term *‘Right First Time’* is widely used in manufacturing and service settings. It refers to a product or service that is produced accurately, without the need for corrective rework. It is one of the pillars of TQM methods propounded by, amongst others, Deming [Ref2.53, Flood 1993]. However, RFT has rarely been applied to complex and creative areas such as a vehicle development function. Blackburn [Ref 2.57, Blackburn, J.D. 1992] observes that little progress has been made applying RFT techniques to white-collar activities because work is easier to observe and track on the factory floor. In spite of, and because of this, he observes:

‘...A white collar “factory” is a much more target rich environment for time compression than the blue collar areas.’

(Blackburn 1992)

Furthermore, during a study of US firms he found that doing it *wrong* first time was a recurring problem.

*

‘In information processing functions such as product design and development, long rework cycles due to quality problems (such as not getting design specifications right) is a major cause of long lead-times.’

(Blackburn 1992)

There have been many barriers to the application of TQM principles to product design. Among them is the fear that TQM techniques would stifle inventiveness, ingenuity or creativity. Critics argue that the creative process involves learning from mistakes, which would run counter to the *‘do it right first time, every time’* doctrine of TQM.

CHAPTER 2

'Instructing engineers to "do it right first time" is equivalent to telling them to try harder and be more careful, not particularly useful advice.'
(Ward et al 1995)

A counter argument is that by segmenting the creative research phase from the quality focused delivery phase, an organisation is better able to manage its creative time. In effect, reducing the time spent *'fire fighting'* concerns during delivery, frees up resource for creativity [Ref 2.58, Palmer 2001].

With these issues in mind, Nissan decided to implement an RFT development process, drawing from the principles of TQM, on the 2000MY Almera. This was to be primarily developed at the UK office of Nissan Technical Centre and manufactured in the UK at Sunderland. Their motivation was to decrease the time to market and reduce development expenditure (Palmer 2001).

2.6.1 The Strategy of Right First Time at Nissan

At a corporate level, Nissan's decision to 'raise the bar' in time based competition was motivated by hyper-competition in the motor industry and the strategic discomfort caused by financial difficulties and falling market share. In effect the performance drop off described by Vandermuwe's [Ref 2.9, Vandermuwe, 1995] *Sigmoid Curve*. In order to implement this strategy change Nissan had to determine tactical and operative level strategies (Figure 2.9). The tactical strategy was RFT Design, and the operative strategy was to apply TQM, knowledge management, and simulation methods to its development process.

CHAPTER 2

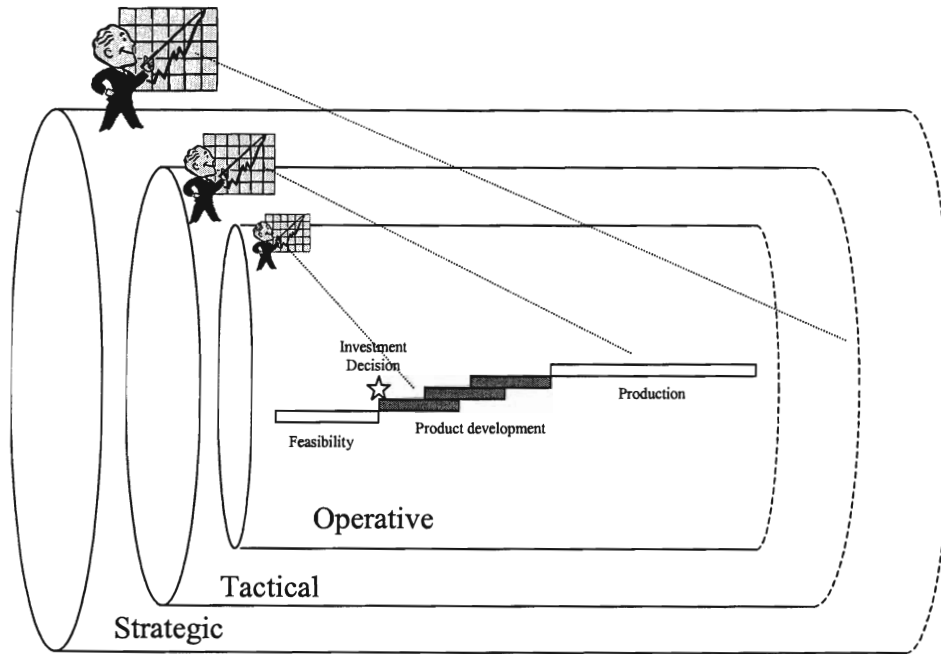


Figure 2.9 – Strategic Implementation Model (Source: Artto, Lehtonen, Saranen 1999)

Having defined RFT as the development policy, Nissan's commitment to its achievement was required at the highest level (Ref 2.58, Palmer et al 1999). Although minor improvements could be made through Kaizen techniques, the proposed RFT Design strategy was to reduce the development lead-time by 25% (41 to 31 months) a source of major organisational change.

'A marginal reduction in [lead] time (10-20%) generally can be achieved by simply improving efficiency. However, major reductions typically require reconceptualization of the entire delivery system.'
[Ref 2.24, Hum & Sim, 1996]

The implementation of TQM methods in the design and development process links effectively into the Choperena's 10 commandments discussed in Chapter 2. Of particular relevance was the requirement for employee commitment and understanding in such a period of change. In addition to this, authors such as Kotter [Ref 2.59, Kotter, J.P. 1995] and Tennant & Roberts [Ref 2.60, Tennant, C. & Roberts, P. 2001] have raised the issue of TQM's cultural impact and its fit to the company culture. Tennant & Roberts' researched the application of quality and reliability tools in the product development phase and concluded:

'The implementation strategy must be designed appropriately to ensure congruence amongst the organisational attributes such as strategy, structure and culture.' (Tennant & Roberts 2001)

CHAPTER 3

The Research Methodology

The research methodology used in this Thesis is principally “Action Based”. Chapter 3 describes why this is relevant in this case and the theory and research which validates its use.

3. Methodology

The research is being conducted mainly within a product development organisation at Nissan. The research is then validated against contemporary research through the literature research and within other organisations, albeit in less detail.

The involvement of a major automotive manufacturer provides a suitable setting in which to investigate the research questions posed.

3.1 Action Research

Action Research is now a common research paradigm used to validate a range of management research [Ref 3.1 Eden & Huxham, 1993]. Action Research has different meanings to different researchers but the essential feature of Action Research is involvement with an organisation regarding a matter of concern. The research described here is based upon involvement with the vehicle manufacturer NTCE concerning the industrial problem identified in the introduction section.

The potential criticism of Action Research stems from this key aspect of involvement. The research approach is based on a situation that by definition is unique. These involvement activities are likely to be specific to a certain time in a certain organisation. This has resulted in concerns over the rigour and repeatability of research that takes this approach. Likewise the generality of Action Research is called into question, typically concerning the generation of knowledge and theory that applies outside of the participating organisation.

Action Research can include qualitative and quantitative methods, but potential criticisms, and the defences used here to counter them, make an Action Research approach similar to purely qualitative methodologies. Any criticisms levelled at both approaches stem from the scientific

CHAPTER 3

definitions of knowledge, where to qualify an observation has to be objective, repeatable, generalisable and measurable. These stipulations are effective and applicable when the subject matter is the inanimate. However in the fields of psychology, sociology and management science the subject matter tends to be more complex and soft concepts such as consciousness, values and attitudes tend to be determinates of observed behaviour. Adherence to the scientific stipulations results in widely accepted, repeatable and generalisable research findings. However these findings tend to be theoretical and at a level once removed from the real world. The resulting theory and knowledge can be beautifully scientific but of little use for implementing change and improvement in practical settings e.g. Robson [Ref 3.4 Robson, 1993].

It is argued then, that by abandoning the objective and the repeatable and involving themselves in the reality of organisational change, action researchers are provided with a richness of insight that could not otherwise have been gained [Ref3.2, Rowan & Reason. 1981]. Eden and Huxham's paper describes the key aspects of Action Research and identifies contingencies researchers should take regarding generality, theory generation and validity.

3.1.1 Generality

It is suggested that Action Research should empower participants and that "local theory" must be generated that applies in the specific setting of the research. However to ensure the generality of the research, there must be clear indications of how the research can be applied in other contexts. This requires that the research findings are described in general terms, in contrast to the situation specific solutions provided to the research participants.

3.1.2 Theory Generation

The Action Researcher is required to identify those issues that arise from the research that are of interest to researchers working in different contexts. The researcher must specify how links between these contexts can be formed and must actively seek to talk with other researchers in the subject area. Therefore the research must have not only a practical leaning. The research must consider existing theory and the development of that theory through an understanding of the generalisable aspects of the research.

Action Research tends to produce Grounded Theory, [Ref3.3, Glaser & Strauss. 1967] where the emerging theory is grounded in the data. The individual nature of each intervention context

CHAPTER 3

means that action research is ill suited to theory testing. Instead theory generation or development is considered the appropriate output of Action Research.

3.1.3 Validity

If Action Research is judged by the traditional scientific criteria of repeatability, generality and objectivity, the validity of its findings are open to criticism. It is essential then that researchers are aware of the key issues of validity when designing and conducting their research.

Addressing the issues of generality and theory generation described above provides the research with internal validity.

External validity can be gained from a variety of sources. Firstly theory generated from actively participating in the process of change is likely to be reliable since it is generated from participants' experiences of change rather than their beliefs. This is to say the researcher can gain access to real behaviours rather than those people think they would exhibit in the change process.

The process of change itself reveals information that would otherwise have remained hidden. The experience of change provides stimulus for the discussion of concepts. The adage "the best way to understand an organisation is to change it" is commonly used to explain the validity of Action Research.

Action Research then has limitations in terms of generality, repeatability and validity. However it can provide insights inaccessible to other research approaches. The limitations of the approach must therefore be recognised and addressed in the design and reporting of the research. Likewise for the approach to be justified, data collecting and reporting needs to concentrate in the areas inaccessible to the other approaches.

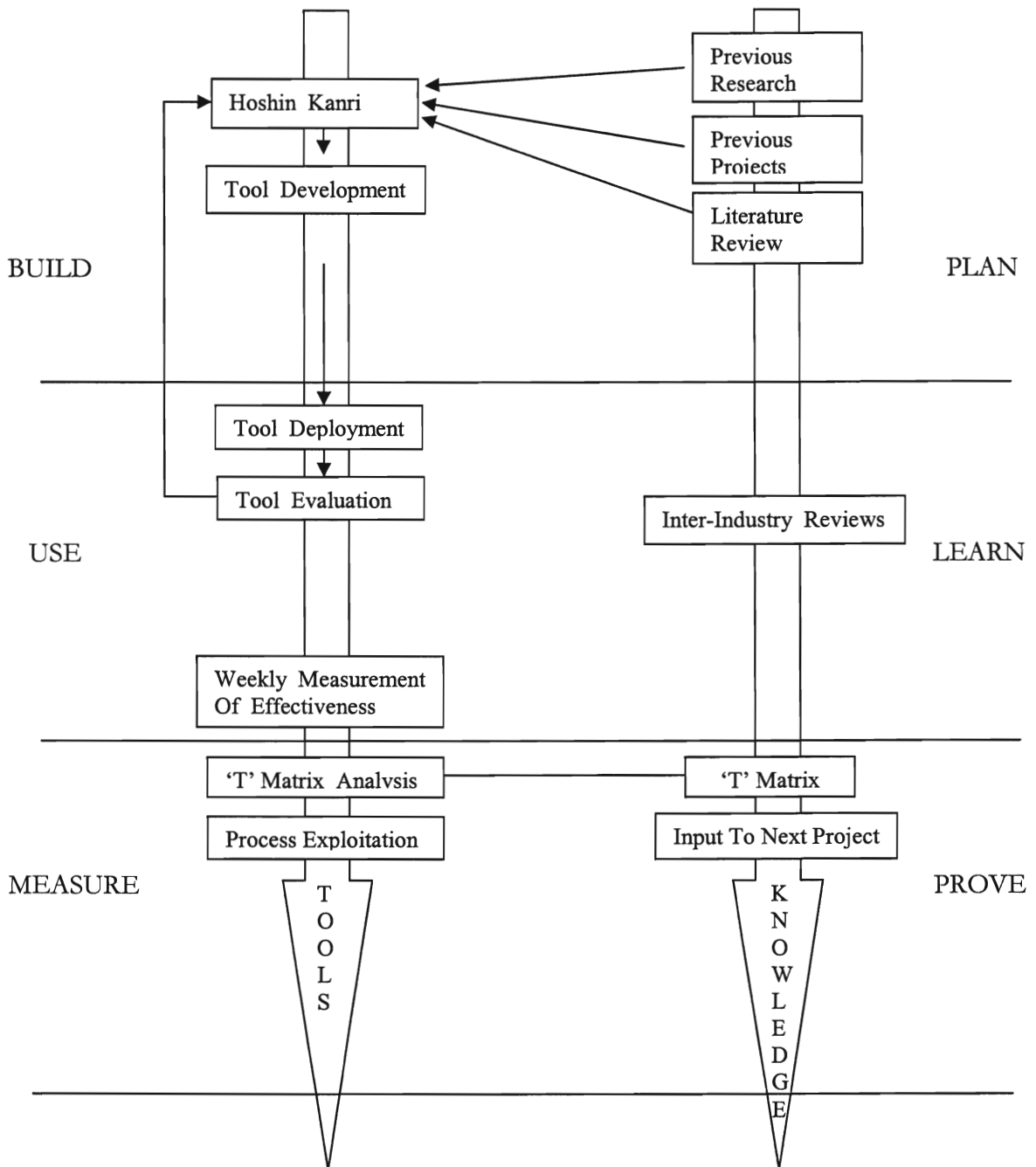
3.2 Research Approval

NTCE and the 'Cranfield Researcher' are working together to gain a full and industrially grounded understanding of catalyst to design change and the effectiveness of tactics to reduce design change. This has taken the form of measurement and definition of reasons for design change in previous programmes. These experiences are then linked to the Hoshin Kanri tactics

CHAPTER 3

along with effectiveness forecasts. The effectiveness is then measured throughout the programme and ultimately judged on a 'T' matrix basis.

The knowledge and tool development occurs in parallel through the following phases.



The Researcher was given charge of the total change initiative, reporting to the Director of Vehicle Engineering in NTCE and to the PIC (Process Improvement Committee), Chaired by the NTCE Deputy Managing Director. The process of change commenced in autumn 1996

CHAPTER 3

and was implemented through the HS – Almera program that came to fruition in early 2000. The period 2000 to early 2002 was a period of consolidating and result validation and early 2002 to April 2004 was the write-up of the Thesis.

The RFT design hypothesis was tested during the planning and execution of the HS Almera project in great depth, using the Action Research process. It was then validated in two alternative engineering companies, assessing their readiness for deployment of RFT Design. This was felt by the Researcher to be appropriate. The alternative being to do more general research on a greater number of companies may not have generated the level of quantitative results necessary to differentiate the Thesis from some of the published data discussed in the Literature Review e.g. [Ref 2.27, Choperena , A.M. 1996].

The Almera project itself was a brand new C Segment Vehicle, with a new Platform, Engine line-up and upper-body. Ultimately, 22% of the parts were carried-over from other Nissan vehicles, but essentially re-packaged in the new vehicle. The development was undertaken in a job-share arrangement between NTC and NTCE (in Japan and UK), resulting in the successful launch of the vehicle, on time, in 2000.

The successes and failures of the project were judged from both quantitative and qualitative points of view as recommended above by Eden, C. and Huxham, C. The Qualitative Research commenced through the gathering and sharing of knowledge at Practitioner conferences (See Appendices for various presentations), involving 5 conferences and approximately 30 papers of relevance. Qualitative analysis of the research inside Nissan was undertaken by interviewing 47 Staff and a deep analysis with 4 Managers. The assessments with the two external companies involved interviews and information exchange with 25 of their employees.

By adopting the recommended principles of Action Research and through the use of an independent researcher in interviews involving NTCE staffs, the Researcher believes that weaknesses in approach to the research are off-set by a richness of data, validated from both qualitative and quantitative view points and tested in alternative mechanical engineering environments.

CHAPTER 4

The concept of right first time (RFT Design)

The intention of this chapter is to discuss the concept of Right First Time Design & Development against a background of historical & contemporary references. From that discussion and a business requirement to reduce R&D expenditure on any given vehicle development program, a definition is asserted, arguing that a reduction in Design change, by 80% post production Design release, will result in a 40% reduction in development cost within the Case Company.

The term "Right First Time" is widely used in many industries. It means many things to many people and has many derivatives. The Car Industry often refers to 'Straight through ratio's' or 'No-Touch ratio's' in production [Ref:4.1 Wheelwright & Clark, 1992]. The essence of these terms is the same. They all seek to measure and strive to achieve a product that is made correctly in 'standard time', without the need for corrective rework.

However, the definition of RFT is rarely applied to the Design and Development (D&D) discipline, nor is it assigned specific targets in this discipline. A literature review, searching for both RFT and D&D, yields only 167 'hits' and in all but 3 cases, the definition is both vague and ill defined, or refers explicitly to the purchase of a tools/consultancy to improve concurrent engineering. The 3 useful hits are defined below.

- [Ref: 4.2a Auto Research Analysis "Designers & Engineers play cupid"]: Principally concerned with understanding the unspoken reaction of consumers and allowing engineers to interpret customer needs in a way that will "surprise and delight".
- [Ref: 4.2b Jeff Loughran, James Cook University 2002]: Principally looking at RFT from the point of view of predictive analysis using Engineering tools.
- [Ref: 4.2c Steve Evans, UK Symposium on Supply Chain Alignment 1996]: Looking at improvements in the use of the supply chain to allow early interaction between carmakers and their suppliers (called COGENT).

The purpose of this chapter is to synthesize and propose a suitable definition of RFT in Design and Development (D & D) and assign specific targets.

CHAPTER 4

4.1 Total Quality Management (TQM)

The definition will draw on the five pillars of TQM (Total Quality Management). In order to adequately explain this definition of RFT Design, it is necessary to firstly define these five pillars of TQM, as they form the foundation of the practical execution of RFT Design.

In the mid 1980's, TQM was hailed by Western Industrial Management as the secret to the success of the Japanese in their exploitation of most manufacturing industries, but most notably in the Motor Cycle and Motor Car sectors [Ref: 4.36 Womack & Jones 1990]. An example of this was Rover Group, which through its links with Honda, installed its TQ Initiative. Rover utilised a consultancy (PA Consulting Group) and indeed a whole industry of consultancies grew up around selling the TQM message. [Ref:4.3 Charles Tennant, 1998]

Interestingly, no such initiatives prevailed in Japanese Industries, however the basic Deming Principles were ever present. Edward Deming's influence on Japanese Manufacturing Industry was and is huge. [Ref:4.33 Deming 1986]

Dr Deming received his doctorate in mathematical physics from Yale University in 1928 and has since been awarded a number of *honoris causa* degrees. He is the author of many books and 171 papers. The books have been translated into several foreign languages. Additionally videotapes about his life and philosophy have aided the application of his teachings worldwide.

Dr Deming is well known for his work in Japan. In 1947 the Japanese requested Deming, an American statistician and management theorist, to help them improve their war torn economy. From 1950 onwards he taught top management and engineers methods for management of quality. The Japanese industrialists were receptive to the idea of improving quality because they wanted to have a larger export market. His first formal course on statistical control was attended by 220 engineers. His teaching went well beyond traditional statistical control courses as it involved a management philosophy.

Deming taught about problem solving and teamwork, this was new to statistical quality control. He was critical of some statistical quality control practices of the day, such as the use of slogans to reduce production defects, which he argued was counter productive. Deming believed in improving the process and not in blaming the workers. By developing

CHAPTER 4

organisational champions he took the idea of statistical quality control and moved it towards a method of management. Japanese industrialists became committed to the idea of improving their quality by adopting Deming's methods. By implementing his principles of total quality management (TQM) it dramatically altered the economy of Japan and in recognition of this, the Union of Japanese Science and Engineering (JUSE) instituted the annual Deming prizes for achievements in quality and dependability of a product.

In 1960 the Emperor of Japan awarded Dr Deming the Second Order Medal of the Sacred Treasure. Based primarily on his work with Japanese managers, Deming [Ref:4.4 Walton, 1986] outlined 14 steps that managers in any organisation could implement to achieve a quality management programme:

14 STEPS TO TOTAL QUALITY MANAGEMENT

1. Create constancy of purpose for improvement of product and service. Constancy of purpose requires innovation, investment in research and education, continuous improvement of product/service and maintenance of facilities
2. Adopt the new philosophy. Management must undergo re-training and begin to believe in quality products and services
3. Stop depending on mass inspection. Inspect products/services only as a means to identify ways of improvement
4. Don't award business based solely on the lowest quotation. High quality should count equally
5. Constantly review and improve product/service
6. Train and retrain. Establish a commitment to training at highest levels
7. Leadership is the job of management and they therefore have a responsibility to discover the 'barriers'.
8. Create an environment where workers can express concerns with confidence and no fear of reprisals if they make waves
9. Breakdown barriers between areas. Do this by the promotion of teamwork. Foster inter-relationships among areas and encourage higher quality decision-making.
10. Remove any slogans, exhortations and targets for the workforce. Find real ways to motivate staff
11. Eliminate numerical quotas. These impede quality more than any other working condition. They leave no room for improvement. Flexibility is needed to give customers the level of service they need

CHAPTER 4

12. Remove things preventing pride of workmanship. Give respect to staff and feedback on their performance
13. Promote education and retraining as continuous improvement, job descriptions will change and new skills must be learnt
14. Take action to accomplish the transformation. Management must support and work as a team to achieve 1 – 13.

When America also saw a reduction in its own world market share in relation to Japan, American business re-visited Deming and TQM. It is also recognised that the Quality management experts, Joseph Juran [Ref 4.40] and Philip Crosby [Ref 4.41], also contributed to the development of TQM theories, models and tools, but for the purpose of this research the Deming approach is chosen as the framework for RFT Design.

So we can determine that TQM is ‘a system of continuous improvement employing participative management and centred on the needs of customers’ [Ref:4.5 Jurow& Barnard, 1993]. The key areas of TQM are:

- Employee involvement
 - Training
 - Problem solving teams
 - Statistical methods
 - Long-term goals
 - Long term planning
 - Recognition by management that systems and not people produce inefficiencies?
 - Breaking down of interdepartmental barriers
 - Redefining customers as Internal (staff) and External (patrons)
 - Promoting a state of continuous improvement
- [Ref:4.5 Jurow & Bernard, 1993].

TQM was adopted in the USA by Harvard College Library [Ref:4.34 Masters, 1996] who identified 4 barriers to the adoption of TQM in their experience.

Vocabulary; objections to terms such as ‘total’, ‘quality’, and ‘management’ which imply high standards are not already being met

Commitment; TQM takes several years to implement and requires a long-term commitment by management

CHAPTER 4

Process; Humans by nature are impatient and try to solve problems quickly, contrary to TQM's careful process analysis

Professionalisation; Professional staff can be resistant to turning over their practises and services to what they perceived as the whims of customers [Ref:4.6 Sirkin 1993].

Additionally it would be impossible to satisfy all customer whims and choices.

The TQM tools are often referred to and whilst simple, they nonetheless provide a consistent and effective range of techniques for problem analysis.

The contemporary seven TQM tools as determined by Nissan [Ref: 4.7 Nissan TQ story 1999] (in association with Professor Kando) are: -

1. Stratification - Divide the data by item. Stratification can be used to find the common points or quirks.
2. Pareto analysis - Diagram that divides the cause for a number of faults, claims etc by category and then displays them in order of size on a bar chart.
3. Fish-bone diagram - (Cause & Effect diagram) Diagram that arranges the relationship between the causes that influence the results and then systematically arranges them in a fish-bone formation.
4. Histogram - Diagram that shows data with a large amount of dispersion in easy to see column charts.
5. Graph - Graphically represent the data in an easy to understand display of comparative sizes and changes in situation over time.
6. Scatter diagram - Diagram for showing the mutual relationships between two corresponding sets of data.
7. Statistical Process Control (SPC) Chart - broken line graph of control limitation lines that displays changes in characteristic values which are used to preserve stability in process conditions.

CHAPTER 4

4.2 TQM in Nissan

Since the proposed theory of RFT Design is being tested in Nissan it is useful to note how Nissan utilises TQM and the seven TQM tools.






In 1995, Nissan set about winning the Deming Prize for Management. After forming a small Head Office group to co-ordinate activities, it launched its own TQM Initiative to “Re-establish Deming's basic rules”. In addition to re-instilling the seven tools it added a further seven: -

1. Relationship diagram - Diagram that uses arrows to logically show the relationships between the problem and the causes that influence it.
2. System diagram - Tree diagram that depicts in greater detail the steps needed to attain a target.
3. Matrix comparison diagram - Diagram that shows the relationships between two or more elements.
4. Arrow diagram - Flow diagram that consider work progress and operation steps for setting-up the optimum schedule plan and conducts process analysis for efficient management of plans.
5. PDPC - Flow diagram that shows with arrows what steps must be taken in regards to situation trends at each stage.
6. Affinity diagram - Diagram that arranges data by the affinity of data to such linguistic data as fact, opinions and ideas.
7. Matrix data analysis - Method for arranging large amounts of data and obtaining easy to read conclusions.

(In 2001, the Company consolidated these principles in its V-Up initiative and broadly adopted a 6 Sigma [Ref:4.8 Bendall 2001] approach to problem solving)

CHAPTER 4

It also defined the five basic pillars of TQM as follows:

1. Set Clear Targets 
2. Manage Using Facts 
3. Improve Communications 
4. Use the P.D.C.A. Cycle 
5. Standardise Best Practice 

These basic principles are further explained below: -

4.2.1 Set Clear Targets

Central to Deming principles of Plan, Do, Check, Action and the Japanese Kaizen philosophy (small continuous improvements). In order to improve, one must measure ones performance against a base line or target. These targets should be clearly stated, achievable but stretching. The targets should also be clearly communicated and deployed in a way that each individual can clearly understand his/her contribution to target attainment.

4.2.2 Manage Using Facts

Supported by the 7/14 TQ Tools, "Management Using Facts" encourages all employees to base their decision making on objective data rather than emotional "gut-feel". Whilst, in the extreme, this may remove management instinct, it does mitigate risk. Arguably this has led to somewhat conservative decision-making, but this says more about TQ's application rather than its intent.

4.2.3 Improve Communication

Self-explanatory, yet a problem at the heart of many companies. The principle of deploying "Clear targets" and the elimination of waste (or Muda) – [Ref:5.9 J. Womack & D. Jones 1996] all require good communication within and outside departments.

4.2.4 Use the PDCA Cycle

Taken directly from the Deming philosophy, this pillar encourages all TQM practitioners to use a Plan - Do - Check - Action approach to a project or process. Put simply, for any program, firstly be demanding and vigorous with the Plan, setting clear targets. Then execute the Plan. Check that the Plan has achieved its original targets and take necessary

CHAPTER 4

countermeasure steps to correct variance. Finally 'Action' the plan, exactly inline with the Quality, Cost and Delivery (QCD) requirements.

4.2.5 Standardise Best Practices



Having established processes and practices that are capable of delivering stated targets, ensure that they are captured and deployed throughout the whole organisation. This ensures consistency of approach and indeed aids communication. "Best Practices" are always capable of improvement and mechanisms to update are a requirement of any Kaizen System.

4.3 Right First Time Design

As previously stated, the definition or intent of "Right First Time" is rarely applied to the Design & Development discipline. In fact the opposite often applies [Ref: 4.10 Ward 1995]. Most, if not all established D & D processes demand an iterative approach to the product development cycle of Design - Make - Test - Fail - Re-Design. Almost all D & D organisations have an organisation structure that supports this basic philosophy e.g.

Design Dept:	To design, draw and release the parts.
Trial Engineering:	To procure or make the parts
Test/Experimental:	To test the part to given procedures in order to derive potential concerns with the design.

Some would and do claim that 'Right First Time' D&D is both impractical and inappropriate, encouraging over-engineering and stifling creativity [Ref:4.10 Ward 1995]. Ward in fact goes on to argue about 'set based design' where the engineers are encouraged to make a deliberate effort to define & explore sets of possible solutions, rather than modifying a single or generic solution. Once again, taken to the extreme this may be correct. On the other hand allowing "creative chaos" to prevail absorbs time and can, in itself, ultimately stifle creativity as the organisation moves from one fire-fight to the next.

However, the author proposes that a practical balance can exist between creative chaos [Ref:4.11 Prichard 1997] and RFT. This balance exists within the TQM environment and promotes creative chaos and innovation during research and concept development stages, but demands the RFT rigour during the product development stage. For vehicle development this can be conceptually mapped as follows (See Figure 4.1):

CHAPTER 4

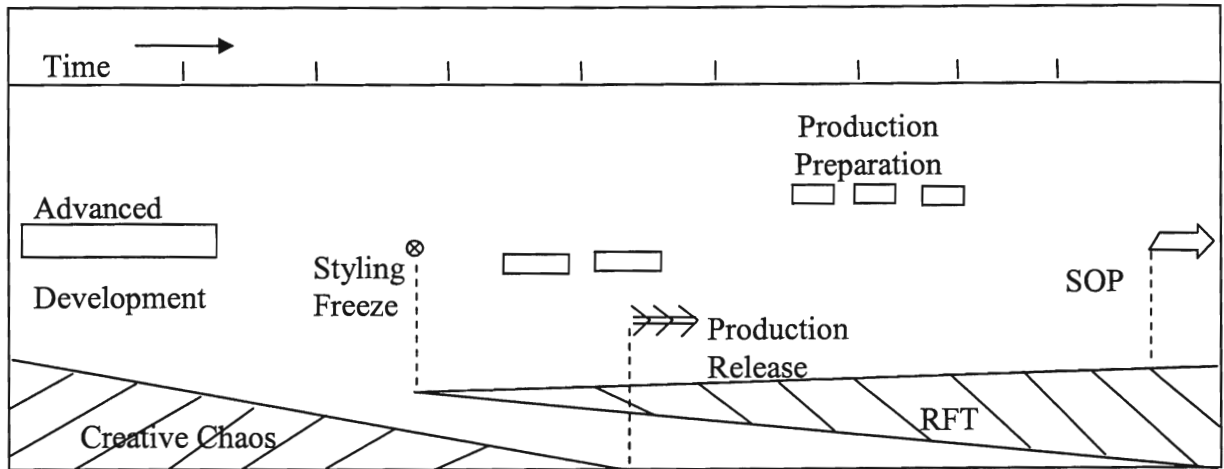


Figure 4.1—Proposed balance between Creative Chaos and RFT in D&D programmes

The diagram is the author's image of how a RFT Design environment could co-exist with a creative/innovative one. Design companies such as IDEO [Ref:4.12 Tom Kelley 2001] have determined and defined a 'Creative Chaos' means of producing innovative solutions (e.g. iMac). Likewise, Seymour & Powell famously [Ref 4.42 Channel 4 TV programme] created a new bra using similar techniques. These techniques revolve around giving 'inventors' freedom to brainstorm solutions and then mock them up. They rely on a strong understanding of customer requirements and a 'hot-house' of ideas, where no idea is readily dismissed. The creative chaos that ensues culminates ultimately in innovative solutions. However one criticism is that these companies rarely see the final product into production. [Ref:4.25 Balborter & Pazarzi, Ref 4.26 Jenkins et al 1997]

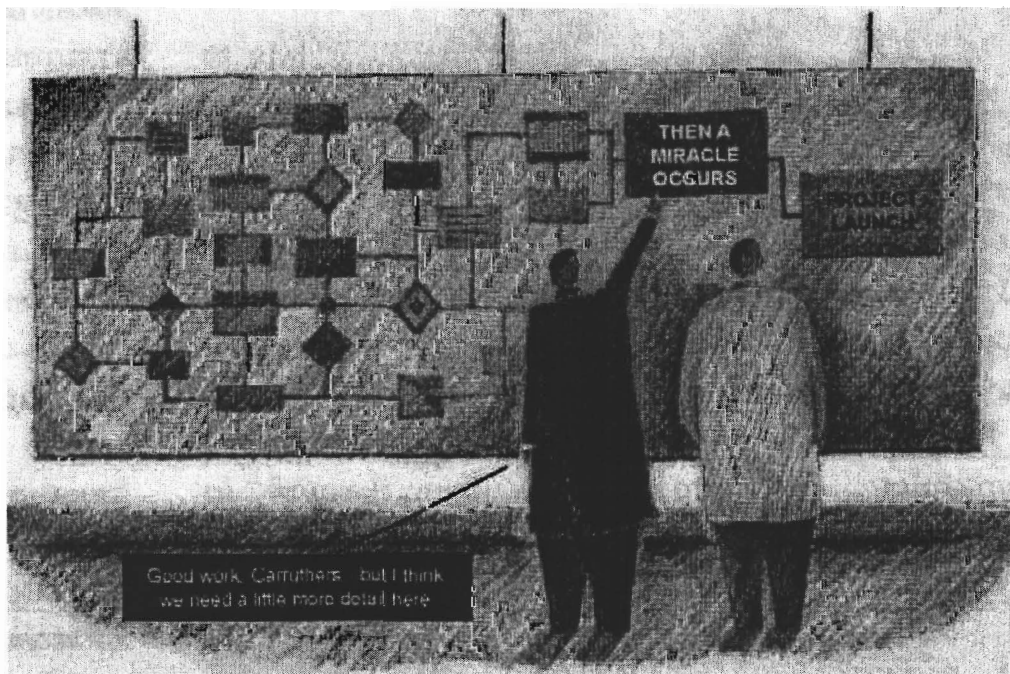


Figure 4.2 There is a better way

CHAPTER 4

Most companies report [Ref:4.13 Bourton Group 1999] that they are disappointed or unsuccessful in key aspects of their innovation projects, and 90% report no great success in meeting such profit-critical criteria as product cost targets, planned volumes and market plan. Even more disturbingly, a majority view this state of affairs as 'satisfactory' –a view not supported by the evidence shown in figure 4.5, or by the rising pressure to perform better. 'Few have mastered the management of this process' says the Engineering Council.[Ref: 4.14 Design Council 1994, Ref 4.24 PA Consulting 1993]

For several decades now the emphasis in Western companies has been on improving manufacturing operations, and there is no doubt that significant benefits have been obtained.

However, whilst they must continue to improve operations, future gains in this area are unlikely to provide the major differentials in competitiveness achieved in the past.

Yet the business pressures continue to increase, making the need for improvements ever more urgent [Ref:4.15Parker 1997, Ref 4.16 Business Process Resource Centre 1998 & Ref 4.17 Kidd 1997] Product life cycles in all sectors are decreasing rapidly [Ref: 4.37 Stalk & Hout 1990]. New foodstuffs go from idea to supermarket shelf within a few weeks. Hewlett Packard and other major electronic companies earn 50% of their sales from products less than three years old. In this environment, achievement of time to market, milestone adherence and product cost is critical. (Fig: 4.3)

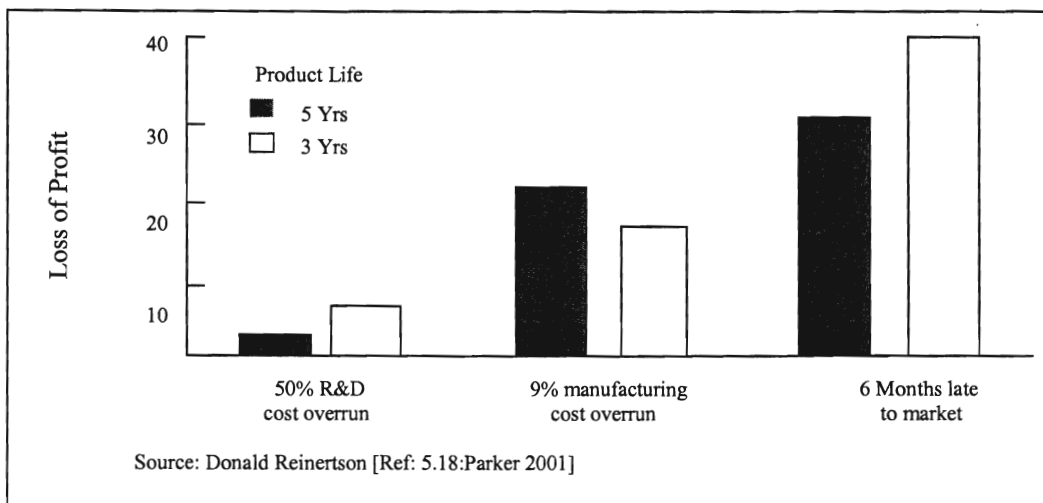


Figure 4.3: Attainment to milestone is more influential than non-recurring development costs

CHAPTER 4

It seems that there is now a general recognition amongst business leaders that they must do something different in innovation and new product development to meet these challenges. They are 'talking the talk'. However, most are not yet 'walking the walk' in the sense of doing something about it. Maybe the pain threshold for action has not yet been reached, or more likely the pain is there but the belief is that there are still easy, non-radical, solutions that will deliver the required improvements. For example, some software providers are promoting product data management (PDM) as the solution to all product development ills! The author believes that simply automating ineffective ways of working will simply enable one to make the same old mistakes more quickly.

Information technology is vital in supporting the development process but will not in itself change the process to make it more effective. The ways in which a company works are more critical than the technology you use. [Ref: 4.18 Parker 2001] The contribution of people to making new systems work can easily be overlooked in the rush to implement software. All areas, whether organisation, systems, or processes, need to be considered.

In traditional Western companies only 25% of effort on product development actually adds value (Fig:4.4). [Ref: 4.18 Parker 2001] Automating this way of working with software will not improve the situation. Most time is spent on re-work, waiting or unnecessary work. Although often a perceived solution, increasing engineering resources is not the answer.

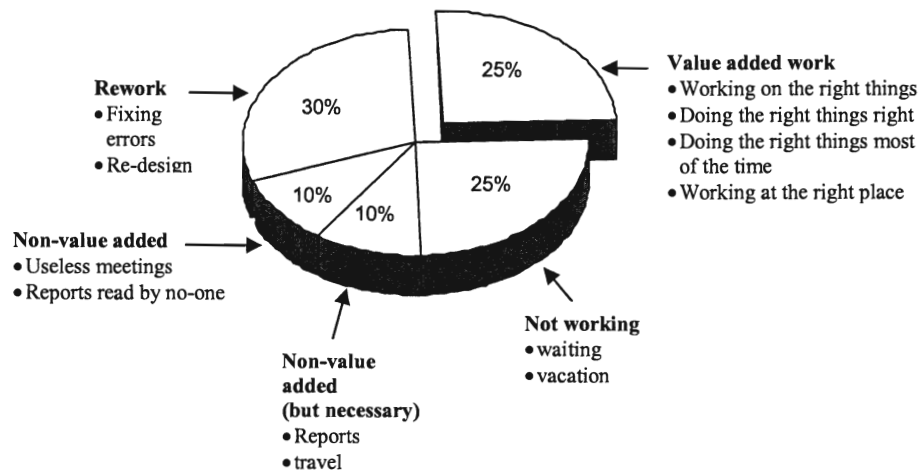


Figure 4.4: The way of undertaking NPI could be much more efficient

CHAPTER 4

The Opportunities

The financial benefits of successful innovation are enormous [Ref: 4.19 Enstone 2002, Ref 4.20 The Economist 1999, Ref 4.21 Staley & Boche, Ref 4.22 Deschamp & Noyak 1996, Ref 4.39 Smith & Reinertsen]. New products lay the foundation for future profitability through enhanced market attractiveness, increased sales and higher margins. Yet getting better products to market faster often proves difficult.

Why is this? One often finds that new production introductions follow an ill defined, poorly controlled process implemented by part-time teams working without direction in different departments.

The 2000 Bourton Group [Ref: 4.23 Bourton Group 1999] survey on innovation produced a revealing summary of inconsistencies between how companies manage innovation projects and the business objectives they seek to fulfil (Fig: 4.5). Equally telling is some of the detail behind this. Only 12% of companies routinely measure the key project performance criteria of cost, time and quality.

So it is surprising to find that over half of companies regard their innovation project management as generally 'satisfactory'. Continuing to compromise with fire fighting and overruns will not enhance future capability. Successful companies have [Ref: 4.18 Parker 2001]:

- A high quality new product introduction process.
- A clear and well communicated new product strategy
- Senior management commitment and accountability
- High quality, cross functional teams
- Best practice project and programme management
- NPI measures of performance that are regularly reported and reviewed
- Process tools and techniques that are routinely used

CHAPTER 4

Situation	Nevertheless in companies surveyed...
While few projects are a great success....	... only 40% always have clear accountability for project deliveries
While reduced time to design and market new products is a major business pressure....	... only 30% always use milestone control to ensure on-time delivery ... only 25% always have a well defined, mandatory planning method to ensure that they know what is going to be done. ... only 20% always use timing and resource planning for multiple projects to ensure projects are adequately resourced and hence delivered on time
While cost and shareholder returns are the greatest business pressures....	... only 20% always use systematic cost planning and control ... only 20% always assess the risks in projects ... only 10% always have well defined criteria for killing projects
While performance measures are seen as the best enablers to improved performance....	... only 28% always have well defined criteria for project reviews ... only 30% always use agreed measures to ensure that projects meet their targets

Figure 4.5: Behaviour does not match objectives [Ref: 4.18 Parker 2001]

As can be seen, few companies are able to take a concept into production and deliver it on time. In the context of vehicle development and the Nissan Master Schedule for development, which determines clear milestones for the evolution of a car, the author proposes a 'Schizophrenic approach' creating an organisation capable of both 'creative Chaos' and 'RFT Development' [Ref: 4.27 James 1999].

This thesis, concentrates on deriving delivery of the RFT processes through the Almera project. Later research conducted as a follow-on [Ref:4.19 Enstone 2002] studies the area of Creative Chaos.

4.3.1 Creative Chaos

Often referred to as 'Blue Sky' development, an environment must exist that allows engineers to be creative. Inevitably, many of the ideas created in this phase will fail or be proven impractical. However, an environment where creativity is nurtured will ultimately yield technology leaps [Ref:4.19 Enstone 2002]. It is important that this research is guided to some extent by customers' requirements, although this can only be used as a guide. The customer doesn't always know what he/she wants. [Ref: 4.28 Burns & Evans, 2001]. For many engineers, creative chaos will be motivational but in most organisations, it may only represent a small proportion of the total R & D budget. The major emphasis is on Application development, where successful companies apply 60-70% of their R&D capacity [Ref: 4.18 Parker 2001].

CHAPTER 4

Out of 'Creative Chaos' a few 'winning ideas' may be identified and if suitably mature, then they may be proposed to an Application program.

4.3.2 Right First Time (Application Program)

This is the main scope of this research. The RFT Design concept is tested in real-life vehicle design projects. To aid testing, a definition and a theoretical target for RFT Design is given with an explanation for this choice.

Finally the definition and target are studied through the line of historical data at Nissan. A final definition and target are then stated and shown to be based on Deming's TQM pillars, TQM tools and theory and Nissan's previous design and development experience.

The following definition is proposed. "Right First Time Design targets zero design changes after making the initial production release".

The rationale behind this definition is based largely on a cost/risk basis graphically defined below.

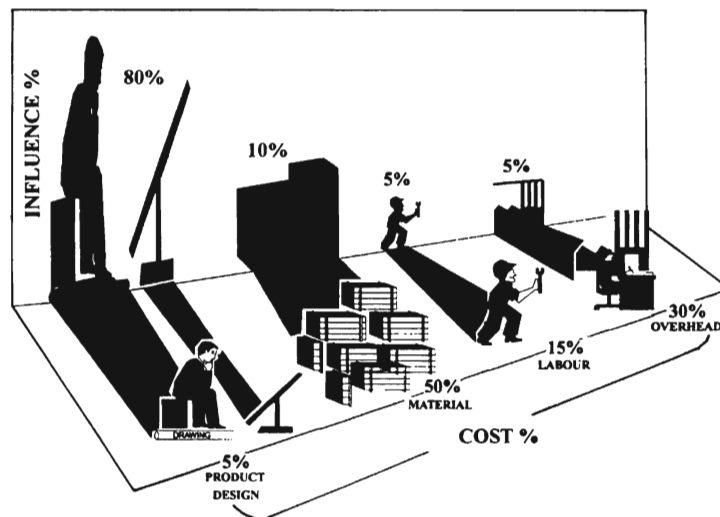


Figure 4.12 - Who Casts the Biggest Shadow? [Ref:4.29 Ford]
80% Of Component Cost Fixed By Production Release

CHAPTER 4

Proportionally, 80% to 90% of a product's cost is fixed during early design; yet 95% of the expenditure in bringing that product to market is committed after the part is released for production [Ref:4.29, Ford, year unknown].

The definition to be evolved must draw upon the TQM definitions of Deming in a 21st Century text, as well as the 'know how' of Nissan through study of its historical data.

Some contradictions naturally occur. The author proposes the necessity to 'manage using fact' and 'set clear targets'. The latter may arguably contradict Deming's 11th step of Quality Management "Eliminate Numerical Quotas". However, this step was determined in the context of manufacturing quotas being achieved without regard for quality achievement and since RFT is essentially a quality target, no contradiction in aim applies. In fact, the approach is absolutely consistent with the spirit of Deming – for example by detailed study of the quality of historical Nissan Design Notes, this is consistent in the application of Deming's step 3, which advocates 'Product Inspection' only as a means of identifying ways of improvement.

The design note qualitative data is the primary data source used in deriving a RFT approach. In addition, the definition of RFT must draw upon the following.

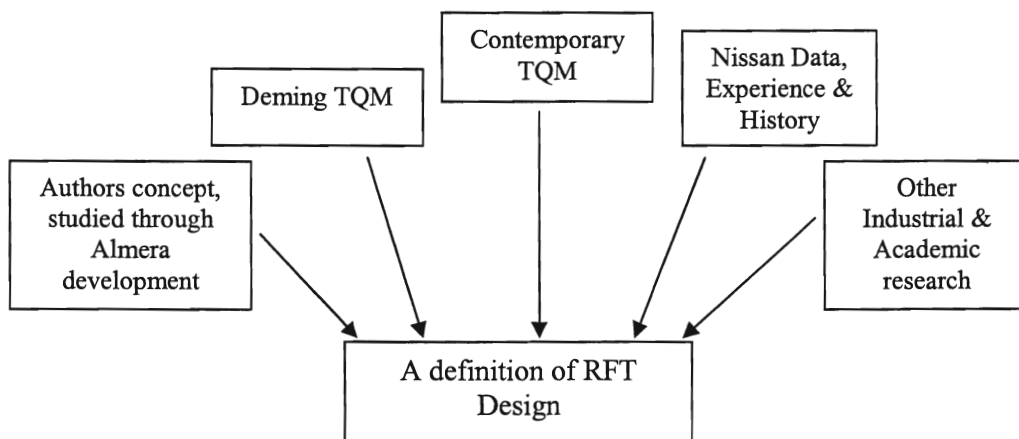


Figure: 4.6 A definition of RFT Design

Any definition of RFT Design must ensure that the design is fully proven before it is released for production. The expenditure profile for a 'typical' new vehicle development is given overleaf: -

CHAPTER 4

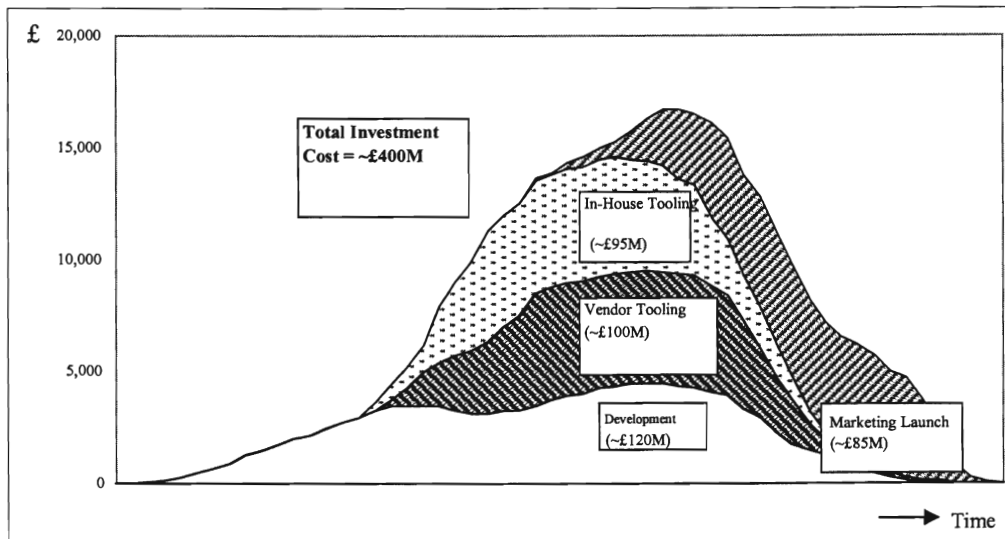


Figure 4.7 – Total investment cost for a new vehicle [Ref:4.30 Nissan 1998]

RFT Design must ensure there are no basic quality concerns within the fundamental assembly and with the reliability, quality or durability of the product after production release.

Pragmatically, "Zero design change after making the initial production release" is somewhat unrealistic and inflexible, when late specification changes may be necessary to satisfy the customer. This is demonstrated by historical evidence showing that late changes required to satisfy the changing market account for typically 15% of historical development changes – defined further in Chapter 5.

The final definition is derived from the fiscal constraints on the Nissan program being used to create the demand and 'test' this design philosophy - The 2000 MY new Almera (codename HS).

As discussed in previous chapters, the program required a 40% reduction in development costs over a previous, similar program (Primera Mk1, code name EQ).

Theoretically this could be achieved by simply cutting the budget, but allowing the resource spend profile to remain the same.

CHAPTER 4

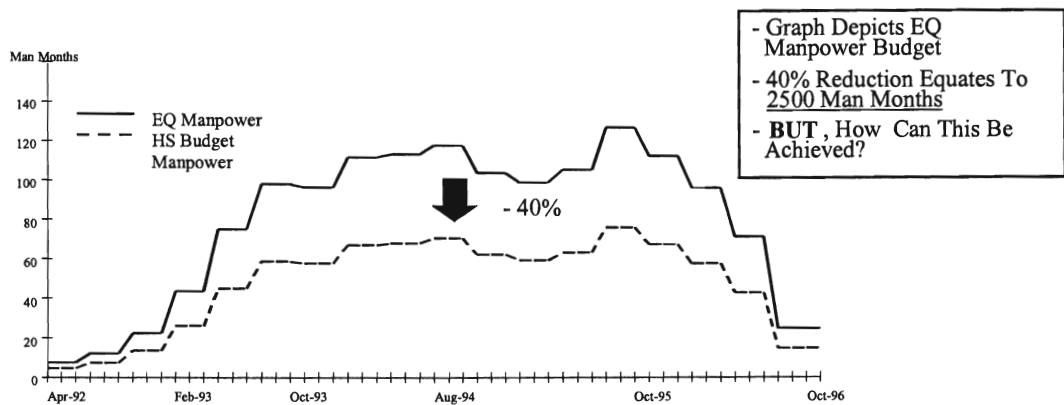


Figure 4.8 “Reduce Development Cost by 40%”

The graph depicts the number of engineering man-months spent on the MK1 Primera project of NTCE.

The development budget for HS (Almera) must see an overall 40% reduction of this expenditure (or 2500 man-months) for the development to be seen as competitive.

Simplistically, the area under the curve must be reduced by 40%, ideally by a linear reduction in spend. However, without any logic to the revised HS profile, it would be unwise to expect a program with a similar content level, utilising the same development processes to simply achieve a 40% reduction in expenditure. A logic must be derived that reduces the area under the curve by 40%, but changes the profile, such that engineers can work both ‘smarter and quicker’.

A correlation exercise was undertaken on Mk1 Primera EQ between resource expenditure (defined here as Man Months or 180 hours per person, multiplied by the number of people working on the project per month) and design change evolution (measured by Design Notes, a technique explained further in Chapter 5).

CHAPTER 4

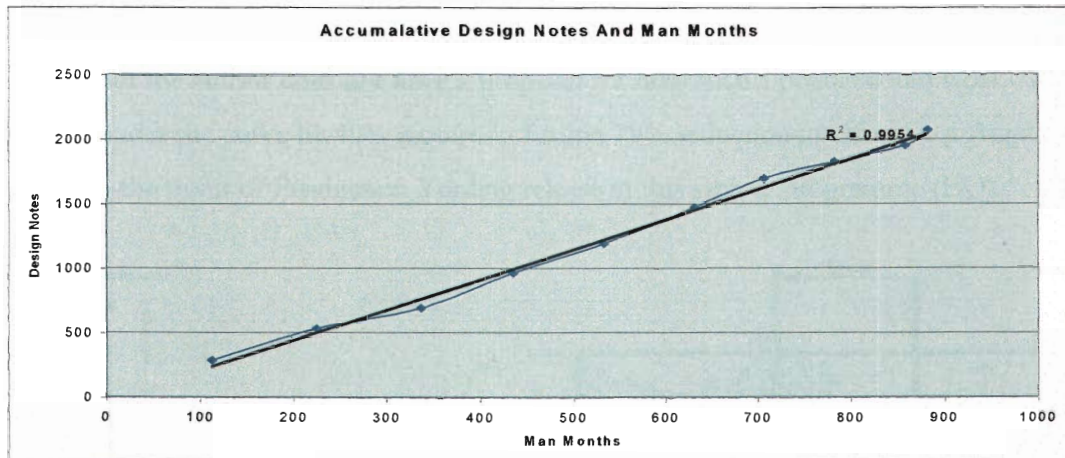


Figure: 4.9 Correlation of accumulated Engineer Time against accumulative Design Note Issue

The correlation calculation determines a high correlation between resources spend and design change calculated as 0.995. Not surprisingly therefore, we can conclude that a reduction in design change, will directly result in a reduction in manpower expended. A 1 to 1 reduction (i.e. A reduction in 1 Design Note would result in a reduction of one person month) was assumed, being consistent with an understanding (but unproven) for NTC (Japan), although the indication from the NTCE analysis (above) was that relationship is nearer to 1 person month = 2 Design Notes.

Pulling forward the program by nine months would therefore derive some benefit, but even assuming a nine-month reduction in development lead-time, a 40% reduction in resource spent would demand a 79% reduction in design change post initial production release.

Graphically this is shown as follows. Firstly the nine-month reduction in development lead-time, which was set as a business target and was therefore mandatory to achieve.

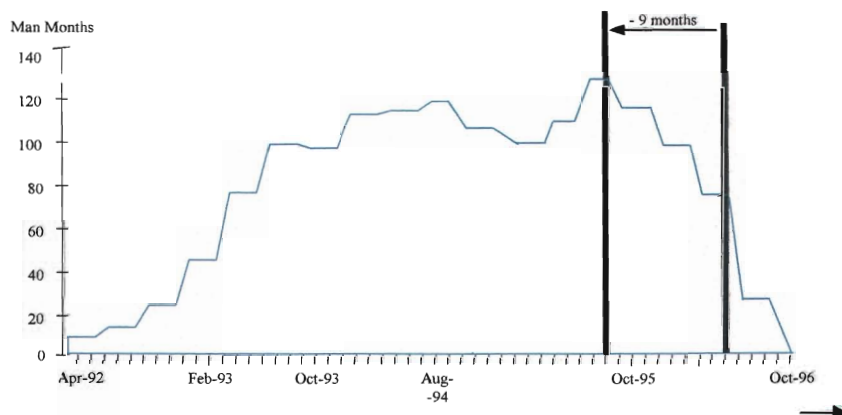


Figure: 4.10 Less Time Equates to Less Development Cost

CHAPTER 4

On its own, this strategy would lead to a reduction in Man-Months of 825 - still below the target 40%(2500 man-months) and, of course, the logical consistency of this profile is not tested – but the author does not have a proposal for how such a profile could work. To cut the area under the curve by 40% requires a further 79% reduction in effort post August '94, this being the point of Production Tooling release in this sample programme (EQ).

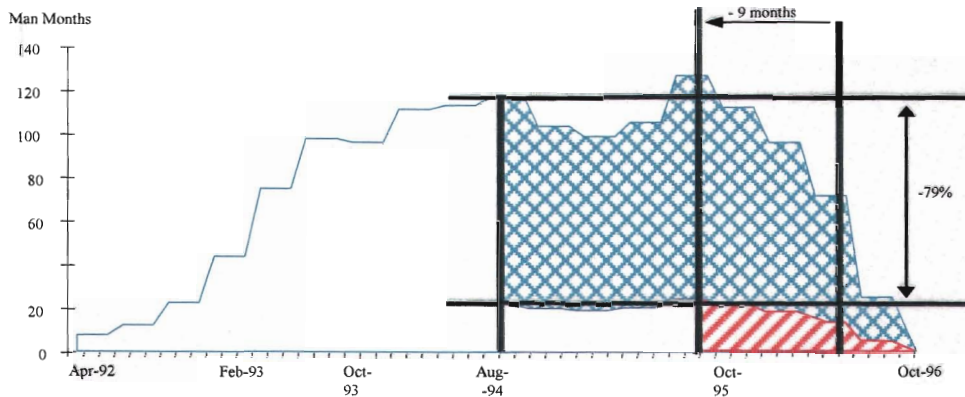


Figure: 4.11 Less Design Change Equates to Less Development Cost

An 80% reduction in Design Change, combined with the effect of a nine-month reduction in development lead-time derives a total manpower saving of 2500 man-months i.e. That required to meet budget. (assuming use of the NTC ratio of 1 man month for 1 Design change). This meets the targets of the case company in terms of effort and lead-time, but not the test of logic/practicality.

It is somewhat impractical to expect a resource expenditure curve to follow the derived target since nothing has changed in the development process to derive an 80% reduction in design change.

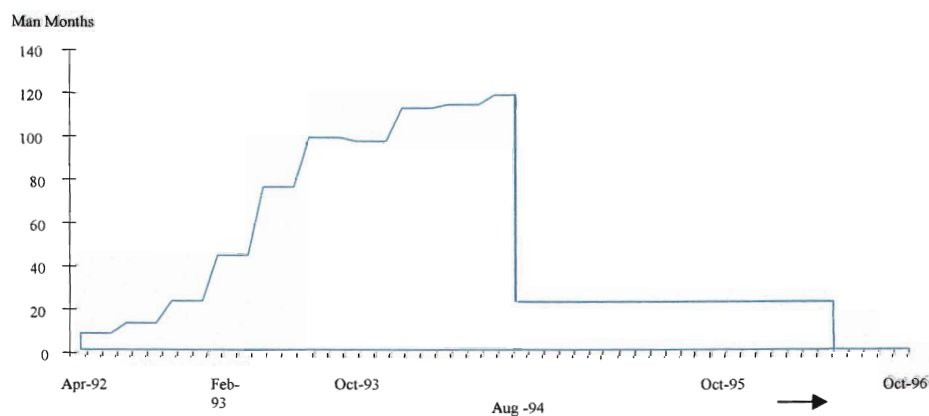


Figure: 4.12 The resultant man-power after a reduction in Design Change

CHAPTER 4

i.e. It is proposed that additional efforts, made earlier in the program can effect a later improvement – therefore the following resource profile model is proposed.

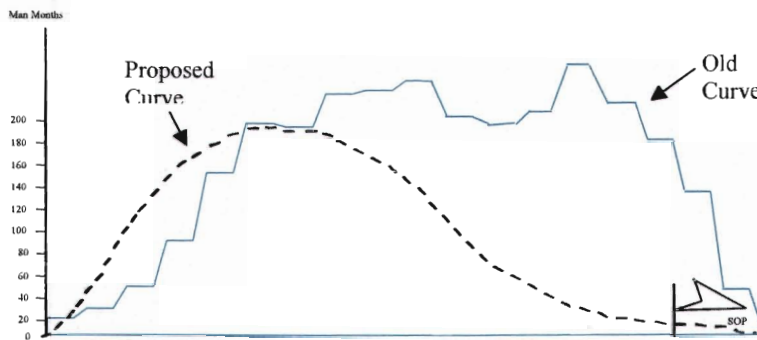


Figure 4.13 HS Manpower Budget Intent – RFT

That is to say that Design activity must be front loaded and right first time. The resources spent on testing should be for confirmation only, not design development – this demands that down-stream talent and experience must be used upstream in the original design. At the simplest level, this proposal is not novel. Front loading of Design & Development effort has been advocated by Reinertsen [Ref: 4.38 Reinertsen 1997] amongst others.

However, these lack specificity on goals and tactics required in describing how the profile might be **achieved**. The broad principle of “thinking it through while it is on the drawing board” are about the most specific suggestions made!

The final, practical definition for RFT Design is therefore proposed as follows (in the context of this Nissan HS Project);

An 80% reduction in the number of post production-release design changes compared to the previous EQ program.

4.4 RFT as a Company Policy

Having defined RFT Design in terms of its target and an expected resource profile, commitment to its achievement is required at the highest level; i.e. it is imperative that its achievement becomes a fundamental business policy [Ref: 4.31 Curtis & Ellis 1997; Ref: 4.32 Schaffer & Thomson 1992]. Assuming acceptance of RFT Design as one of the basic

CHAPTER 4

business policies, then its deployment can be managed through a novel application of Hoshin Kanri (translated as Policy Management/ Deployment [Ref: 4.3 Tennant & Roberts 2001]. This is described in a following chapter, but essentially enables all staff to link their individual annual objectives to the achievement of the RFT Policy.

4.4.1 Hoshin Kanri Policy Deployment Overview

Hoshin Kanri is a Japanese term for Policy Deployment. It is used by Nissan (among others) to disseminate the company objective/policy into individual's objectives. This project saw a modified Hoshin Kanri tool developed, to concentrate explicitly on the deployment of the RFT Design Philosophy.

The aim of this novel Hoshin Kanri is to empower people to design in quality from the beginning. This is based very much on the "No Touch" Kaizen principles of continuous improvements [Ref: 4.36 Womack, J.R., Jones, D.T., Roos, D. (1990). The Machine that Changed the World] operated to great effect by Nissan Motor Manufacturing United Kingdom (NMUK).

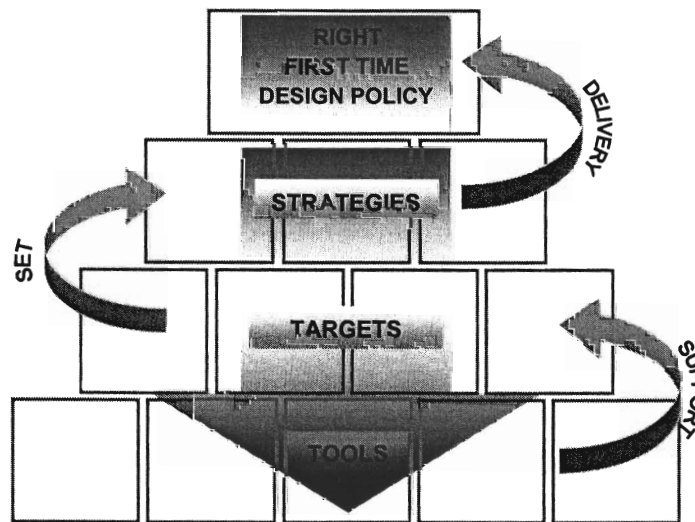


Figure 4.14 - Deployment of A Right First Time Design Policy

The Hoshin Kanri allowed a link of enabling tactics to be made back to the original objective.

CHAPTER 4

Simply, the Hoshin Kanri allows one to link Policy to Strategies to Tactics as follows: e.g.






<u>POLICY</u>	<u>STRATEGY</u> e.g.	<u>TACTICS</u> e.g.	<u>BENEFIT</u>
RIGHT FIRST TIME DESIGN (MEASURED THROUGH REDUCTION IN DESIGN CHANGE FROM EQ)	TARGET SETTING 	- ESTABLISH VLM - COMBINE DESIGN & TEST - etc.	EACH TACTIC IS ASSIGNED A DESIGN CHANGE REDUCTION VALUE BASED ON HISTORICAL ANALYSIS
	SIMULTANEOUS ENGINEERING 	- CO-LOCATE (DESIGN, TEST, ENG, SUPPLIER) - CAPE - etc.	
	PLANNING DRAWING 	- STRUCTURED DESIGN - TEST BY DESIGN - etc.	
	PREDICTIVE DESIGN 	- CAE - QFD - PREDICTIVE STRS - etc.	
	STANDARDISE BEST PRACTICE 	- ENGINEERS HANDBOOK - etc.	

Figure 4.15 – Hoshin Kanri Layout

The detailed Hoshin Kanri for the HS Project is given and explained in Chapter 5.

CHAPTER 4

4.5 Concluding Comments

The concept of Right First Time design has been introduced. The literature, when available, agrees with the concept but is void of content. The author has proposed a simple definition as a starting point and, based on the business requirement to reduce R & D expenditure by 40% and time to market by 9 months has derived a strategy to reduce design change by 80%. This is based on the high correlation between resource expenditure and design change.

This now forms the basis of the thesis whereby the tactics to achieve design change reduction are deployed and their effectiveness measured through a real vehicle development program.

This chapter therefore

- 1) Clarifies the chosen definition of RFT and the targets to be achieved
- 2) Describes the origin of the targets, defended through the derived logic
- 3) Shows how the definition is used within the research method

CHAPTER 5

A Novel Application Of Hoshin Kanri Combining Historical Analysis of Design Change Causal Factors and Associated Costs.

A Japanese technique for “Policy Deployment” is adapted to be applicable as the key tools of the “Change Agent”. The use of this tool, combined with the 11 step maturation process derived by the Nissan “Total Quality Story”, seeks to remove tactical development risks, mitigating “the leap of faith” often seen as a barrier to up-front investment in the development process. This chapter explains the Hoshin Kanri, its strategy, its tactics and the expected outcome of deployment.

The Hoshin Kanri defines the means of deployment of strategies & tactics to achieve the aims of Chapter 5. Later on, the Chapter provides the historical data by which forecasts are made within the Hoshin Kanri. This Chapter defines the source of factual data and ultimately the expected output / success (failure) of the tactics deployed through the Hoshin Kanri.

There is clearly a cost associated with changing a Design. The direct cost of obvious – the “Cash-out” of the company to pay the supplier or toolmaker to undertake the necessary modification. However, there is also an indirect cost within the company. The cost of employees spending time designing, introducing and adapting the change. The cost of one design change within Nissan is defined as [Ref 8.1 Financial Times World Automotive Manufacturing 1999] £, 13,000. Costs in other companies vary, but the principle remains the same. The latter part of this chapter explains how the figure of £, 13,000 was calculated and why it is important in the implementation of a RFT Design.

CHAPTER 5

An overview of Hoshin Kanri has been explained in Chapter 4. As has been stated, Hoshin Kanri is a Japanese technique for deploying company strategy down to an individual's annual objectives. It is used in many Japanese companies as part of the building block of the appraisal & reward systems. An example may be:

<u>Co Strategy</u>	<u>R&D Division Strategy</u>	<u>Trim Dept Strategy</u>	<u>J.Smith objectives</u>
Be a Top Quality Co with High Level Of Customer Satisfaction	Be No1 in "Which?" magazine survey 2003	Zero complaints about trim in the "Which?" 2003 survey	Review "Which?" 2002 results and ensure all concerns are countermeasured

Thus a logical link is made between the Chairman's intent and the Individual daily actions. In Japanese it is written 方針管理 and can be literally translated as Policy Management, but in the anglicised world, "Management" has become "Deployment". This chapter proposes its novel usage as an accomplice for the 'Change Agent'. The internal Nissan term "TQ Story" is used through this Chapter and Thesis to denote TQM and its deployment through Hoshin Kanri.

Fundamentally the Hoshin Kanri is organised classically, grouping Policy (80% reduction in Design Change Post Production release), Strategy, divided by TQM pillars of

- i) Target Setting (Set Clear Targets)
- ii) Simultaneous Engineering (Improve Communications)
- iii) Planning Drawing (Use the PDCA Cycle)
- iv) Predictive Design (Manage Using Facts)
- v) Standardise (Standardise Best Practice)

and Tactics, and logically linking together. Each Strategy has a named "Implementer" and each Tactic has a "Team Leader".

In this novel approach, a number of 'new' information fields are added to the 'RFT Hoshin Kanri', to allow each tactic's introduction to be measured. Included within the additional fields are,

- a) An 11 part deployment measuring system, adding a very visual means of following the status of the numerous actions needed to introduce a RFT approach to design & development [See Appendix 17]

CHAPTER 5

- b) A design change reduction objective (% required) defining the percentage reduction in design change, which could be expected from this tactic given 100% successful introduction. This should be carefully compared with the data in the 9th step of the 11 part technical deployment measuring system. This is the forecast of design change reduction expected as applied to the HS program. The sum of which must add up to 80%.

This 11 part tactical deployment-measuring system is taken from NMUK's TQ Story [Ref: 5.2 NMUK TQ Story] and can be found in Appendix 17.

5.1 Design Change Reduction Objective

On a monthly basis the maturity of each 'tactics' use in the organisation could be assessed and recorded.

As stated, the RFT 'Hoshin Kanri' also allows one to document the desired design change reduction and predict the expected benefit of each tactic' in terms of Design Change Reduction to HS. This forecast is derived from an analysis of Design Change carried out on two previous Nissan programs (DC & EQ). This is described in detail later.

Based on the tactic's maturity (measured by the 11 Step TQM process) a prediction of Design Change reduction for the HS vehicle can be made. The summation of all the tactics must add up to the 80% reduction in design change demanded by the project.

The results of the desired and expected design change reduction are given in Figure 5.7 and are explained later in this chapter. However, for a full understanding Figure 5.7 must be read in conjunction with latter parts of this Chapter, where the historical analysis of Design Change is fully explained.

The HS RFT Hoshin Kanri follows. Note, that due to commercial sensitivity, some aspects of the deployed tactics are not fully described and for confidentiality the names of all team members have been removed. However, within the titles of each tactic, one can grasp the types of tactics used and the complexity and number deployed in-order to meet the design change target.

CHAPTER 5

ITEM NO.	11 STEP IMPROVEMENT PROGRAMME											CHECK	ACTION				
	SUB-ITEM	STRATEGY	WHO	TACTIC	% REQD	TEAM	DO							9 Apply to HS	10	11	
							1	2	3	4	5						6
1		Target Setting	J. Livingstone														
1.1		- APQ Measurement		Design-in USP's improving product attractiveness	1%	A. Peckham	✓	✓	✓	✓	✓	✓	○	○	○	○	✓
1.2		- Carry-over Parts		Maximize the use of carry-over parts	16%	A. Palmer	✓	✓	✓	✓	✓	✓	○	○	○	○	✓
1.3		- Spec Notices		Define & refine the flow of spec change request	10%	A. Burton	✓	✓	✓	✓	✓	✓	▲	▲	▲	▲	✓
1.4		- Master Schedule		Define a 31 month generic Master Schedule	-	I. Blackman	✓	✓	✓	✓	✓	✓	○	○	○	○	✓
1.5		- Performance Targets		Establish targets & revision freeze dates	4%	J. Livingstone	✓	✓	✓	✓	✓	✓	○	○	○	○	✓
1.6		- C Lot Targets		Define specific CUS/NTI targets for C Lot	-	D. Lowes	✓	✓	✓	✓	✓	✓	○	○	○	○	✓
1.7		- Target Costs		Set target costs part by part	9%	S. Kennedy	✓	✓	✓	✓	✓	✓	▲	▲	▲	▲	✓
1.8		- Weight Mgt		Achieve target weight by PT1 stage	1%	Tanaka	✓	✓	✓	✓	✓	✓	○	○	○	○	✓
1.9		- DIN Reduction		Determine max allowable Design change per dept.	-	A. Palmer	✓	✓	✓	✓	✓	✓	○	○	○	○	✓
1.10		- PT1/PT2 targets		Define specific CUS/NTI/STRS targets for PT1 & PT2	-	J. Temple	✓	✓	✓	✓	✓	✓	○	○	○	○	✓
		Total			41%												32%

KEY:
 X = Incomplete
 ▲ = Partially Applied
 ○ = Fully Applied

Figure 5.1: Hoshin Kanri for RFT Design – Set Clear Targets and assess progress using 11 Step Program

CHAPTER 5

11 STEP IMPROVEMENT PROGRAMME																	
ITEM NO.	SUB-ITEM	STRATEGY	WHO	TACTIC	% REQD	TEAM	PLAN						CHECK		ACTION		
							1	2	3	4	5	6	7	8		9	10
2		Simultaneous Engineering	A. Palmer														
	2.1	- Development Job-share		Agree an appropriate job share between NTC & NTCE	-	Mr Nishiyama											
	2.2	- Copy Parts		Agree NTCE input method to NTC responsible parts	4%	A. Palmer											
	2.3	- Guest Engineers		Establish management procedure to accommodate up to 80 Guest Engineers	2%	G. Sorenti											
	2.4	- Cogent		To improve suppliers co-development capability to world class standards for the 21st Century	3%	K. Foxley S. Evans											
	2.5	- Test Engineers		Co-locate Test Engineers with Design	1%	G. Cornforth											
	2.6	- Supplier Selection		To establish a process for suitable supplier selection (ECS)	1%	M. Ewing											
	2.7	- CAD Office		Use of specialist CAD personnel during planning	6%	M. Mizobe											
	2.8	- Manufacturing Engineers		Means of input by process & co-location for M.E.'s	1%	T. Maxwell											
	2.9	- Part Quality		Improve Trial Parts quality for testing	1%	M. Howgego											
	2.10	- BOM Check		Automatic VSLAMLSB check on ANEMS	5%	T. Shirata											
	2.11	- Design Review		Improve Design Review process to compliment milestone management	3%	M. Ewing											
	2.12	- Input to NTC		Establish liaison office in NTC	-	J. Austin											
	2.13	- Cape		Introduce computer aided production engineering simulation	8%	I. Turner											
		Total			35%												26%

KEY:	X	= Incomplete
	▲	= Partially Applied
	O	= Fully Applied

Figure 5.2: Hoshin Kanri – Improve Communication

CHAPTER 5

ITEM NO.	11 STEP IMPROVEMENT PROGRAMME											CHECK		ACTION				
	SUB-ITEM	STRATEGY	WHO	TACTIC	% REQD	TEAM	DO						8 Apply on next project	9 Apply to HS	10	11		
							1	2	3	4	5	6					7 Ready to Apply	
3		Planning Drawing	J. Temple															
	3.1	- VIP		Apply "Vehicle Innovation Program" to HS Platform	See 1.2	A. Palmer									1/05/97	O		
	3.2	- Electrical Platform		Derive Electric Platform strategy	1%	P. Prior									18/09/97	O		
	3.3	- PBBS		Pre-development of New Technology	0.50%	B. Sneed									X	X		X
	3.4	- Concept Sheets		Establish procedure for concept sheets incl. Marketing	0.50%	J. Barrow									1/05/97	▲		
	3.5	- Voice of Customer		Kick off CUPID with Cranfield University	-	P. Garside S. Evans									1/01/98	▲		
	3.6	- QFD		Provide training & software plus integrate process	1%	I. Turner									17/07/97	O		
	3.7	- Component Planning		Establish generic planning drawing and use on all NTC parts	4%	K. Tomimatsu									17/07/97	O		
	3.8	- Tracking		Establish management tracking system	-	K. Tomimatsu									17/07/97	O		
	3.9	- Software		Introduce guideline for software development	1%	R. Burbridge									17/07/97	O		
	3.10	- NTC		Participate in simultaneous planning drawings with NTC	4%	M. Mizobe									17/07/97	O		
	3.11	- CQTS		Introduce forecasting method & targets	-	I. Fielding									17/07/97	O		
	3.12	- Warranty		Input of history to planning drawings	-	I. Fielding									17/07/97	O		
	3.13	- FTA		Institutionalize FTA & FMEA	1%	C. Richardson									18/09/97	▲		
	3.14	- Digital Builds		Introduce in parallel, Digital Trial build	See 2.3	N. Shone									09/12/97	▲		
	3.15	- Pre C Lot Buck		Manufacture pre C Lot 'BUCKS' for platform test	1%	J. Livingstone									30/03/97	O		
	3.16	- CUS/Nti		5 why's input to planning drawings	1%	T. Maxwell M. Ewing									17/17/97	O		
		Total			15%												14%	

KEY:	X	= Incomplete
	▲	= Partially Applied
	O	= Fully Applied

Figure 5.3: Hoshin Kanri – Use PDCA cycle



CHAPTER 5

11 STEP IMPROVEMENT PROGRAMME																	
ITEM NO.	SUB-ITEM	STRATEGY	WHO	TACTIC	% REQD	TEAM	PLAN						CHECK		ACTION		
							1	2	3	4	5	6	7	8		9	11
4		Predictive Design															
	4.1	- Simulation		Enhance CAE function with FEA & CFD Capability	1%	I. Turner											
	4.2	- Test by Design		Process to ensure suppliers & NTCE undertake STRS & NDS testing at early design stage, by analysis	2%	G. Watson											
	4.3	- FTAFMEA		See 3.13	-												
	4.4	- Homologation		To develop best practice for collection & control of design data for Homologation	-	P. Fitchett											
	4.5	-Tolerance Handover		Identify key systems for early handover to NMUJK	2%	G. Cornforth											
		Total			5%												4%

KEY:	X	= Incomplete
	▲	= Partially Applied
	O	= Fully Applied

Figure 5.4: Hoshin Kanri – Manage Using Facts

CHAPTER 5

		11 STEP IMPROVEMENT PROGRAMME																
ITEM NO.	SUB-ITEM	STRATEGY	WHO	TACTIC	% REQD	TEAM	PLAN				DO				CHECK		ACTION	
							1	2	3	4	5	6	7	8	9	10		11
5		Standardize Best 	D. Waddell															
	5.1	- Weekly Op's Report		Introduce statistical project status report weekly	-	S. Bottomley	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	5.2	- Concern Management		Introduce digital Engineers sketch pad	1%	H. Jones	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	5.3	- Engineers Handbook		Best Practice procedures in each Engineers diary	-	J. Temple	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	5.4	- "Guide too" Process		All key process characterized in ISO traceable format	3%	S. Bottomley	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Total 			4%													3%

KEY: X = Incomplete
 ▲ = Partially Applied
 O = Fully Applied

100%

TOTAL HOSHIN KANRI

79%

Figure 5.5: Hoshin Kanri – Standardise Best Practice

CHAPTER 5

11 STEP IMPROVEMENT PROGRAMME													
ITEM NO.	SUB-ITEM	STRATEGY	WHO	DO						CHECK	ACTION		
				1	2	3	4	5	6			7	8
				✓	✓	✓	✓	✓	✓	✓	9	10	11
		Guide to write a Development Report	D. James		✓	✓	✓	✓	✓	✓	Apply to HS		
i		Guide to 8D Report	D. James		✓	✓	✓	✓	✓	✓	29.8.97		
ii		Guide to obtain Applause Application	I. Turner		✓	✓	✓	✓	✓	✓	30.3.97		
iii		Guide to Supplier Data Exchange	I. Turner		✓	✓	✓	✓	✓	✓	30.10.97		
iv		Guide for Planning Drawing input	I. Turner		✓	✓	✓	✓	✓	✓	30.03.97		
vi		Guide to FMEA	C. Richardson		✓	✓	✓	✓	✓	✓	25.7.97		
		Guide to FTA	C. Richardson		✓	✓	✓	✓	✓	✓	15.4.97		
		Guide to FTA - QFD	C. Richardson		✓	✓	✓	✓	✓	✓	15.4.97		
		Guide to FTA - PA	C. Richardson		✓	✓	✓	✓	✓	✓	30.4.97		
		Guide to Plastic Parts Recycling	P. Eastland		✓	✓	✓	✓	✓	✓	25.7.97		
		Circuit Diagram Flow	P. Garside		✓	✓	✓	✓	✓	✓	25.7.97		
		Guide for typical Material concerns	P. Eastland		✓	✓	✓	✓	✓	✓	30.4.97		
		Guide to Test sample sheet – body parts			✓	✓	✓	✓	✓	✓	16.7.97		
		Guide to DCS set-up	D. James		✓	✓	✓	✓	✓	✓	30.4.97		
		Total											

KEY:	X	= Incomplete
	▲	= Partially Applied
	O	= Fully Applied

Figure 5.6: Hoshin Kanri – Example List of Designers Guides

CHAPTER 5

Figure 5,7 Hoshin Kanri Appointment of Design Change Reduction

Tactics	Spec		Performance		Cost		Work		Mistake		Other	
	Full Score	Pred to HS	Full Score	Pred to HS	Full Score	Pred to HS	Full Score	Pred to HS	Full Score	Pred to HS	Full Score	Pred to HS
1. Target Setting												
1.1 (1%)	1	1										
1.2 (16%)			1	1	1	1	4	4	1	1	9	9
1.3 (10%)	10	5										
1.5 (4%)			4	4								
1.7 (9%)					9	5					1	1
1.8 (1%)												
2. Simultaneous Engineering												
2.2 (4%)	1	1					2	2			1	1
2.3 (2%)			1	1							1	1
2.4 (3%)			1	1							2	2
2.5 (1%)			1	1								
2.6 (1%)			1	1								
2.7 (6%)			1	1			4	4			1	1
2.8 (1%)							1	1				
2.9 (1%)									5	0	1	1
2.10 (5%)									1	1		
2.11 (3%)			1	1			1	1				
2.13 (8%)							8	4				
3. Planning Drawing												
3.2 (1%)	1	1										
3.3 (0.5%)	0.5	0										
3.4 (0.5%)	0.5	0										
3.6 (1%)	1	1										
3.7 (4%)			1	1			2	2			1	1
3.9 (1%)									1	1		
3.10 (4%)							2	2			2	2
3.13 (1%)			1	1								
3.15 (1%)			1	1								
3.16 (2%)							1	1				
4. Predictive Design												
4.1 (1%)			1	0								
4.2 (2%)			2	2								
4.5 (2%)							2	2				
5. Std Best Practice												
5.2 (1%)									1	0		
5.4 (3%)									3	3		
TOTAL (100%)	15	9	17	16	10	6	27	23	12	6	19	19
TARGET (100%)	15		17		10		27		12		19	

Full Score = 100% reduction in Design Change

Prediction for HS = 79% reduction in Design Change

Figure 5.7 attempts to simplify the Hoshin Kanri to a statistical analysis that allows one to follow the forecasted achievement of the RFT Design policy (FASTD). The Tactics column lists Tactics by the Hoshin Kanri code number, categorised using the 5 TQM Pillars. It also summarises the expected maximum reduction in design change if the Tactic was fully applied and that percentage expected to apply to the HS Project. The X Axis divides reduction in design change, divided into those categories undertaken in the original Historical analysis. I.e. Changes due to Specification Changes, Performance Shortfall for example Test Failures, Cost Reduction demands, Workability concerns raised

CHAPTER 5

in Trial Assembly, pure Engineering Mistakes and Other reasons. This categorisation allows the author to relate reasons for Design Change (from the historical analysis) to the tactics that he and the team in Nissan have developed (See Figures 5.4.1 and 5.4.2). The sum of the Full-score columns broadly equate to the average reason for design change percentage seen in previous programs (Spec 15%, compares with 14% in DC and 15% in EQ; Performance 17% comparing 17% and 19%; Cost 10% comparing 10% and 9%; Workability 27% comparing 30% and 21%; Mistakes 12% comparing 13% and 10%; and Others 19% comparing 16% and 26%). This assures that countermeasures taken on HS did not over-emphasise one particular area (you cannot reduce Mistakes to less than 0% no matter how many countermeasures you make!). Thus from the table, one can see that the Hoshin Kanri tactics applied to HS always add-up to less than the maximum score, ensuring and demonstrating a broad range of tactics are applied, which totally add-up to a predicted design change reduction of 79%.

The Hoshin Kanri was used as the major tool to drive strategy development and tactic deployment, by the author between December 1996 and February 1999 (end of Pilot Plant build). An estimated 500 people were involved and some 300 FASTD badges presented for significant involvement in Tactic development or deployment. The Hoshin Kanri was frozen at February 1999 having a prediction of 79% reduction in design change (1% short of target) having been reviewed in a Senior Management meeting for every month over the interim period. The Hoshin Kanri had become the "Stress" in the organisation to continue tactical improvements even as late as Pilot Plant build. When the forecast was static at 54% for 4 months in a row, it was having this lack of progress clearly visible that motivated NTCE management to review the whole improvement cycle again with new vigour.

As commented earlier, the Hoshin Kanri was 'frozen' as of HS "ET Refine Production Release" 26th February 1999. This is the same point in time, taken for the EQ project, from which to measure the number of design changes. From this point on, it remained only to monitor the number of design changes resulting from the HS development, categorise reasons for design change, assure the quality of the HS product and consider improvements for the next project. The accumulated 'HS Forecast' was a 79% reduction in Design Change post production release.

CHAPTER 5

The route to the successful deployment of RFT, was the understanding of historical bottlenecks to RFT Design. Knowing the requirement for 40% reduction in development costs and 25% reduction in development lead-time, led to the correlation with post production release design change. As explained earlier, in this project, the prognosis and research hypothesis was that design change represents the bottleneck to resource/time reduction and that RFT was/is the policy to break through this bottleneck.

However, definition of supporting strategies and tactics can only be trustworthy when 'tested' against historical evidence of design change history.

NTCE had undertaken two projects of a similar scale in the previous five years. EQ (or 1996-2002 Primera) launched June 1996, which was the key financial reference for HS and DC (or Micra 1992-2002) launched mid 1992. Adopting the TQM Pillar of "Manage Using Facts", the detailed reasons for post production design change were analysed.

5.2 Definition of a Design Change

A key discussion point was how to count design changes.

The agreed starting point was clear. A change could only be counted if it was issued by NTCE Design. NTCE 'Approval' Drawings do not cover every dimension or feature on a given component. This is the responsibility of the supplier. NTCE drawings only cover dimension or features that effect "The quality, reliability, durability, function or performance" of a product. In general, this is given at the system or assembly level. To clarify this, NTCE modified the QS9000 [Ref 5.7 QS9000 Third Edition, 1998] Statement and added it to all its Approval Drawings as one of the tactics of its Hoshin Kanri deployment (Fast-D Project).

CHAPTER 5

This statement reads: -

‘All Design Changes and Modifications that impact on form, fit, function, performance and/or durability shall be identified, documented, reviewed and accepted by the relevant Nissan design personnel before their implementation (including child parts).

All other changes shall be identified, documented, reviewed and authorised by the relevant Nissan plant QA’.

In essence, this means

A Design Change requires written authority from NTCE before going into production (signed by at least manager level in the relevant Design Department).

- It is defined as a change to a feature, dimension or performance outside that given by the tolerance or defined as satisfactory within the test procedure.
- NTCE approval to a design change is not constrained to dimensions, features or performance given on the Approval Drawing. It covers all components and sub-systems.
- Process changes can be made without reference to Design provided they do not infringe on the Design Change criteria i.e. dimensional, feature or performance outside tolerance or standard.
- Any Design Change would normally be accompanied by STRS reports and possible vehicle testing. Its issue for production will always be formal, taking the form of a Design Note, PDN, Print Clarification, Technical Communication or the most appropriate mechanism. It will always be signed by at least one NTCE Design Manager and a General Manager in the case of vital parts.

CHAPTER 5

A "change" could then be considered on three levels.

1. By Design Note: One design note can release a number of dimension, etc, changes and is raised to release a 'package of changes' for any given system.
2. By Drawing Sheet: A design note is sub-divided by drawing sheet with all changes on that sheet being combined as one batch.
3. By Feature: Each individual dimensional or feature change is detailed by drawing issue level on the drawing itself.

A decision was taken to measure post production release design change by Design Note (figure 5.8) and Drawing Sheet (figure 5.9). By feature (figure 5.10) was excluded due to the complexity of re-capturing the data. By Drawing Sheet (figure 5.9) would later become the preliminary measurement method, being less subject to counting abuse i.e. saving up many design changes and releasing them all as a batch on one design note.

For information, a sample Design Note is given overleaf, demonstrating both a "Design Note" count and a "Drawing Sheet" count. Following this is an extract from a Drawing Title Block, showing Design Change, by feature.

CHAPTER 5

Figure 5.8 - Example of Design Note

DESIGN NOTE / 設計通知並部品計劃圖表		CHANGE/REVISE 變更		PRODUCTION STOP/START 生產停/復		WORK IN PROGRESS 在進行中	
DATE / 日期	PLANNING DEPT. / 計劃部	DESIGN DEPT. / 設計部	DESIGN NO. / 設計號碼	PRODUCTION STOP / 生產停	PRODUCTION START / 生產復	WORK IN PROGRESS / 在進行中	WORK IN PROGRESS / 在進行中
NO. / 號碼	90901 21704 (120)	90901 91600 (144)	90901 21700-B132				
DESCRIPTION / 描述	Parts modified. Fin Assy - Back Door Lower Block No. 900-91			Formulation of T2 build countermeasures for S.O.P. introduction.			
REASON / 理由	Release of Fin Assy - Back Door Lwr Dwg in accordance with Spec under HB0-3810 which requested that a specific tolerance be applied to all clip bosses to improve clip "thrust". This design note formalizes provisional design note ZIU-4231. Introductions: S.O.P.			Application: 120, 144			
IMPACT / 影響	N/A			WEIGHT CHANGE (+/-) N/A			
STATUS / 狀態	N/A			Fin Assy - Back Door Lower			
APPROVAL / 核准	[3] [7]			VT2			

Defined as One Design Change

CHAPTER 5

Figure 5.10 Example of Changes Derived by Feature

THE MATERIALS MUST CONFORM WITH NES M0304 (SUBSTANCE USE RESTRICTIONS)							
AS SHOWN	137	7:1-4 SPRNG	BRAT-RR SEAT BACK CATCH-RR, LH 76787 1F500	3			
AS SHOWN	150	7:1-4 SPRNG	BRAT-RR SEAT BACK CATCH-RR, LH 76785 1F500	2			
AS SHOWN	300	ASSY	BRAT-ASSY SEAT BACK CATCH, LH 76783 1F500	1			
DIFFERENCE							

REVISED BY	REVISED DATE	REVISED BY	REVISED DATE
DESIGNED BY	DESIGNED DATE	CHECKED BY	CHECKED DATE
SCALE	SCALE	APPROVED BY	APPROVED DATE
R			
5. SMALL IS RYNNELL ID. NC95 J-BEVYR1DGE			
DRAWN BY: 劉國輝 CHECKED BY: 鄧國輝 APPROVED BY: 鄧國輝			
PART NAME: 後座靠背 PART ID: 76783			
BRAT-RR SEAT BACK CATCH, LH			
DRAWING NO: 76783 1F500			
NISSAN EUROPEAN TECHNOLOGY CENTRE LTD			
CAD			

REVISED BY	REVISED DATE	REVISED BY	REVISED DATE
DESIGNED BY	DESIGNED DATE	CHECKED BY	CHECKED DATE
SCALE	SCALE	APPROVED BY	APPROVED DATE
1) ENDESS ADDED 2) HOLE ADDED 3) SEAT:BC ADDED 4) S/WELDS ADDED 5) HOLES MOVED 6) HOLE CHANGED			
BRAT-RR SEAT BACK CATCH, LH			
DRAWING NO: 76783 1F500			
NISSAN EUROPEAN TECHNOLOGY CENTRE LTD			
CAD			

Defined as One Design Change

CHAPTER 5

5.3 Design Change Count

A full data count was not absolutely necessary for the benchmark exercise, thus a mixture of data prevails - Mainly due to resource constraints of recovering achieved material. The analysis as presented consumed twenty-one man weeks.

	No of Design Changes
1. European DC (by NTCE)	1671
2. European EQ (by NTCE)	2495
European EQ (by NTC)	1876
European EQ (Total)	4371
3. Japanese EQ (Total)	2897
4. Japanese B14 (Total)	1261
(Typical domestic only vehicle - HS size)	
5. USA B14 Sentra (by NRD)	664
USA B14 Sentra (by NTC)	1261
USA B14 Sentra (Total)	1925
6. Japanese HS Sedan (1) (Total)	1471

NB: Important reference data for Fast-D

CHAPTER 5

The significance of each of these indices is as follows.

1. European DC - A project with a similar job-share between NTCE and NTC- Japan (but with later NTCE involvement) as HS produced in Europe by NMUK, with a similar supplier base.
2. European EQ - The primary reference project for HS macro targets including development cost, piece cost and development schedule. Having a similar job-share between NTCE and NTC as HS and the most recent projects.
3. Japanese EQ - Domestic market only, with only a 4-door derivative. However, a useful reference of comparative complexity of a global development project with an equivalent domestic only project i.e. 0,55 times as many design notes.
4. Japanese B14 - Similar sized vehicle to HS, launched 1996 into the domestic (Japanese) market only, utilising the traditional development process.
5. USA Sentra - Adding the global dimension to B14, demonstrating the benefit that Nissan sees in job-shared development with NRD (Nissan Research & Development - NTCE's sister company in USA) due to utilisation of common (Japanese) suppliers. Design change only 1.5 times that of the Japanese B14 model (No.4)
6. Japanese HS Sedan 1 - Mother vehicle of HS, but for Domestic (Japanese) sales only. The 1474 Design Notes can be compared with Japanese EQ (No.3) 2897 to quantify NTC's improvements in development efficiency i.e.51% reduction in Design notes.

CHAPTER 5

Simplistic rules of thumb can therefore be derived, generally as ratio's, which describe the relative efficiencies of domestic only verses global vehicle development, historically and contemporary i.e.

- A European manufactured D Segment vehicle e.g. EQ (4 door and 5 door) consumes 1,5 times more design change than a Domestic (Japanese) only derivative e.g. EQ (4 door).
- A Japanese manufactured D Segment vehicle e.g. EQ (4 door) consumes 2.3 times more design changes than a Japanese manufactured C Segment vehicle e.g. B14.
- A USA manufactured C Segment vehicle e.g. Sentra consumes 1.5 times more design change than a Japanese manufactured C Segment vehicle e.g. B14.
- A European manufactured D Segment vehicle e.g. EQ consumers 2.3 times more design change than a USA manufactured C Segment vehicle e.g. Sentra.

Therefore we can "correct" the analysis to directly compare USA versus Europe as follows:-

- D Segment to C Segment comparison
(See Japan EQ (2897) to Japan B14 (1261)) : 43.5%
- Euro EQ (D Segment) corrected
For C Segment : 1901 Design Notes
- USA Sentra : 1925 Design Notes
- European Manufactured C Segment vehicle should consume almost the same number of design change as its equivalent USA manufactured cousin.
- European EQ post production design change cost £20.1 million in tooling (vendor plus in-house) modification.

In-conclusion, therefore, the number of design changes expected for HS projected in a "conventional" development would range as follows:-

- Upper limit EQ level - 2497 (2 body types, 3 engine types)
- Medium EQ corrected for C Segment – 1901 (assuming a Scale down effect)
- Lower limit DC level – 1671 (1 body type, 2 engine types)

CHAPTER 5

Since HS will be a C Segment vehicle, with 2 body-types and 3 engines, the 80% reduction level needed to be taken from a value somewhere between 1901 and 2497.

Since the original objective was to reduce development costs based on EQ development Scale, a design was made to use the EQ upper limit data as reference, but corrected to add a 5% “allowance for early handover”, resulting in an assumed level of Design Change of 2750, in itself, equating to £20,1 million. Therefore, the absolute number of Design Changes to be allowed within the Project, to achieve 80% reduction, would be set as 550.

5.4 Design Change Categorisation

Having established that there were 1671 post-production design changes (measured by the Drawing Sheet method – See Figure 5.9) on DC and 2495 on EQ, further analysis was undertaken.

The design change reason was re-analysed by the designers responsible for the changes and then categorised as follows:-

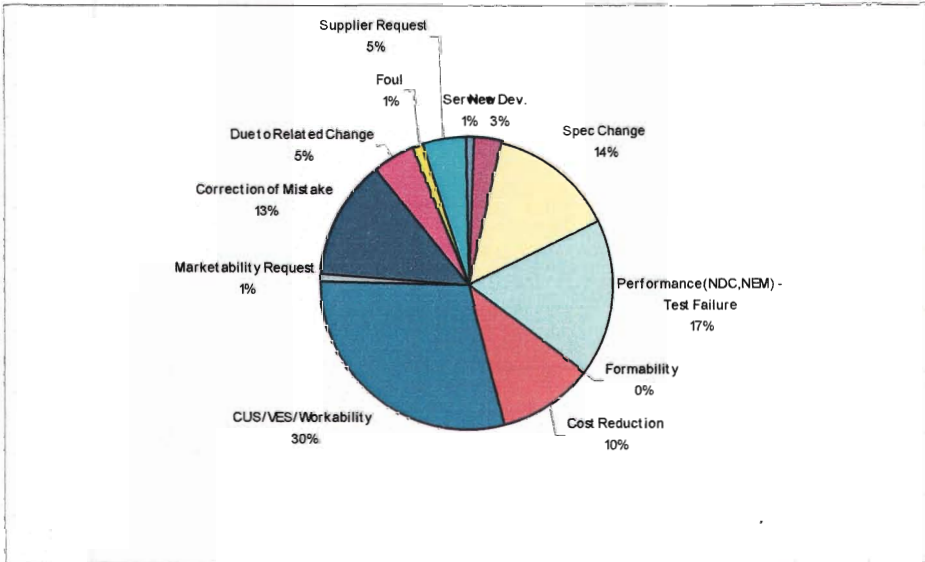
The change was due to either

- New development requested or,
- Marketing specification application change or,
- Performance/Test failure or,
- Metal formability concern or,
- Need for Cost reduction or,
- Workability/assembly concern or,
- Customer usage/marketability concern or,
- Correction of mistake or,
- Related change (due to other depts requirement) or,
- Foul with another part or,
- Supplier request or,
- Service department request

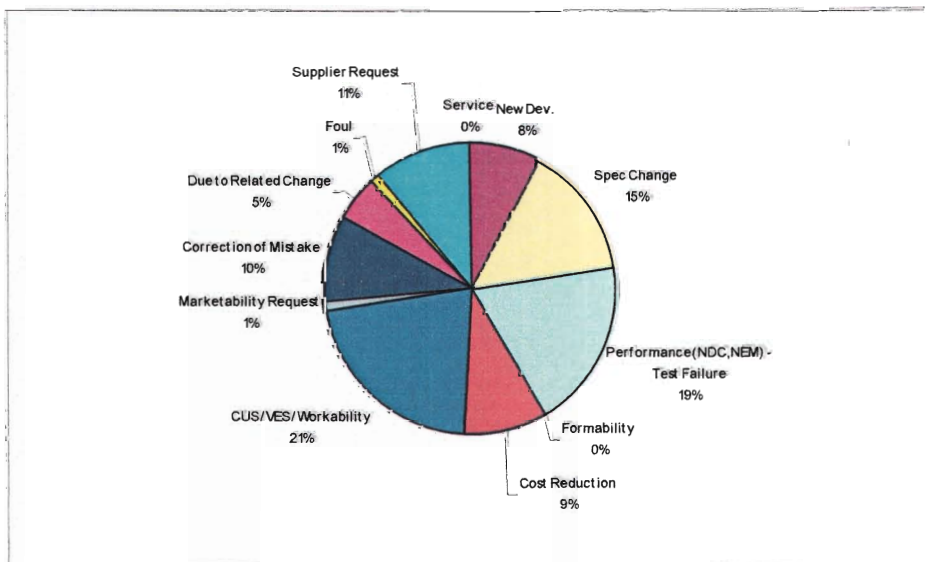
CHAPTER 5

Analysis reveals:-

5.4.1 DC Design Change Categorisation (NTCE only)



5.4.2 a) EQ Design Change Categorisation (NTCE only)



CHAPTER 5

On average therefore, Design Change between the two analysed Projects were very similar and defined “on average” as:-

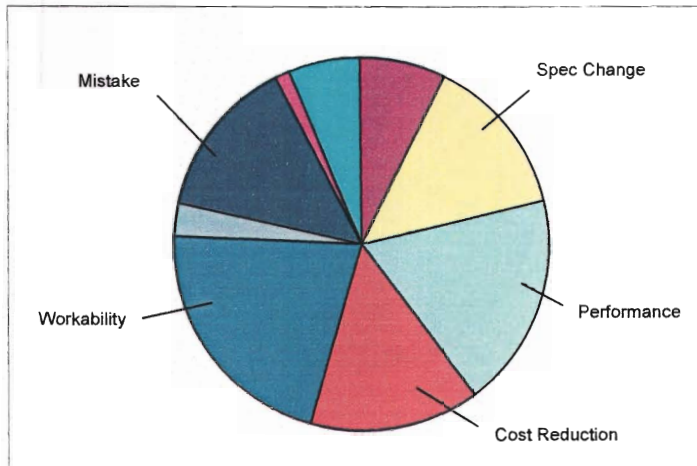
- Spec Change _____ 15%
(i.e. Changes requested by Marketing to improve Product Attractiveness)
- Performance Countermeasure _____ 17%
(i.e. Test failures requiring countermeasure)
- Cost Reduction _____ 10%
(i.e. Changes made to meet target cost)
- Workability Countermeasure _____ 27%
(i.e. Changes to improve fitting in the factory)
- Mistakes _____ 12%
- Others _____ 19%

Split by Design Section, the proportions change somewhat, depending on technology, specific job-shares, supplier capability, etc and this would become important later in defining Design Section monitoring.

CHAPTER 5

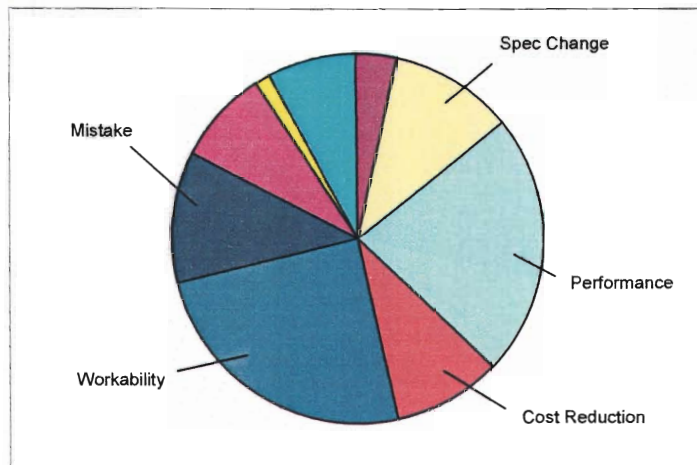
5.4.2 b) EQ Design Change Categorisation, Split by function

i) Electrical



Total changes 674

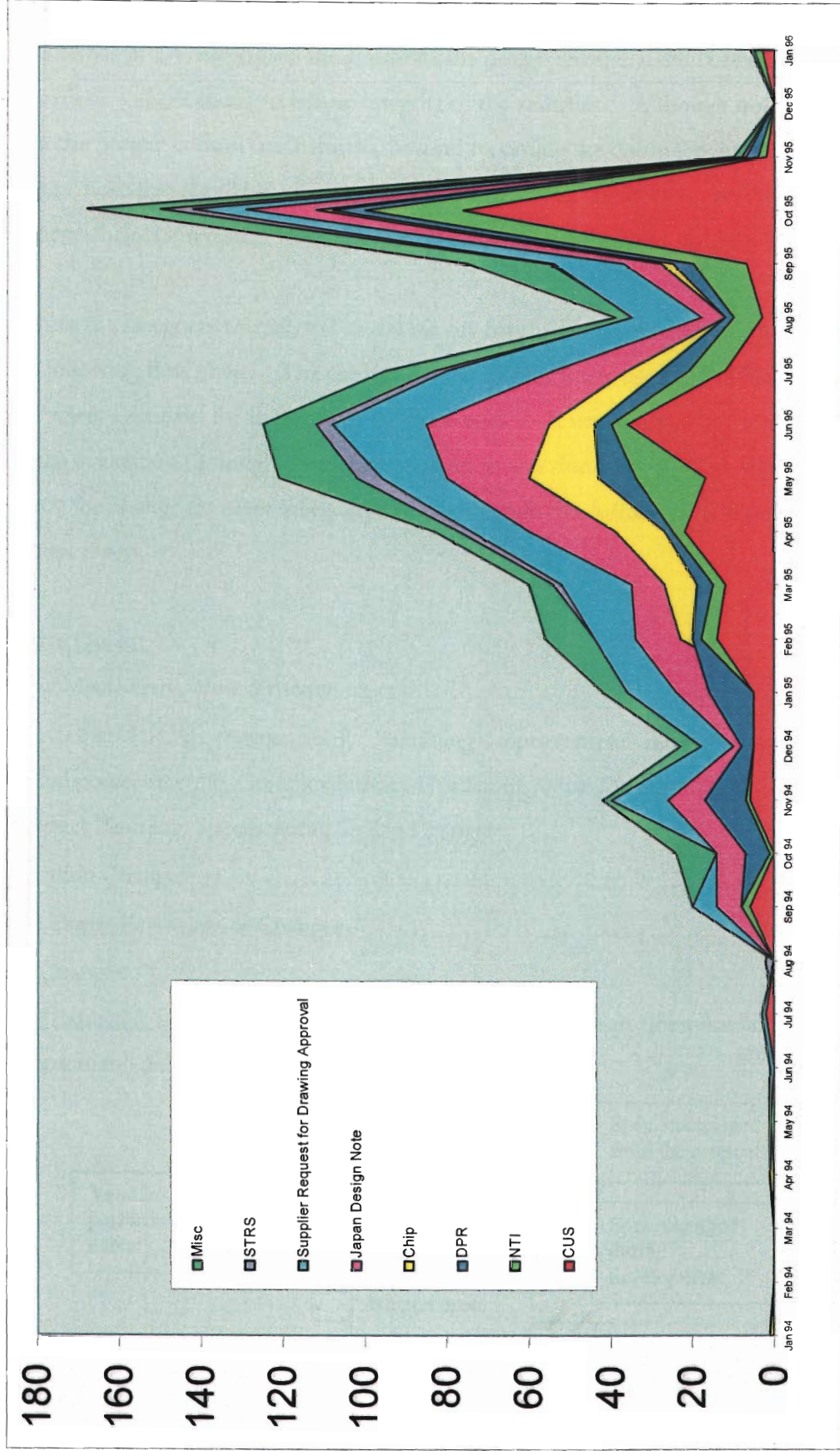
ii) Body



Total changes 757

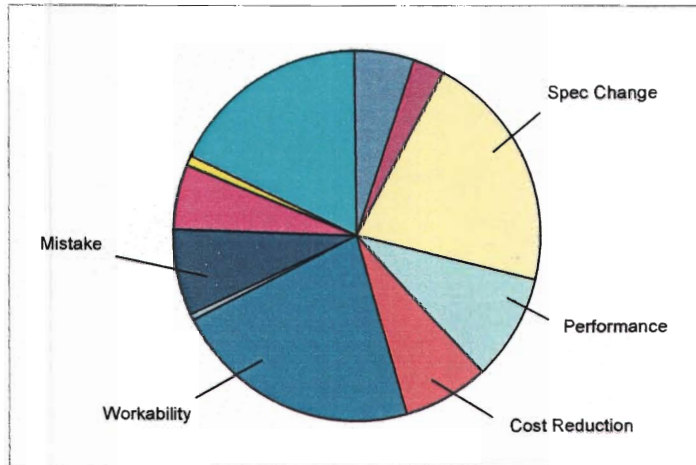
CHAPTER 5

5.4.2 c) EQ Design Change Categorisation against Time (i.e. Design Change Timing)



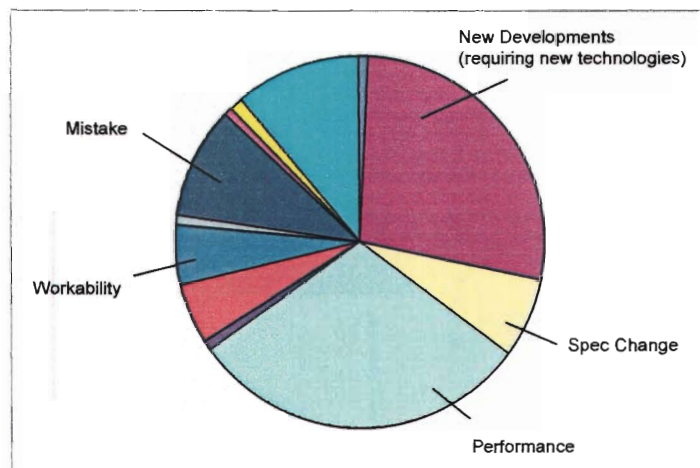
CHAPTER 5

iii) Trim



Total changes 659

iv) Chassis



Total changes 405

It was also considered useful to analyse reasons for design change over-time. The results were not unexpected. Peaks of Design Change occur at Trial Builds and during testing immediately following Trial Builds.

CHAPTER 5

5.5 Design Change Causal Analysis

Whilst the analysis in 5.4 categorised the source of the design change, it didn't reach the true cause. A further analysis was necessary to ensure integrity of the statistics. Although not finally fully exploited in the project control mechanisms, beyond recording the crude separation between “E” type changes (those that should have been unavoidable by good engineering) and the rest, this analysis is nevertheless interesting from a historical understanding of past projects.

In this analysis the designers re-analysed causal factors for the change by evaluating each change against the following flow chart. The chart was a hybrid of a chart used by Mr Nakamura-PPD (Principal Project Director) for the original Nissan Stagea. It was adapted and improved – in particular, the evaluation of design change categorisation was done for EQ with the engineer who actually made the change (in most cases) rather than through the Administration department in the case of Stagea, Japan.

1. Attractive Quality

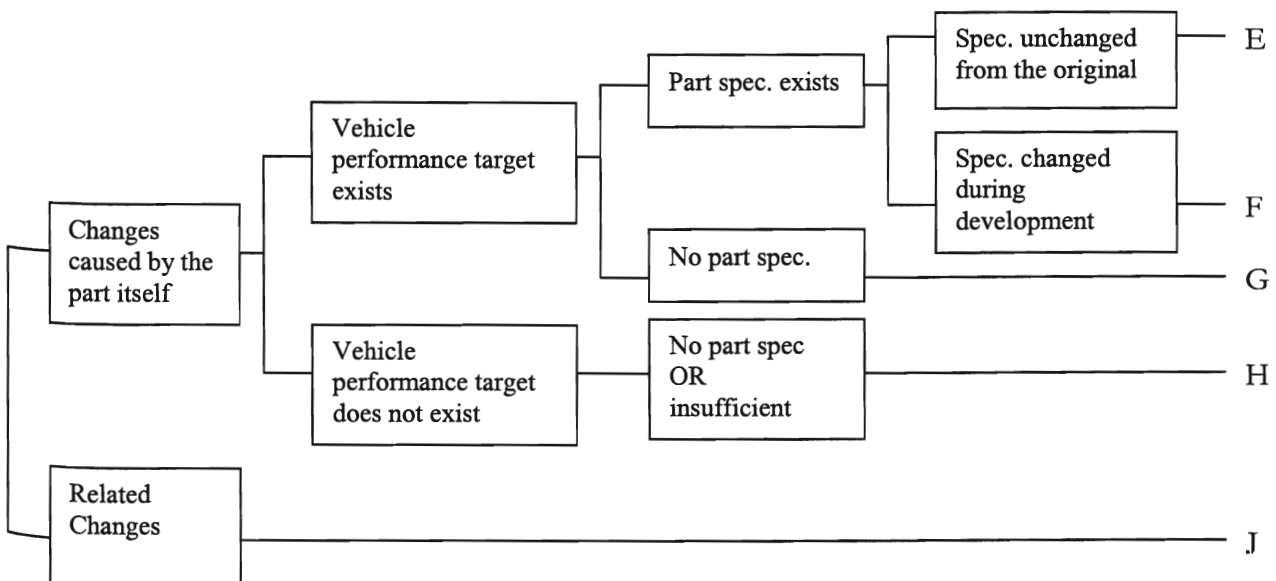
1.1 New Mechanism, New Structure e.g.....A

- Electric Super HICAS (Suspension), ‘Handling Improvement’ related parts; Electronically controlled power steering, Complex Surface Headlamps, Mini-Disc Deck.

1.2 Product Planning, Specification, Styling Changes

- Specification ChangesB
- Vehicle Target Performance ChangesC
- Styling Changes D

2. Quality Expected by Customers (and already known to Nissan, therefore should be in the specification and delivered in the design “Right First Time”)

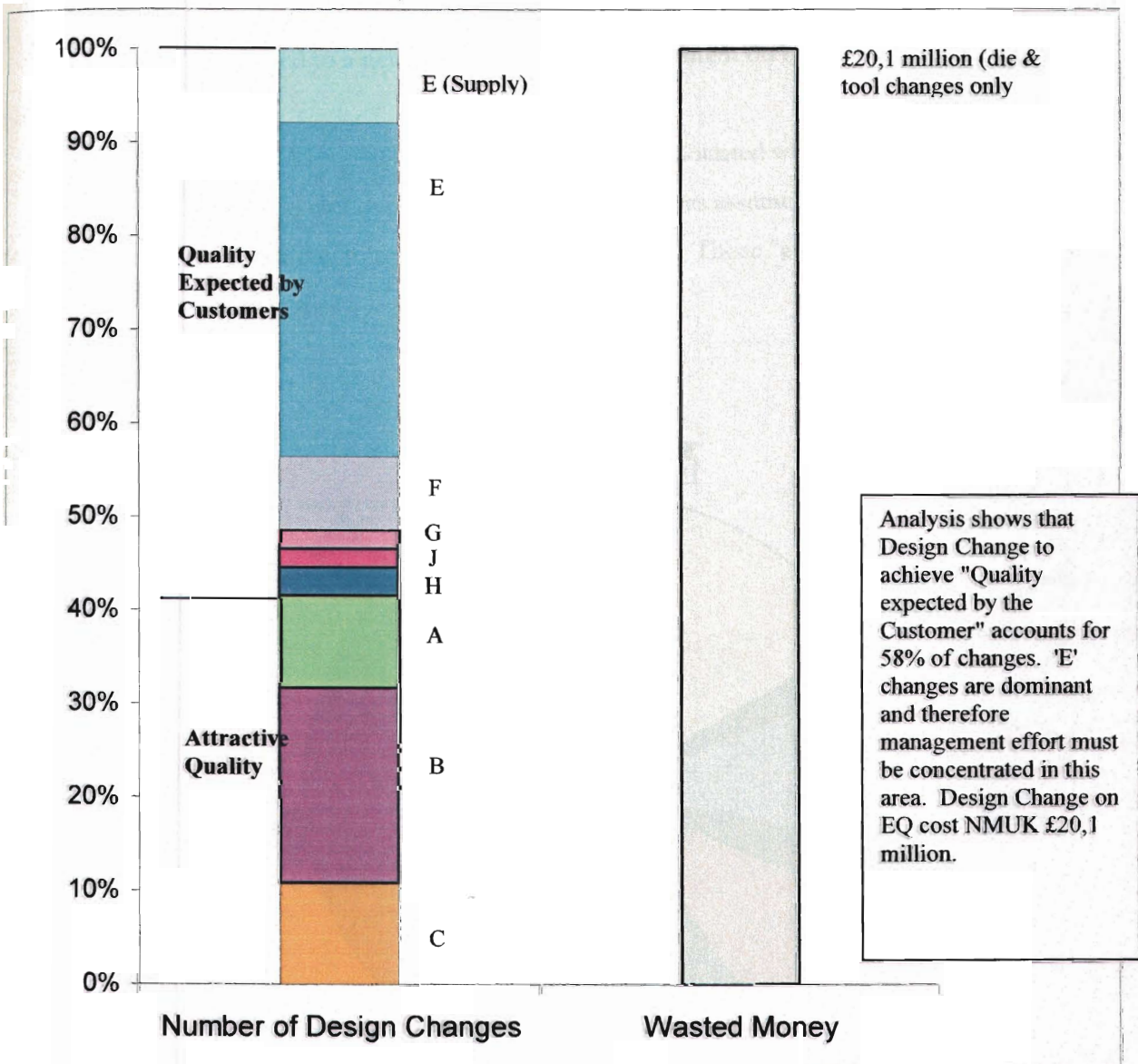


CHAPTER 5

Essentially, this places causal factors into two primary categories

- i) Quality Expected by the Customer: That is changes made to satisfy the original marketing/technical targets of EQ.
- ii) Attractive Quality: Areas of EQ enhanced during the projects life, to react to changing customer needs, as perceived by "customer representative departments" e.g. Marketing or styling.

5.5.1 Design Change Causal Factor Result



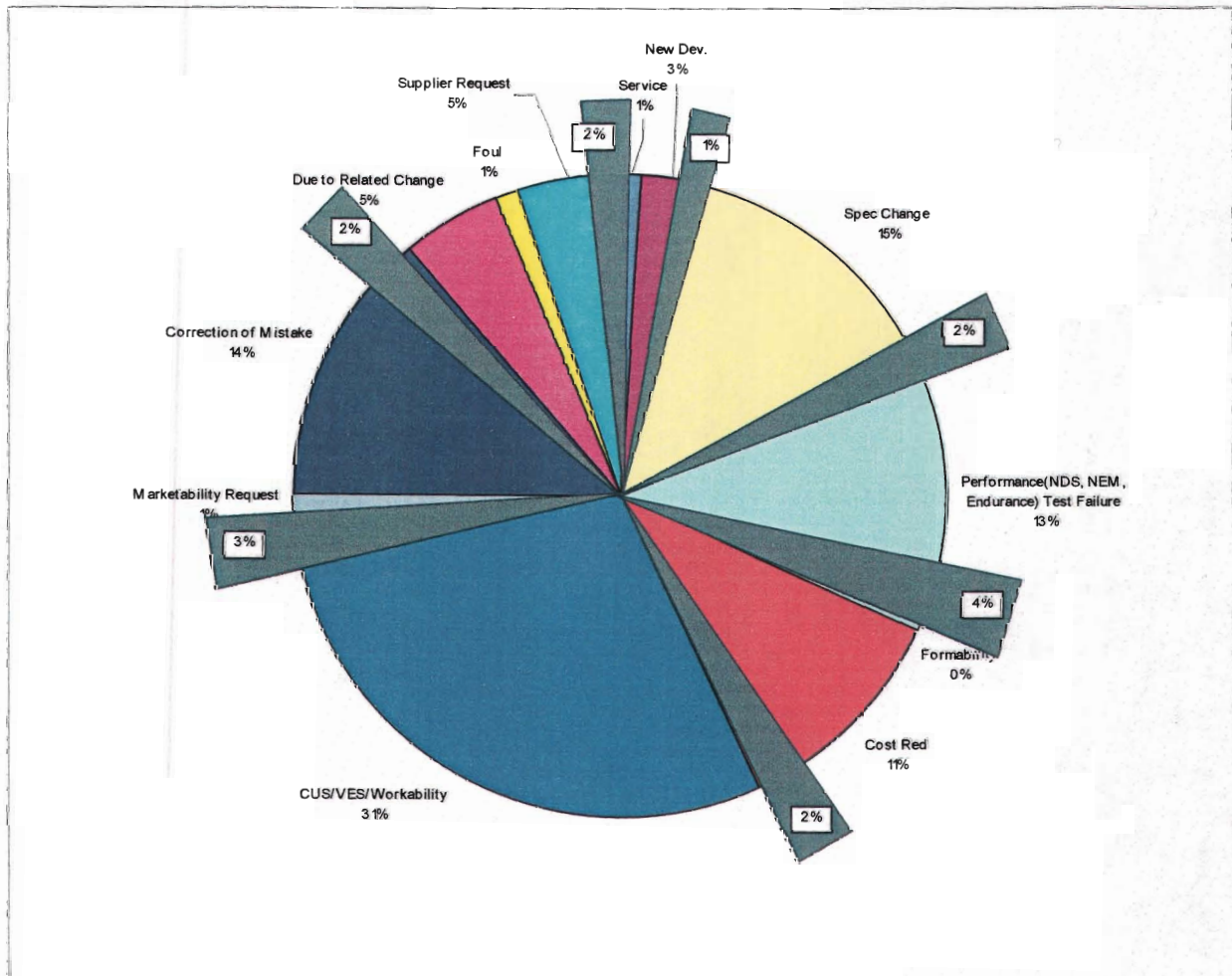
CHAPTER 5

The analysis shows that Design change to achieve "the quality expected by the customer" accounts for 58% of changes. This is equivalent to the 60% found on the Japanese Stagea project for reference. 'E' changes are dominant (circa 50%) and also show us that improvement in Engineering Predictive capability would reduce Design Change. This will please the consultants who sell technology as a solution to "Concurrent Engineering" but equally we can conclude that this in itself is not enough and that any development efficient improvement strategy must take a wider view. Design change on EQ cost NMUK £20.1 million.

5.5.2 HS Carry-over Components from EQ

On the assumption that carry-over parts from an existing model would not require further design change when applied to a new model, the carry-over content on HS was analysed.

It was found that 16% of EQ's design changes were associated with parts that were planned to be carried over (utilised without change) onto HS. i.e. it was assumed that 16% of the design changes would not re-occur due to their development maturity. Those "avoided" design changes fell into the following categories



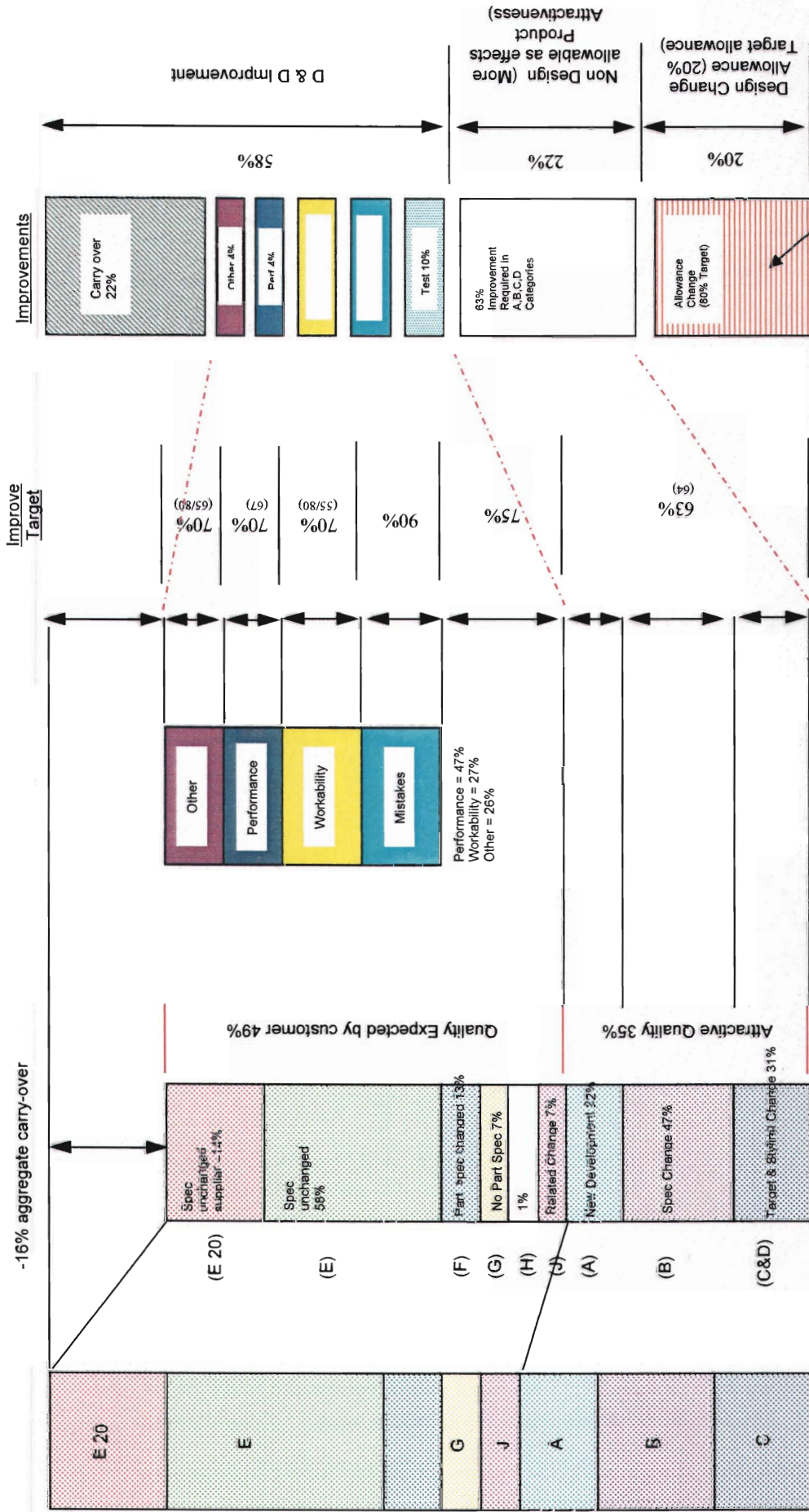
CHAPTER 5

Using the EQ data, we can thus determine the improvements required to achieve the 80% reduction in Design Change, associated with “Attractive Quality”, where it is prudent to give as much scope as possible for change, and “Quality Expected by the Customer”, which is basic engineering and where one needs to minimise Design Change.

Combining charts 5.5.1 and 5.5.2 allows us to set some tentative targets, based on the EQ data.

CHAPTER 5

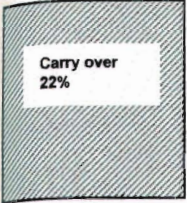
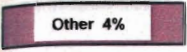
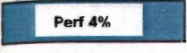
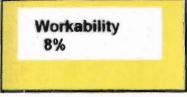
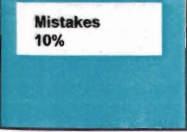

5.6 Design Change Reduction – Analysis and Tentative Targets



Each design change re-examined to determine if it was caused by external influence to Design, or if it is simply contributed to meeting the original target quality (Quality expected by customer). Improvement targets have then been set for each category (with a view to NTC's targets) which contribute to an overall improvement of 80%

CHAPTER 5

5.7 Potential Strategies and Potential Tactics for Design and Development

POTENTIAL TARGET	EXPLANATION	POTENTIAL TACTICS (brainstorming for Hoshin Kanri)
	<ul style="list-style-type: none"> Utilising "traditional" development methods the aggregate carry-over content from EQ to HS is 16% 16% includes an assumption that some changes will result even on c/o or pre-developed parts (80% and 50% of new part resp.) Improvements (to 90% and 80% of new parts resp.) are required 	<p>1) MAXIMUM CARRY-OVER</p> <ol style="list-style-type: none"> Undertake "pre-development" on new systems Control using [C] II and CDS Shelf Engineering Refer to below
	<ul style="list-style-type: none"> 70% (from EQ) reduction in changes resulting from Supplier Requests, Fouls, Formability, Services etc.. 	<p>2) INTERFACE DATA MANAGEMENT</p> <ol style="list-style-type: none"> CAD group Expert drawing checks Project Control including CDS/Base Plan Cogent (Drawing Quality & Project Management)
	<ul style="list-style-type: none"> 70% (from EQ) reduction in changes resulting from NEM, NDS, STRS 	<p>3) SYSTEM PLANNING DRAWING</p> <ol style="list-style-type: none"> Test by Design Organisation Change DR Process Revise STRS procedure Revise Copy Part definition Simulation Guest Engineers
	<ul style="list-style-type: none"> 70% (from EQ) reduction in changes resulting from CUS, Genkaku, VES, etc. 	<p>4) SIMULTANEOUS ENGINEERING</p> <ol style="list-style-type: none"> Simultaneous Planning Drawing VKS to NTC (Sim Eng) VKS "shadow" organisation B70 function to NTCE Check-Sheet establishment Improve CUS Process/Nti Process Buck, Stereo lithography, PUG VIP (Standard Structures) CAD Group
	<ul style="list-style-type: none"> 90% (from EQ) reduction in changes resulting from DPR's, Drawing Errors etc. 	<p>5) FAST D</p> <ol style="list-style-type: none"> Fast D (Designer Handbook) Auto VSLA/VSLB check APR Procedure Electronic D Notes and Check List System Overview Sheets
	<ul style="list-style-type: none"> 75% (from EQ) reduction in changes resulting from Spec Changes at Vehicle or Part Level, or related change 	<p>6) CLEAR TARGETS</p> <ol style="list-style-type: none"> Strengthen Vehicle Evaluation Organisation Change

Strategies and Tactics for Non Design and Development

A 63% (from EQ) reduction in design change is required resulting from instructions from:

- 7) Cost Reduction: Renovation of Cost Management process to avoid requirement to raise Chips to meet revised targets (resulting from Yendaka, market trends etc.)
- 8) Marketing Input: Define a Schedule from Marketing Input to avoid late changes/uncontrolled input. e.g. Spec freezes etc.
- 9) Styling Change: Define Styling Freeze and adopt this principle for Europe
- 10) Others

CHAPTER 5

5.8 Deriving the Final Targets

In developing assumptions, there is no “right answer”. However from the analysis we can determine where we expect design changes and an image of the necessary improvement required in each category. Ultimately, NTCE ended up defining a “Soft-target” in the “Spec” or “Attractive Quality” area, determining a need for a 65% improvement. Performance concerns, Cost concerns, Workability concerns and others were all determined to be improved by 75%, Mistakes by 100% and carry-over to be maximised as much as possible.

These targets are compiled from fact, analysis and adjusted to support the particular peculiarities of this development. They add up to 80% reduction in design change on a “typical” Case 2 NTCE development, taken from a historical analysis of previous data and a determination to allow on one hand, maximum freedom to Product Planners to improve Attractiveness and on the other, freedom to engineers to maximise carry-over content and commonisation.

So with all these factors taken into account, it was determined that on HS, under a typical traditional development, a forecast of Design Change would be

Forecast of HS Design Change --- 2750 changes

(Using Traditional Process)

And Reason for Changes	Spec	15%
	Performance	17%
	Cost	10%
	Workability	27%
	Mistake	12%
	Other	19%

Tactics would be developed to reduce each of these factors by the following percentage.

Spec x 65% = 10% reduction

Performance x 75% = 13% reduction

Cost x 75% = 8% reduction

Workability x 75% = 20% reduction

Mistakes x 100% = 12% reduction

Others x 75% = 14% reduction

CHAPTER 5

Improvements in these areas consistent with historical analysis were felt to be achievable and with a maximised carry-over content could achieve 80%.

Referring to the Hoshin Kanri earlier in the Chapter (Figure 5,7), it categorises the 5 elements of TQM against the 6 reasons for Design Change. This figure is again re-presented below. It shows the predicted performance in each category in respect to HS project.

CHAPTER 5

5,10 Initial Allocation of Targets and Judgement of Acceptability

	Average (%) DC/ED	Target (%)	Hoshin Kanri Production	Judgement
Spec x 65%	15	10	9	△
Perf x 75%	17	13	16	○
Cost x 75%	10	8	6	×
Work x 75%	27	20	23	○
Mistake x 100%	12	12	6	×
Other x 75%	19	14	19	○
	100	80	79	○

In Nissan nomenclature (actually Japanese education system) we judge the performance in each category as follows.

< Key >

○ = Fully achieved

△ = Marginal

× = Failed to achieve

In summary therefore, whilst the Hoshin Kanri expects to broadly achieve the overall target of 80% reduction in Design Change (79% forecast which was finally accepted as a pragmatic forecast achievement ratio on which to authorise release of Tooling), it does so by under-achieving in Cost and Mistakes, but over-achieving in Performance failures, Workability concerns and others.

This was judged as adequate to proceed as a pragmatic forecast.

Thus, “the die was cast”. The strategies and tactics defined in the Hoshin Kanri were developed to the best of every one’s abilities. A monitoring system was set-up in Design Administration to report Design Change numbers by department on a weekly basis. The total number would be “allowed” as 550 design changes. A secondary monitor also looked at reasons for change according to section 7,4 and in particular the “E” changes (avoidable mistakes) were also reported weekly – a target being set as a maximum of 275(50%) changes in this sub-category.

From this point on (February 1999), the author could only observe the results of his strategy and define the reasons for design change and the success / failure of his strategy in each category.

CHAPTER 5

5.11 The Cost of Design Change

Within the context of the Hoshin Kanri, it was also important to be able to derive a cost per design change. The Hoshin Kanri allowed us to predict from history the number of design changes that any given Tactic would save. If the tactic required any expenditure to implement it, it was important that one could demonstrate a Return On Capital. It was therefore apparent, that if one could determine the cost of one design change on average, multiplied by the number of predicted saved design changes resulting from tactic deployment, then one could derive a payback.

The Cost of Design Change is calculated here, by considering the sum of direct & indirect costs in previous projects.

5.11.1 Cost of Tooling Changes (Direct Costs)

The “Cash-out” cost of an average design change is calculated simply by taking the cost of “Design Change Contingency” on previous projects (average £20m, being made up of post-production release design changes to Vendor and In-House Tooling, modifications to Line Layout, etc) and dividing it by the member of design changes post production release (2500). Therefore the direct cost of Design Change per Program can be defined as £8K.

5.11.2 Indirect Cost of Design Change

A much more difficult calculation, is the internal cost associated with Design Change. These are not recorded in any detail inside Nissan, thus a separate analysis was undertaken.

This analysis, undertaken by Nissan’s Design Administration Department, studied all design changes in NTCE and NMUK for a period of 1 week, the averaged data being presented here (Sample size 48 changes). It is presented in Figure 5.11.

CHAPTER 5

Figure 5.11 - Hours Taken to Implements a Typical Design Change

Activity	Explanation	Hours Taken (for an average design change)
Problem Investigation (Engineer)	The time expended by the manufacturing/ test or design engineer in analysing the failure and devising a solution to prevent its recurrence.	8
Spec-tender Raising (Engineering)	Once the solution is determined, it must be formally disseminated to the supplier authorising the development of the solution into a formal & feasible proposal.	4
S/T Check (NTCE Manager)	The check undertaken by managers, administrators & buyers in authorising the release of Spec Tender information.	4
Approval Drawing Check (NTCE Manager)	Upon receipt of a formal proposal for design change from the supplier, it must be challenged & check by design review	8
Design Note Issue including Amendments (NTCE Manager)	Raising the necessary document (a Design Note) to release the design change to the BOM (Bill of Material) along with its applications.	4
Release through Admin (Design Admin at NTCE)	Checking of the BOM to ensure all applications have been correctly released.	4
Release by DCC (Production Control at NMUK)	The process of 'adapt & abolish' undertaken in the manufacturing Co. essentially releasing the BOM to production.	4
Release by Purchase to Supplier (Purchase in NMUK)	Authorisation of tooling change along with associated negotiation of Cost movement.	4

CHAPTER 5

Supplier Discussions (By NTCE and NMUK)	Negotiations on cost or timing associated with the change, usually involving engineers & buyers.	8
Drawing Updates (Engineer)	Resulting from discussions, a proportion of the changes will be subject to modifications & on-going negotiations.	8
Re-Release (NTCE and NMUK)	Re-release of changes & confirmation of which Spec Tenders should be applied for the next trial build.	8
Timing Negotiations (Production Control of NMUK)	Detailed negotiations on delivery timing for prototypes, packaging requirements & on-going Design Change adoptions.	4
Cost Negotiations (Purchase)	Finalisation of cost effect negotiations resulting in release of cost data to the purchase computer system.	4
Release Change (Authority / DCC)	Adoption of the change into the BOM.	4
Filing, etc (All)	Tidy-up work on filing, etc.	4
Total		80 man-hours

The cost of 1 man-month is £10,000(from NTCE Finance Dept),

Thus 80 hours work is $10000(\pounds)/4(\text{wks}) \times 40(\text{hrs}) \times 80(\text{man-hrs}) = \underline{\pounds 5000}$.

CHAPTER 5

5.11.3 Direct & In-Direct Costs

Direct Costs	£ 8,000
Indirect Costs	£ 5,000

Total Cost of Average Design Change	<u>£ 13,000</u>
--	-----------------

Note: The concept of “lost opportunity” is not used here. For example, we are not calculating the value of new car sales by launching the car early, or the impact of employee frustration and resignation. These categories would be very difficult to validate and may reduce confidence in the rest of the calculation, which already shows a significant impact as £13k per design change

5.11.4 Why Is This Useful?

In the context of this project and indeed, in the world of engineering, knowing this cost and having it accepted by the company’s accountants is a “God-Send” because it quantifies the often mysterious world of engineering into a terminology understood by non-engineers. That is to say, the engineer can now point to a tool that will reduce design changes by 10 and say it will save the company x Euros/Pounds/ Yen per project, thus deriving a Pay-back period of Y.

Linking to the Hoshin Kanri, we can define by data and fact, the forecasted reduction in design change by introducing a new tactic. For the sake of argument, let us take the example of CAPE [Ref 5.8 Kochan, Anna 1999].

CAPE in Nissan is a software package that allows digital models of components (together which constitute a complete motorcar), to be assembled on a virtual assembly-line in a computer, thus enabling the Design Engineer to detect assembly problems without the need for a physical trial build.

CHAPTER 5

Through adoption to HS project, the calculated reduction in design change was 4% or 100 design changes per project. The average cost of these 100-design changes can now be delivered.

$$100 \times \pounds 13,000 = \pounds 1,300,000$$

The capital investment of CAPE at NTCE was £40,000. Needless to say, one doesn't need to be an accountant to understand the economics of the argument and orders for the system were immediately placed.

The uniqueness of the formula should not be lost. Earlier in the Chapter, the "Leap of Faith" was explained. As will be shown later in the thesis, other engineering companies had been unable to "take the leap of faith" needed in investment of time and energy upfront in the development program. However, Hoshin Kanri, linked to a thorough historical analysis of design change reasons, linked to a tactical deployment forecasting system in "Design change unit" plus knowing the cost of a 'Design Change' mitigates the risk. We no longer need to view the up-front work as a "Leap of Faith", we can view it as an investment with a definable ROI.(Return On Investment) .

5.12 Conclusions from Chapter 5

The purpose of this Chapter has been to describe the generic process of Hoshin Kanri and how it was applied to this project. For reasons of commercial confidentiality, it is impossible to detail exactly the tactics that were deployed through the project in-order to reduce design change. However, it's possible to grasp the general thrust of each tactic and its predicted effect to reduce design change in the case company.

The final documentation relates deployed tactics and their forecasted improvements with historical analysis of design change on previous projects. The Hoshin Kanri represents the core management tool deployed over a period of 2 years to drive the project from a factually based perspective and ensuring adoption of TQM tools. One should therefore consider this novel application of Hoshin Kanri as part of the Intellectual Property in Design Change reduction management – The author thanks Nissan for allowing it to be explained in this Thesis.

Finally, a cost for every design change eliminated is derived, allowing an ROI to be established for the project

CHAPTER 6

The Results at the Start of Production

The Initiative to reduce Design Change by 80% was wrapped up in a Program called FASTD. FASTD became the central focus of NTCE for a period 1996 to 1999 and figured highly in the annual corporate objectives. It represented the focal point for winning the D+D contract for the HS vehicle and seeing the commitments achieved.

Almost all Technical Staffs of NTCE were involved in some way, either through tactical development or in the post analysis and countermeasure phase of the project. All those staff directly involved were awarded with a FastD “badge of Honour”.



FASTD (an acronym for Fast Development and “Find Away to Streamline Development”) was also designed as a Knowledge Management initiative. From Figure 6.6, one can see a list of Designer Guides. These represent the capture of the processes developed through the Hosbin Kanri and validated through this project. They are indexed to the Generic Master Schedule of a 31 Month vehicle development schedule. They represent the core knowledge of Nissan in achieving a 31 Month vehicle development with less than 200 design changes. This information is highly sensitive and can only be referred to in this thesis.

The Designer Guides were contained in an Engineers Handbook – the concept was one of a Filafax, containing the Engineers Diary. The thinking being that Engineers will use their Diary daily, but a Central Procedures Manual would simply “gather dust”.

In 2003, the Engineers Handbook has been succeeded by an Intranet based Knowledge Management System, but nevertheless, linked to the Engineers Microsoft Scheduler and other Corporate Standards. The Design Guides are still published and updated, because the activities planned through this research were successful and achieved their aims, both in terms of an 80% reduction in Design Change, but also in terms of a 40% reduction in Development budget. As can be seen in the following Chapter, some of the Secondary measures did not achieve their targets, but were compensated by over-achievements in other areas. This chapter explains and elaborates on the practical results from the implementation of RFT Design.

CHAPTER 6

6.0 THE RESULTS AT “START OF PRODUCTION”

With the planning completed, the development started in earnest. It is also true to say that iterations of the Hoshin Kanri continued in an attempt to reach the 80% forecast.

Continuous monitoring of design change and the reasons for design change were also introduced. These were reported weekly (at the Directors Weekly Operations Meeting) in a simplified means i.e. Total Design Change and Class E1/E2 changes (those that should have been avoidable).

For the purpose of completeness in this thesis, the final results have been analysed at a number of levels, not only those used internally within Nissan. This thesis also benefits from hindsight and the ability to review causal factors of the actual changes encountered on HS.

Looking firstly at the primary measurement of Design change, both at “Design Sheet” level and by “feature” (see Chapter 5). Analysis has also been undertaken of the “control mechanisms” or “secondary measurements” leading up to a design change.

- CUS = Workability Concerns
- STRS = Supplier Testing Concerns
- DCS = Vehicle Testing Concerns

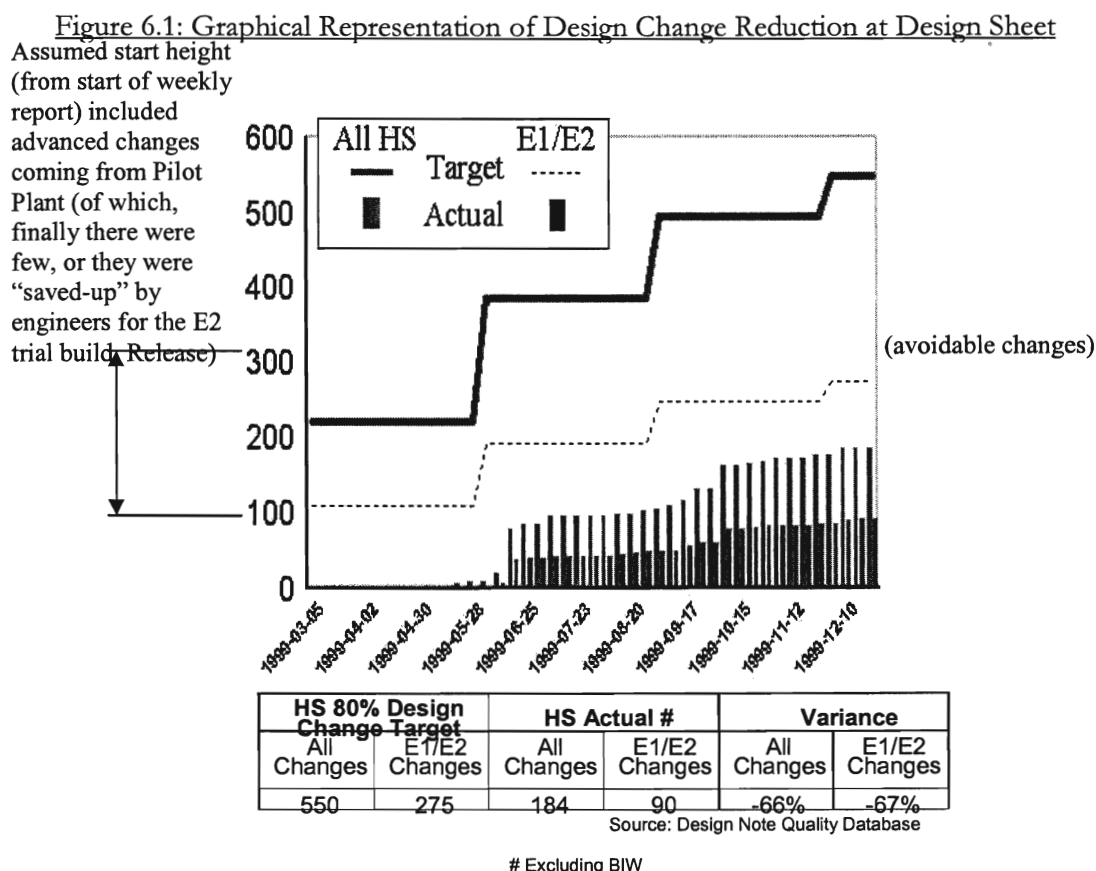
For reference, a number of other factors have been evaluated for completeness of Project Performance measurement e.g. Trial Parts delivery and resource effectiveness. All of this data ultimately feeds into the T Matrix (Chapter 7) for analysis within this Thesis and feedback to future Nissan projects.

6.1 Design Change Reduction

Using the Primary “currency” of Measurement, the project achieved its aim of an 80% (actually 93.3%) reduction in Design change. That is a measurement of design change by “Design Sheet Level”, which was deemed as a good balance of measurement reliability versus complexity of data collection. The measurement system also took into account

CHAPTER 6

differences in “job-share “ between HS and the previous models of EQ and DC that had been used as the reference. That is to say that Body in White (Metal Panel) design changes were excluded. This was due to an evolution in NTCE responsibilities between EQ and HS, with NTCE taking responsibility for the Engineering on a greater proportion of the vehicle



The graph above represents an extract from the Weekly Report, tracking design changes from E2 trial build through to SOP (Start of Production). Using this tracking system, a target of no more than 550 changes was established, with actual changes amounting to 184. This equates to the previously mentioned 93.3% reduction in design change.

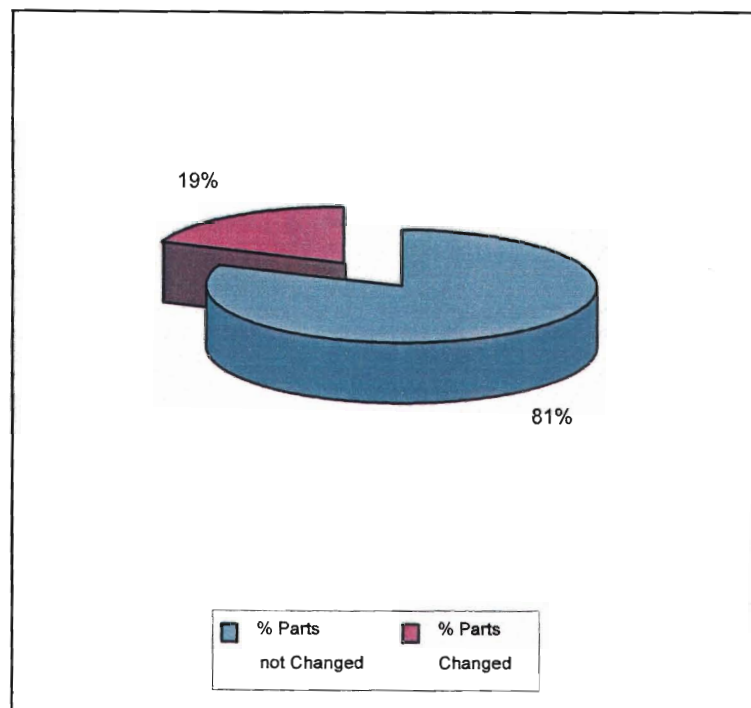
During post-project analysis, the author was able to make a more in-depth analysis of the design change through a one-week review of all the drawings (cross referenced to ANEMS –

CHAPTER 6

the Nissan Design Release System), reviewing each and counting the number of revisions to each part. Utilising this secondary measure of measuring design change on any one of the 4500 parts under NTCE responsibility, an 81% reduction of design change reduction was observed.

This count also included those design changes deemed not to have borne a “Design Change” cost. The original hypothesis was to reduce design change, thus reducing the “Cost of Design Change”, therefore there was a body of thought that non-cost bearing changes should be excluded from the count (for example, adding a note on the drawing). Ultimately the author felt uncomfortable with this exclusion, arguing that any change bears a cost, even if only one of Engineers time to release the change. It is also a measure of efficiency and clearly falls into the E1/E2 category of changes that should be avoidable. In the final analysis, the two schools of thought issue was irrelevant, since the 80% reduction target was also achieved at this level, including those changes with (arguably) no cost bearing (See Figure 6.2).

Figure 6.2: Design Change at a Feature Level (Drawing Issue Level)



CHAPTER 6

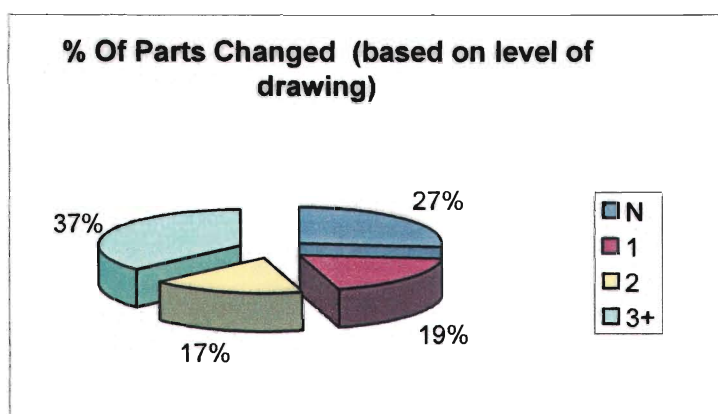
FROM HS BOM (ANEMS)			
All Parts	No. of Changes*	% Parts not Changed	% Parts Changed
4500	857	81%	19%

Source: Design Note Quality Database & ANEMS BOM for HS

*includes non cost effect changes

A further analysis of parts having design changes greater than 3 (See Figure 6.3) was also undertaken (in this analysis, Body Design Changes, which were not included in the target, (as not under NTCE's responsibility in the EQ count) were now included). This is an interesting analysis as it demonstrates that almost 40% of those parts that were changed, changed 3 or more times. In this instance, Design Change is measured at Drawing Feature level (the most detailed level, therefore picking up even on minor mistakes, such as spelling corrections)

Figure 6.3: Percentage of Drawings at Design Change Level 0(N) & Greater



Drawing Level	No. of Changes	%
N	1558	27%
1	1092	19%
2	1011	17%
3+	2152	37%
	5813	

Source: ANEMS

CHAPTER 6

In detail, the 10 parts having the greatest number of design change are given below

NTCE Top 10 Parts With The Most Drawing Changes

	Part	Changes	Comments
1	Headlining	9	Modification to design of components forces
2	Accelerator Pedal	8	Cost reduction
3	Headlamp	8	Due to being a Reverse KD component, Design changes were forced from Japan. Cost reduction and crash test results also forced design changes.
4	PKB Device	8	Styling Changes
5	Accelerator Cable	7	Cost reduction Releases
6	T/M Control Linkage	7	Marketability requests to change shift feel.
7	Door Mirror	7	Addition of workability instructions plus part Development/tuning
8	Headlamp Cleaner	7	Component incorporates a telescopic feature. As this design is new to Nissan it required Additional refinement
9	Inside Mirror	7	Drawing clarification, plus part development/tuning
10	Player Cassette	6	Cost Reduction exercises combined with part development

This is an interesting analysis in terms of future improvements, as it suggests there are some “chronic” concerns in the development of these part types. If these concerns can be addressed in more detail and better understood, further improvements may be possible in the future.

6.2 Workability (CUS) Analysis

A number of secondary analyses were undertaken to ensure that a pure reduction in design change was a legitimate measure of design efficiency. The first analysis concerned itself with a reduction in workability concerns (See Figure 6.4), the primary cause of design change on both EQ and DC projects. The analysis below, details the issuance of CUS (Come Up Sheets), the paperwork system for recording workability concerns.

From the analysis below, the total numbers of CUS raised on ED (1731) were reviewed and their raising profile “corrected” to that of the HS development schedule (40 months to 31 months).

CHAPTER 6

These 1731 “Potential Concerns” were then tested against the HS Planning Drawings, through the Simultaneous Engineering Teams. i.e. The Manufacturing Engineers in the Sim. Eng. Team made an evaluation of the historical concerns against the planned vehicle. The testing took many forms, including one of CAD simulations, mock-up or Engineers instinct. In total, 1760 concerns were reviewed (i.e. all the ED concerns plus a number of other ad-hoc issues) and 841 “Advanced CUS” were raised. The raising of these Advanced CUS, forced the Design Engineers to take Design Countermeasures to the satisfaction of the Manufacturing Engineer within the Sim. Eng. timing (i.e. Prior to Prototype Tooling release).

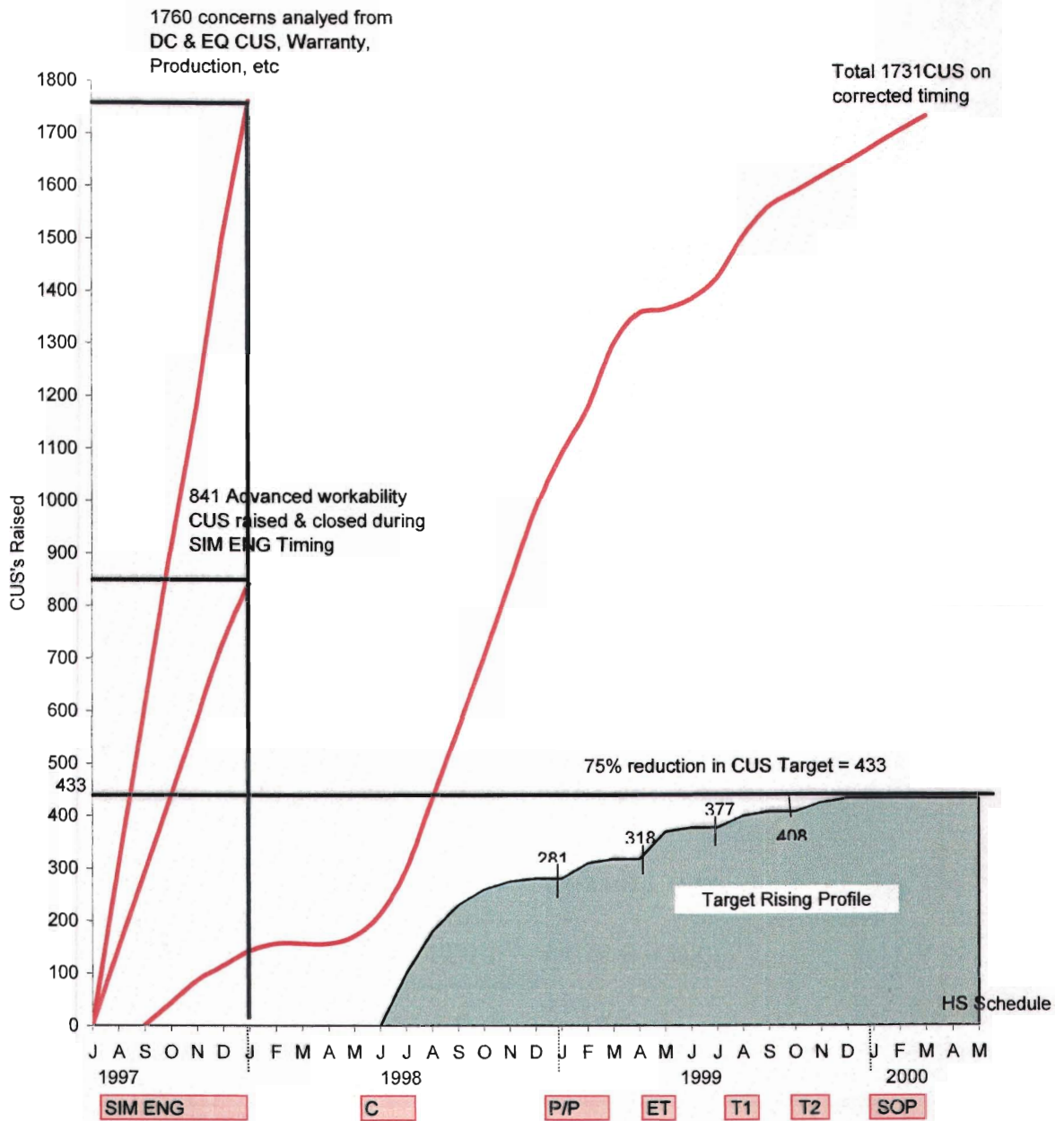
This activity was consistent with parts of the Hoshin Kanri Tactics given in Chapter 5, items 2.7, 2.8 and 2.13. The target to reduce Workability by 75% was also applied to the raising of CUS (there is not a 100% correlation between Design Change and CUS raising, but for ease, this correlation was assumed). The target was therefore set for a maximum number of CUS, at each build, totalling 433. This is demonstrated graphically below.

Some notes on the process are premised here

- At the planning stage (Simultaneous Engineering Activity) a manufacturing concern checklist was created and used as a tool to evaluate design concepts.
- The concern checklist was created from previous CUS analysis (e.g. DC, ET), facility constraints, workability, current concerns, supplier concerns and post SOP reworks.
- Ok judgement checked at Design Review 2 (DR2)
- FASTD simultaneous engineering activities between factory and design to reduce CUS included e.g.:-
 - Torque rationalisation.
 - Fixing rationalisation (to Nissan Engineering Standard-NES).
 - Variation control
- Actual aspects of how this activity was under-taken cannot be shown due to commercial sensitivity.

CHAPTER 6

Figure 6.4: Target Development for CUS Raising Profile



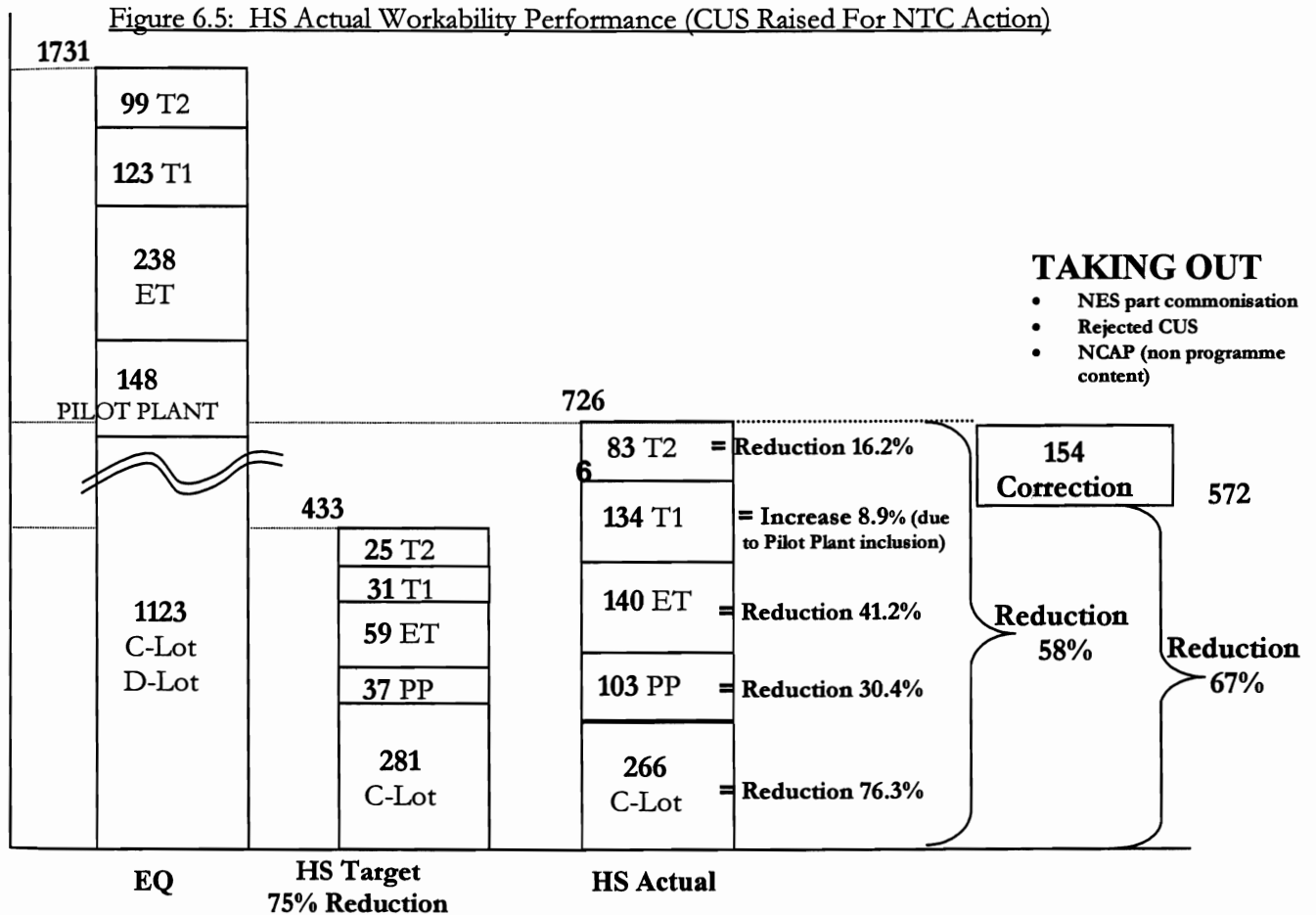
Against the 433 maximum CUS raising target and excluding CUS for BIW (to equitably compare EQ with HS vehicle programs), a total of 726 CUS were actually raised. To be strictly correct, it was felt appropriate by the author to exclude 154 from this count. The 154 were as a result of 3 reasons

CHAPTER 6

- 1) NES Commonisation – an initiative started after development planning, to reduce the complexity of fixings carried on the two Production Lines in NMUK
- 2) Rejected CUS, where the CUS was an incorrect evaluation of the concern
- 3) NCAP related – Marketing changed the target for NCAP Crash performance during the program from 3Star to 4Star. This resulted in a large additional activity and new countermeasures being introduced to production at T1 and T2 builds for the first time – thus additional workability concerns.

Finally then, the corrected number of CUS raised was 572, some 139 CUS above target.

Figure 6.5: HS Actual Workability Performance (CUS Raised For NTC Action)



Notes on Achievement against Targets

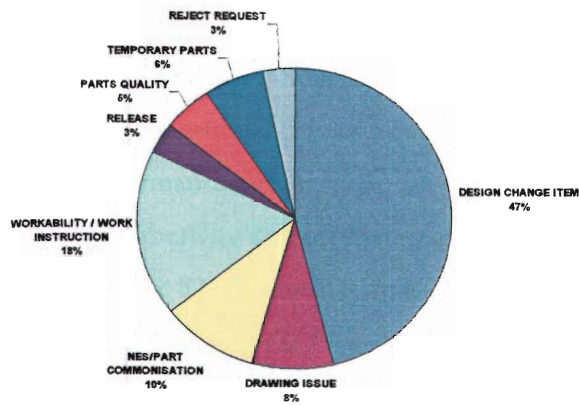
To assess the CUS reduction target achievement of 58% or 67% vs 75%, the following should be considered:

- A total of 61 CUS were raised for NES parts commonisation. This was particularly important for HS because it had to share the NMUK line with DC and therefore its NES parts. This was not the case with original EQ development.
- A total of 87 CUS raised by NMUK Engineering on NTCE were rejected for reasons including quality and temporary part application.
- 6 CUS were raised on NCAP 4* modifications (prior to inclusion in the HS NCAP programme).

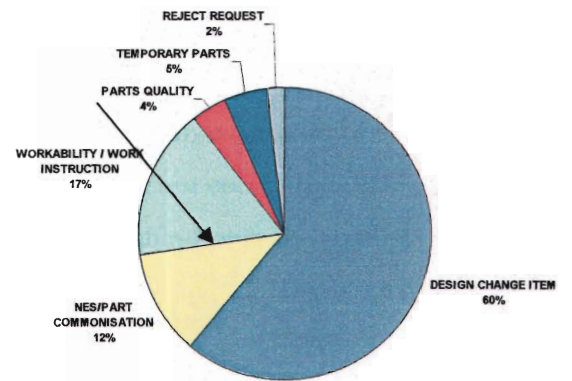
CHAPTER 6

The reasons for raising CUS at each checkpoint and Trial Build are analysed below (Fig6.6).

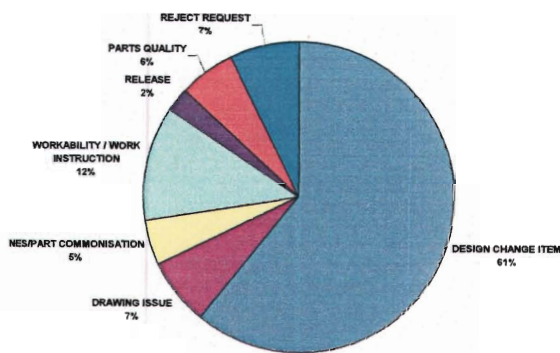
Figure 6.6: CUS~Reason Analysis



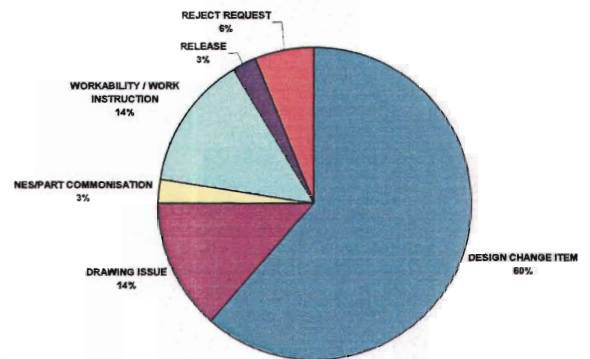
C-LOT CUS ~ Total 266



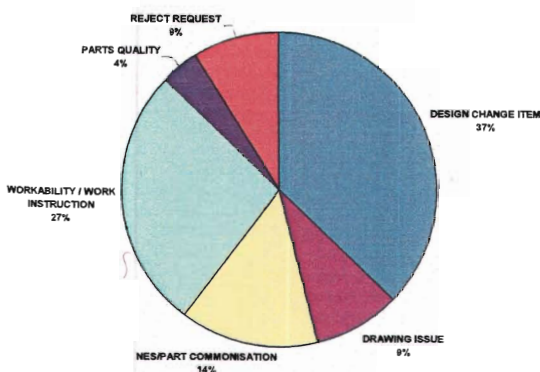
PILOT PLANT CUS ~ Total 103



ET CUS ~ Total 140



T1 CUS ~ Total 134



T2 CUS ~ Total 83

Notes on the Pie-Charts

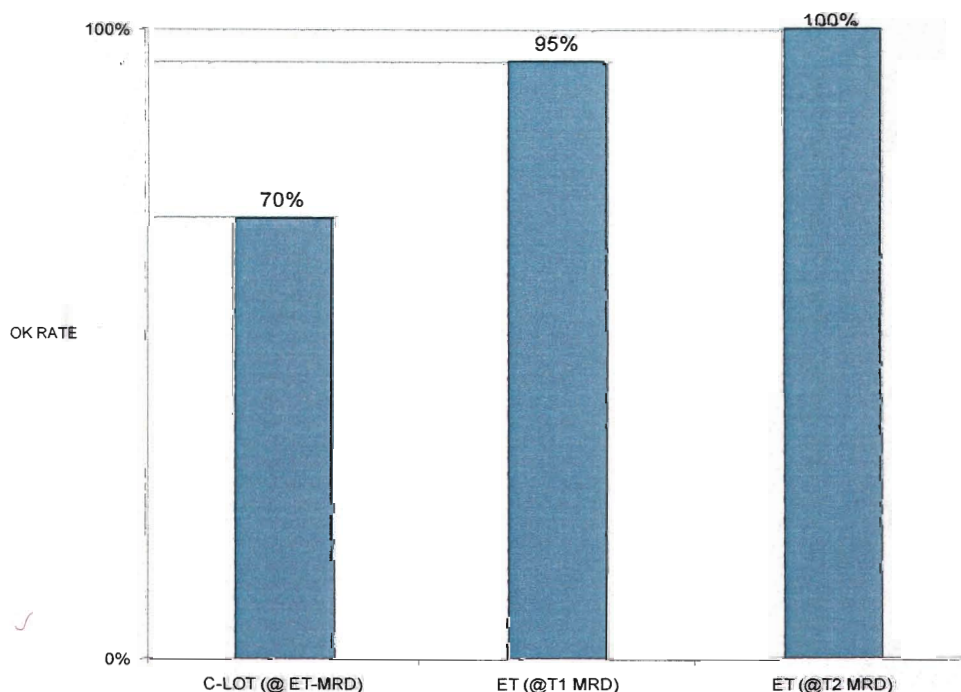
These pie-charts explain why and when the CUS were raised at a relatively crude level. Nevertheless, analysis in this form gives one the basis of Kaizen into the future projects

CHAPTER 6

6.3 STRS (Supplier Test Reporting System)

Another secondary measurement is the effectiveness of “right first time” testing. Supplier Test Reporting System, or STRS, is a Nissan Global system, which requires the Supplier of components to test them to a predefined system. The STRS system is a record of Supplier information (after validation by Nissan Engineers) stating date of test completion, if it’s OK or otherwise and finally receipt of the Test Report. In the Hoshin Kanri, the strategy to reduce STRS failure is given in Figure 5.2, Item 2.3, 2.6; Figure 5.3, Item 3.7; and Figure 5.4, Item 4.2. In the first instance, the ability to achieve a high rate of successful component testing at the earliest possible stage of the project was considered. Targets were set thus and a high degree of emphasis placed on “Test by Design” or “Predictive Testing”.

Figure 6.7: Development Targets For STRS Performance



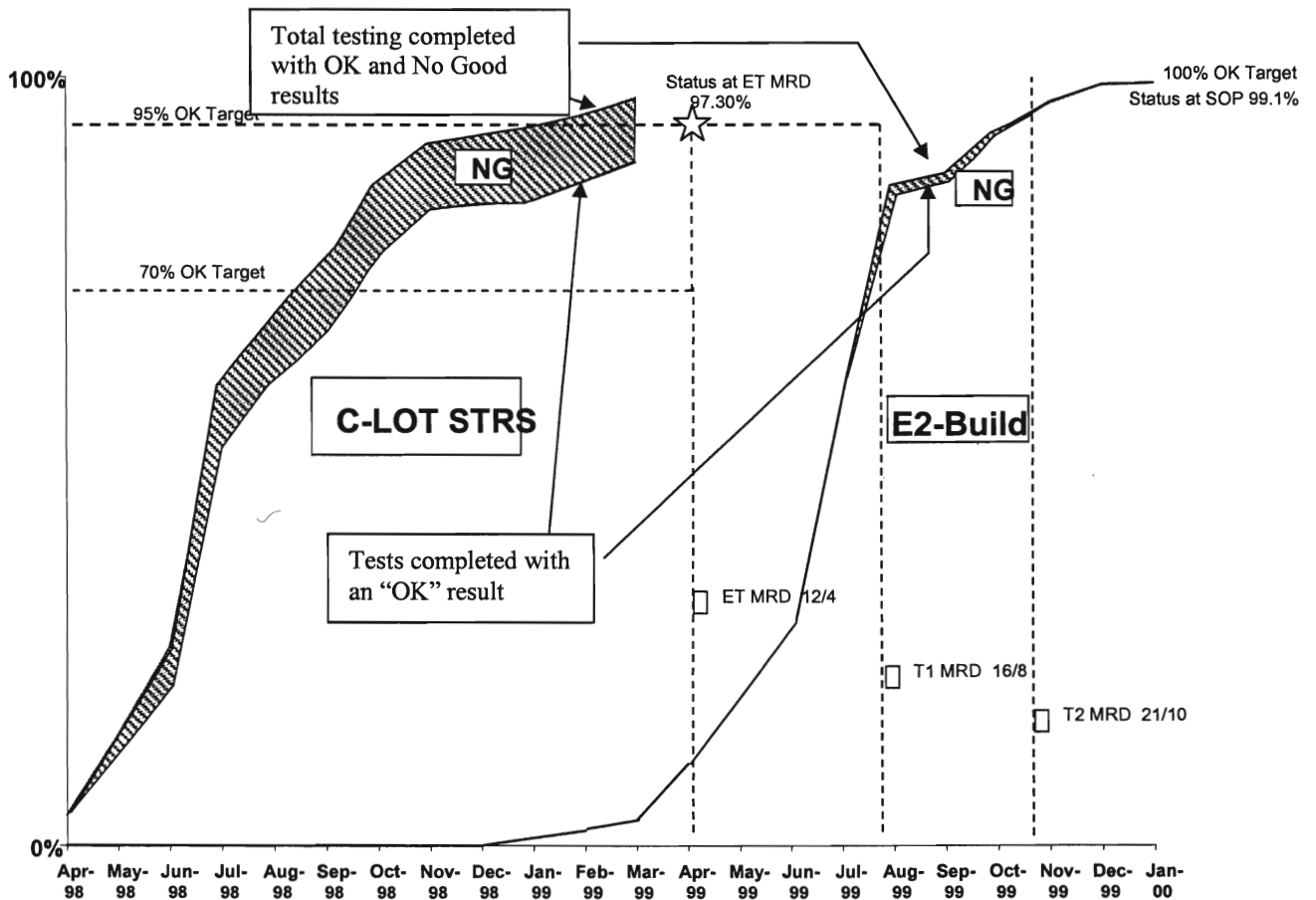
These development targets represent the final result of testing and reaching an “ok” conclusion at each Trial Build. The timeline of testing varies, with some testing, such as vehicle durability, lasting many months (longest lead-time test is 9 months).

CHAPTER 6

The results were as follows, being expressed against the time line of the project and against the targets at the various stages. In reality, the tactic of “Test by Design” had a dramatic effect on the improvement in OK test results at an earlier stage than previously achieved. This is in part due to the additional emphasis placed on the activity – testing was now deemed to have a high profile and thus motivated the Test Engineers to improve on their performance (similar to the Hawthorn Experiments [Ref 6.1, Roethlisberger & Dickson, 1939]).

As stated the resultant improvement in STRS testing against NDS was remarkable compared with previous projects although finally missing the tough targets set for the later part of the project. This is outlined graphically below: -

Figure 6.8: STRS Achievement Against time



CHAPTER 6

Comments On The Achievements Against Target

The C Lot STRS target was achieved 6 months ahead of schedule, primarily due to NTCE reoccurrence prevention analysis at the Simultaneous Engineering stage and supplier prediction activity.

Production STRS failed to meet the tough T1 and T2 targets, but achieved a 100% OK rate by Start of Production

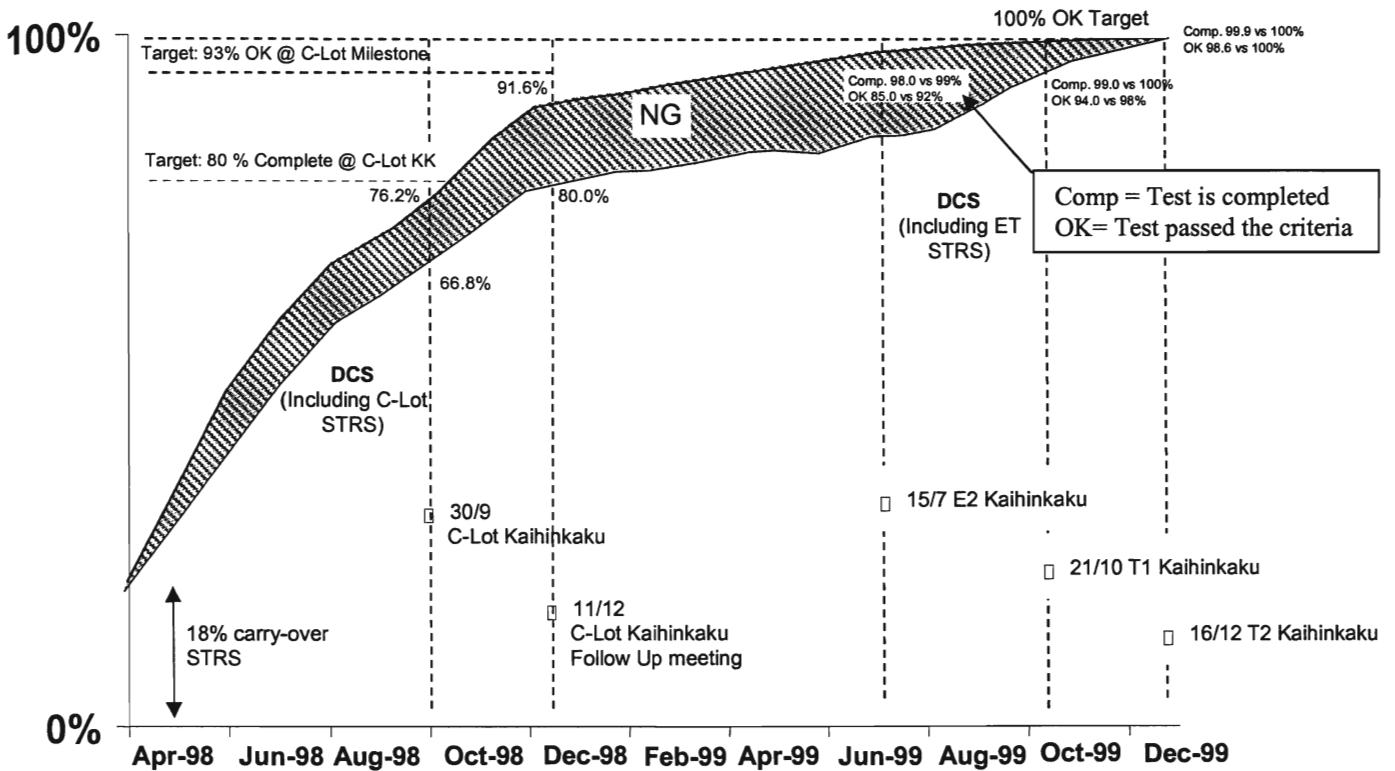
[N] Denotes first time OK test results. That is to say, the lower line defines completed testing with OK results and the upper includes NG (No-Good) results. By SOP, it is clear that all tests must be OK and be 100% complete, although the target of this research was to reach that condition by T2 MRD (to allow sale of T2 vehicles). This was not achieved

6.4 Vehicle Test DCS (Development Concerns System)

Likewise, under the auspices of reducing “Performance Failures” by 75%, targets were set for Vehicle Testing timing and achievement rates, which are undertaken “in-house” at NTCE. Again the results are graphed against their time line below.

CHAPTER 6

Figure 6.9: DCS - Development Control System (NTCE Testing*)



*CALCULATED BY NTCE ANALYSIS METHOD. I.E. CADICS REPORTING (CADICS, STRS, C/O STRS)

Notes on the DCS Achievement against Target

C-Lot

NTCE'S C-Lot test schedule was delayed by late test vehicle and cut body delivery. The affects of these delays were minimised by overtime, shutdown working and 24hr body testing. Test status did not meet targets around the original Kaihinkaku timing (93% complete 80%ok rate). At the Kaihinkaku follow up meeting timing (11/12) NTCE met the ok rate timing and almost met the completion rate timing.

ET and T1

Did not achieve the targets at the time of the Kaihinkaku's primarily because of limited test time before the meeting. No significant concerns existed.

T2

Very slight misalignment to target due to safety and security items and delayed trim environmental testing.

CHAPTER 6

The chart once again depicts the completion of testing in terms of “tests finished” and “OK” rate. While DCS evolution is continuous, two points are noted for reference.

ET Kaihinkaku (End of Prototype testing)

A target of 99% completion was not achieved (98% achieved) but a larger gap also exists on the OK ratio, where a target of 92% OK was set (85% achieved).

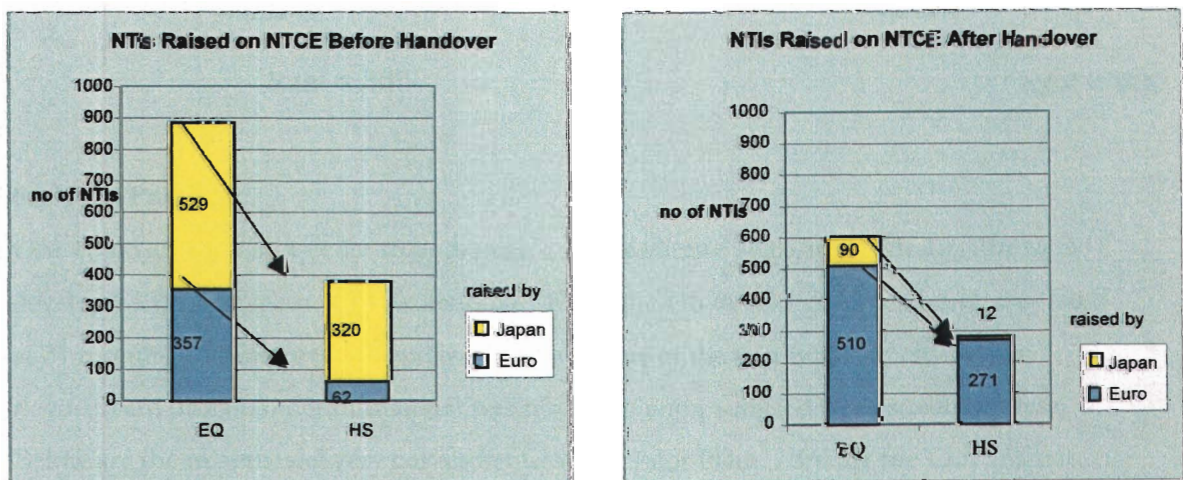
T2 Kaihinkaku (End of Production Parts Testing)

A target of 100% completion was basically achieved (99.9%), but a small shortfall in OK ratio (Target 100%, versus an actual of 98.6%). This created the need for vehicle rework and countermeasure development prior to SOP.

DCS Testing is controlled by a Closed Loop Paper Report called NTi (Nissan Technical Information). These paper reports contain the Test Concern and in 5 Steps, its analysis of root cause, the Design Action taken and the validation of the countermeasure at the next Trial Build. The author was therefore able to make a comparison of “Performance Testing” improvement by viewing the NTi information of EQ and HS. That analysis is given below.

Figure 6.10 NTI ~ Analysis and Comparison of HS and EQ NTI

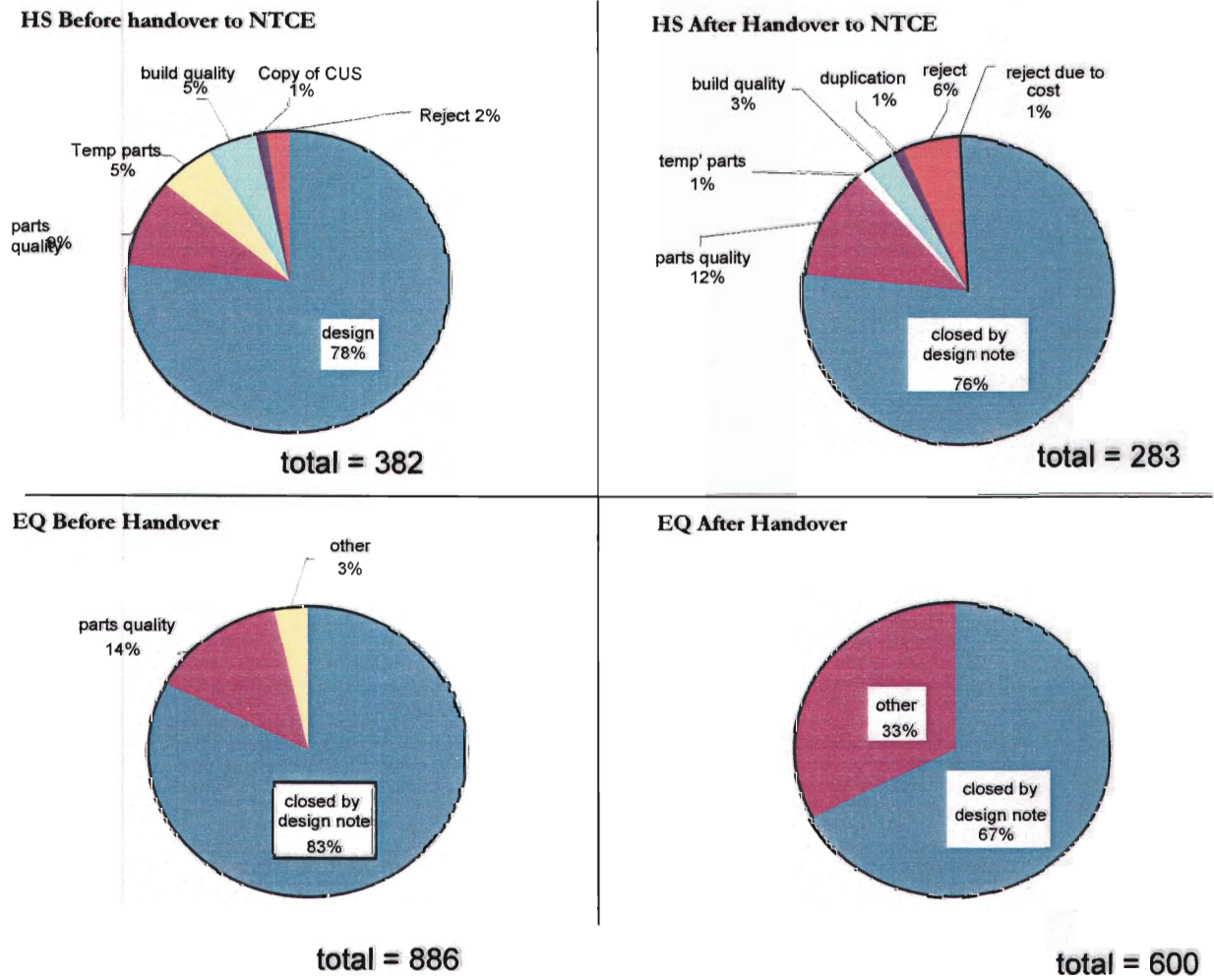
1) Reduction in NTIs from EQ to HS



CHAPTER 6

One is able to further analyse this by cause. An analysis was undertaken on each of the NTi's to understand the reason for the testing failure in-order to provide detailed information and Knowledge to the next program. This analysis follows.

2) Breakdown of Concern Cause

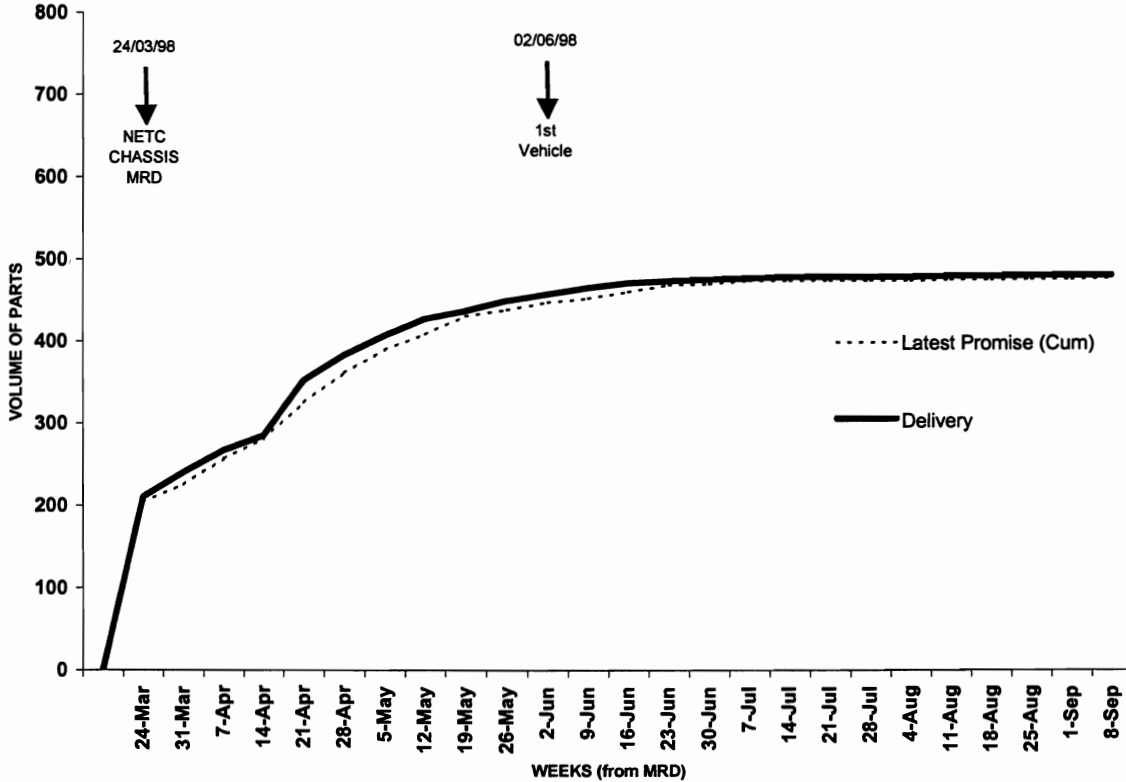


6.5 Trial Parts

One could argue that in-order to undertake a full predictive analysis of a design, the total development lead-time must be extending. Since the HS development lead-time was fixed at 31 months, it is important to analyse parts delivery at the trial builds to ensure that downstream procurement of material was not being compromised by upstream analysis. Below are the material delivery curves for Clot and Pilot Plant. Firstly the Clot analysis.

CHAPTER 6

Figure 6.11: C lot Parts Delivery Achievement Profile



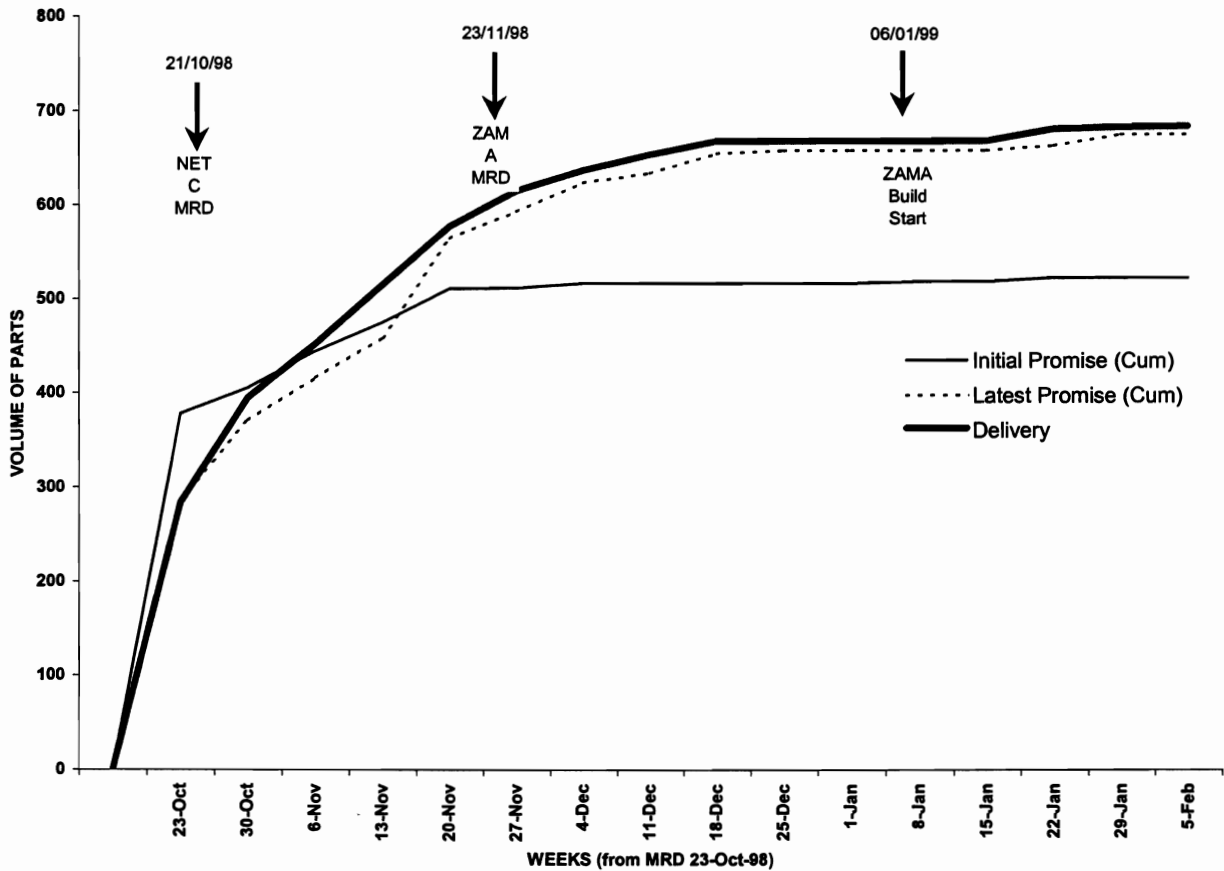
Also noted for completeness are the Suppliers who were late (names deleted due to commercial sensitivity), the description of the problem and the agreed countermeasures. Again, this analysis is taken to allow future improvements to be quantified and also demonstrates the PDCA cycle.

SUPPLIER	MAJOR CONCERN DESCRIPTION	COUNTERMEASURE	
Supplier Names Deleted due to Commercial Sensitivity	1	Poor manufacture of resin parts	Better attention to detail. Off Prod Tool for ET
	2	Incorrect assembly levels & damaged parts	Improve communication, regular project meetings.
	3	Distortion due to welding. Poor location of spring	Improve Welding technique & fixtures
	4	Missing / incorrect parts fitted to assemblies	Create Master sample for assy/ inspection purposes
	5	Dimensional, Visual, and Design concerns	Work closely with supplier to improve all aspects
	6	Front Wiper System not to Drg or Design Intent	Improve Quality Assurance & Attention to Detail
	7	Missing parts and poor assembly.	Parts removed for inspection, improve assy checks.
	8	Parts failed strength tests	Parts redesigned and manufactured
	9	Material incorrect. Parts not painted	Parts reworked, Waiting for permanent c/m
	10	Dimension, discrepancies between mating parts	Rework to match mating parts (Improve Tooling)
	11	Missing parts, and incorrect part supplied.	Add final visual checks prior to dispatch
	12	Parts cracked and poor fit of assembled items	No reply to Rank A,

CHAPTER 6

The same analysis for Pilot Plant Trial Parts deliver is given below

Figure 6.12: Pilot Plant Delivery Achievement Profile



At Pilot Plant, the parts delivery profile is given above with main concerns given in the table below:-

MAIN CONCERNS

SUPPLIER	MAJOR CONCERN DESCRIPTION	COUNTERMEASURE	
Supplier Names Deleted due to Commercial Sensitivity	1	Dimensional errors, and missing level 2 parts	Audit supplier and NETC QA workshop activity
	2	Incorrect Parts supplied and dimensional errors	improve final inspection
	3	Damage, and dimensional concerns.	Audit supplier and NETC QA workshop activity
	4	Glue contamination poor build quality.	Audit supplier and NETC QA workshop activity
	5	Dimensional concerns	Ongoing improvement activity improve sub suppliers
	6	Incorrect part and sharp edges	Improve final inspection and build quality
	7	Dimensional errors,	NETC QA workshop activity
	8	Dimensional errors and missing features	Improve knowledge of NETC requirements

CHAPTER 6

Quality of parts at a trial are measured by a Rank system – Rank A being the delivery of unacceptable parts, Rank B being in need of rework and Rank C being missing Paperwork, etc. An analysis of parts quality at the C lot and Pilot Plant trials are given below.

Figure 6.13: Trial Parts Quality at C Lot

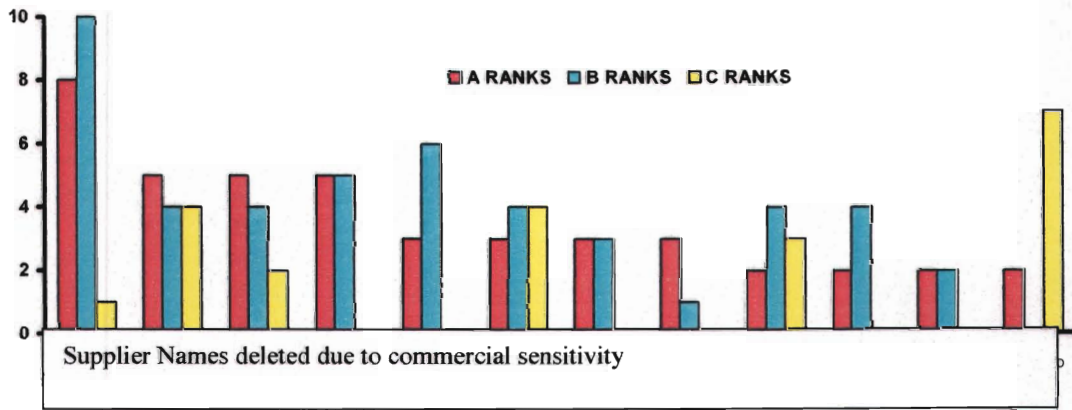
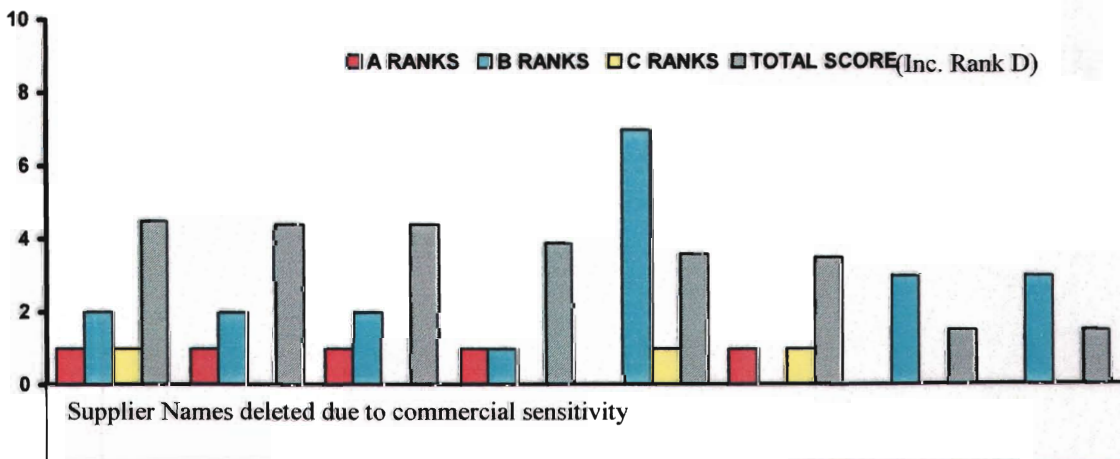


Figure 6.14: Pilot Plants Parts Quality



CHAPTER 6

At Clot and at Pilot Plant, the main delivery concerns are given in the two tables. This is evaluated to determine the generic reasoning for delivery variance to Plan.

Figure 6.15: Component Delivery Variance to Plan at Pilot Plant

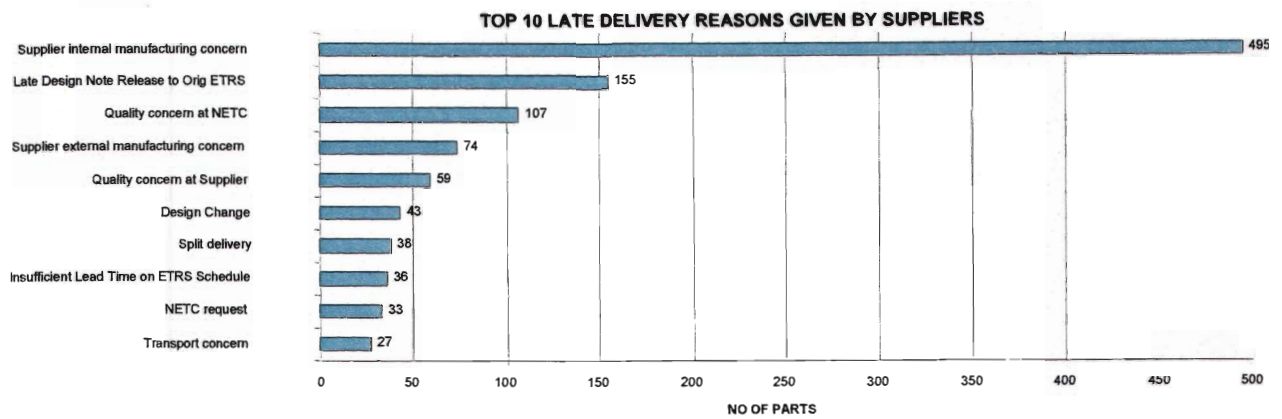
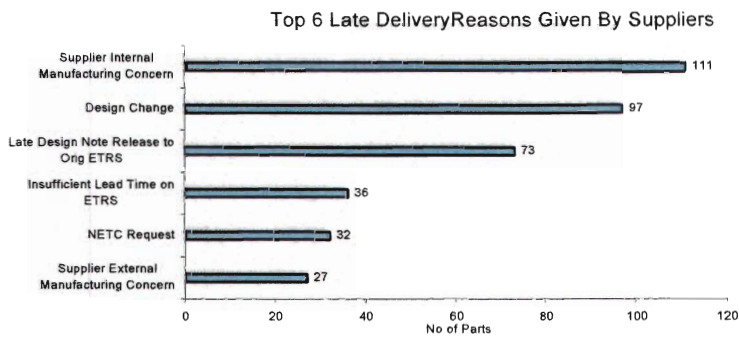


Figure 6.16: Pilot Plants Parts Quality



CHAPTER 6

Finally, for completeness, 16 parts were not available at Pilot Plant build, thus delaying build for several days and ultimately slightly delaying vehicles being handed-over to Test department – Causing a delay of testing.

Figure 6.17 Missing Parts at Pilot Plant Build (extract from Internal Report)

No.	Item	Missing	Cause	Countermeasure	Responsibility		NETC System Parts ✓
					NTC	NETC	
1	Side Guard Moulding	1	5 Door – C-Lot. No European parts were developed to reduce costs. NTC did not order parts for Pilot Plant. 3 Door – Only LH parts were ordered for Pilot Plant.	From the 2 nd half of Pilot Plant production level parts are available for 3 and 5 door, LH and RH.	○	●	✓
2	Sill Spoiler	2	Copy Part should have been ordered by NTC.	NTC to procure part for Pilot Plant retrofit.	●		✓
3	Splash Guard Grommet	4			●		
4	Splash Guard Screw	5			●		
5	Bumper Side Spoiler	6			●		✓
6	Door Inside Handle Escutcheon	7			●		
7	Door Lock Switch	8			●		
8	Inr Kicking Plate	9			●		
9	Fuse remover	10			●		
10	Navt. Display	12			●		
11	Seatbelt Holder	13	Domestic C-Lot judged NG for Europe. NETC redesigned the part for Pilot Plant timing. 4 trial parts procured by NETC for a PP joint check activity.	Dry fit parts were procured for Pilot plant.	○	●	✓
12	RR 12V Socket	14	NETC release was on time. Part did not contain the KD socket. This was a supplier error.	Japanese partner supplied part for retrofit.		●	✓
13	Glove Box Key Cylinder.	16	Copy Part should have been ordered by NTC.	NTC to procure part for Pilot Plant retrofit.	●		
14	Seat Belt Buckle	17	KD RH seats do not have seatbelt buckles. NETC ordered the buckles to be fitted by Engineering. (Ref. JL6402; A/Line ref. 13114366000).	Extra Parts procured for Pilot Plan		●	✓
15	O2 Sensor Harness Clamp	18	Copy Part should have been ordered by NTC.	NTC to procure the part for Pilot Plant retrofit.	●		
16	Battery Stay and Clamp.	19, 20	NMUK used KD batteries for the Pilot Plant to save costs. European batteries have a different clamping method; the stay and clamp as supplied did not fit.	KD Clamps used for Pilot Plant. Design condition to be applied for ET.	○	○	

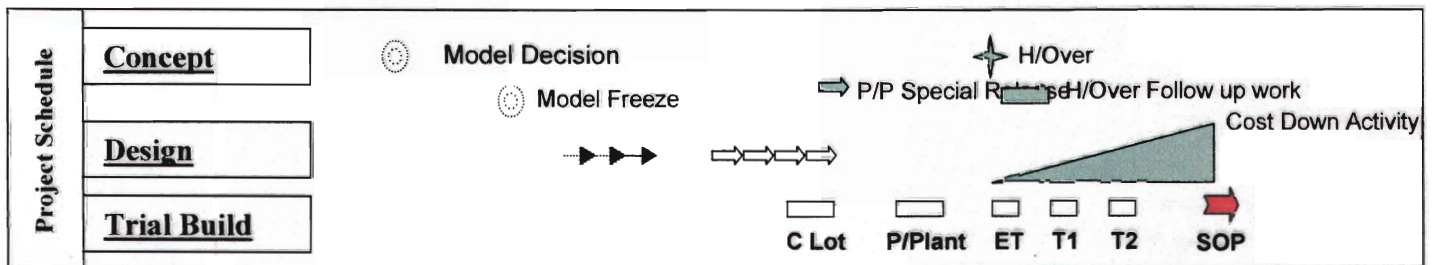
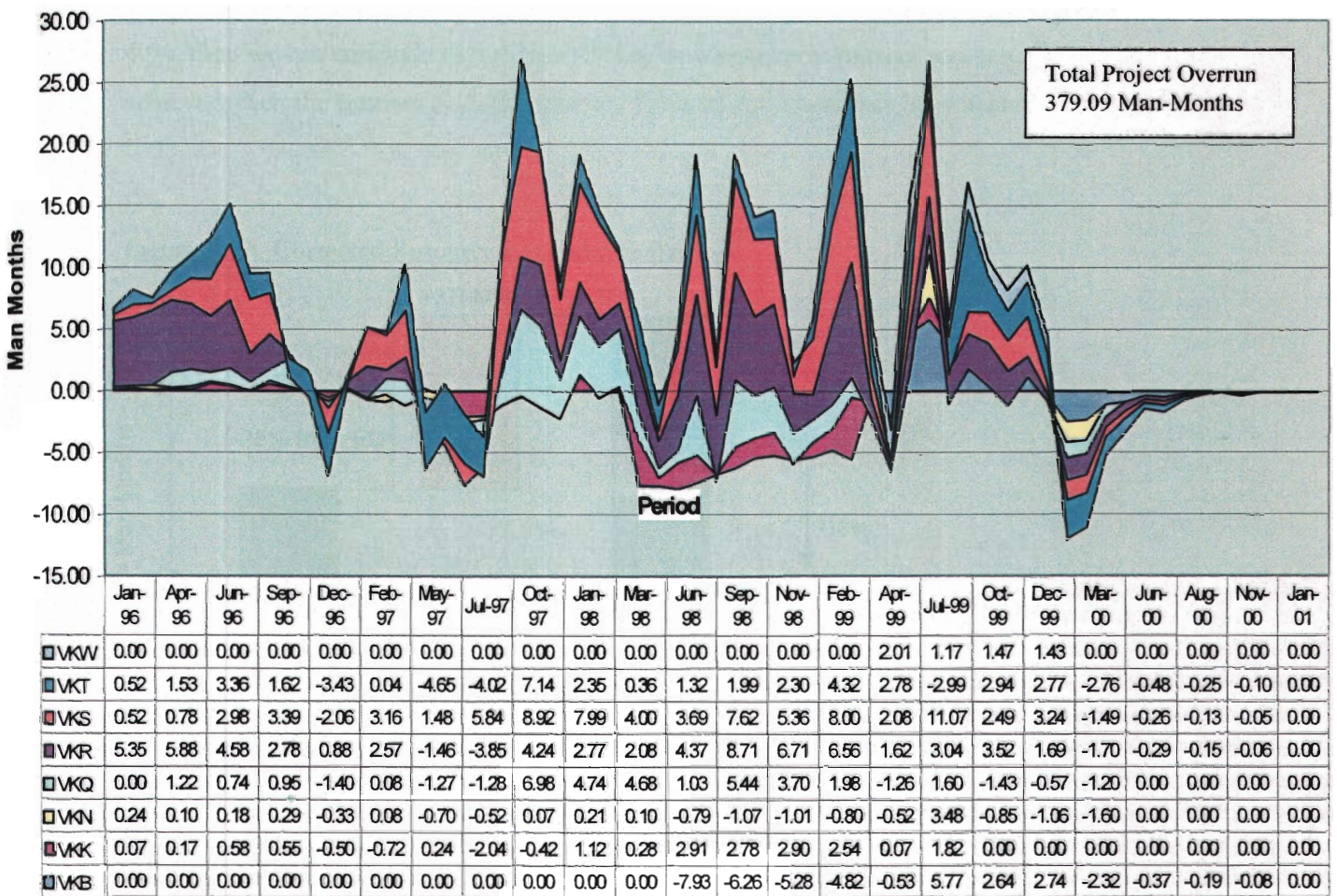
Key
● Prime Responsibility
○ Secondary

CHAPTER 6

6.6 Resource Report

Finally, the primary reason for the whole improvement exercise should not be forgotten, i.e. To achieve a 40% reduction in resource expenditure compared with EQ. The raw data, detailing variance against budget is given below. It should be remembered that in the final analysis “apples and apples” must be compared.

Figure 6.18: Vehicle Design Division HS Project Variance

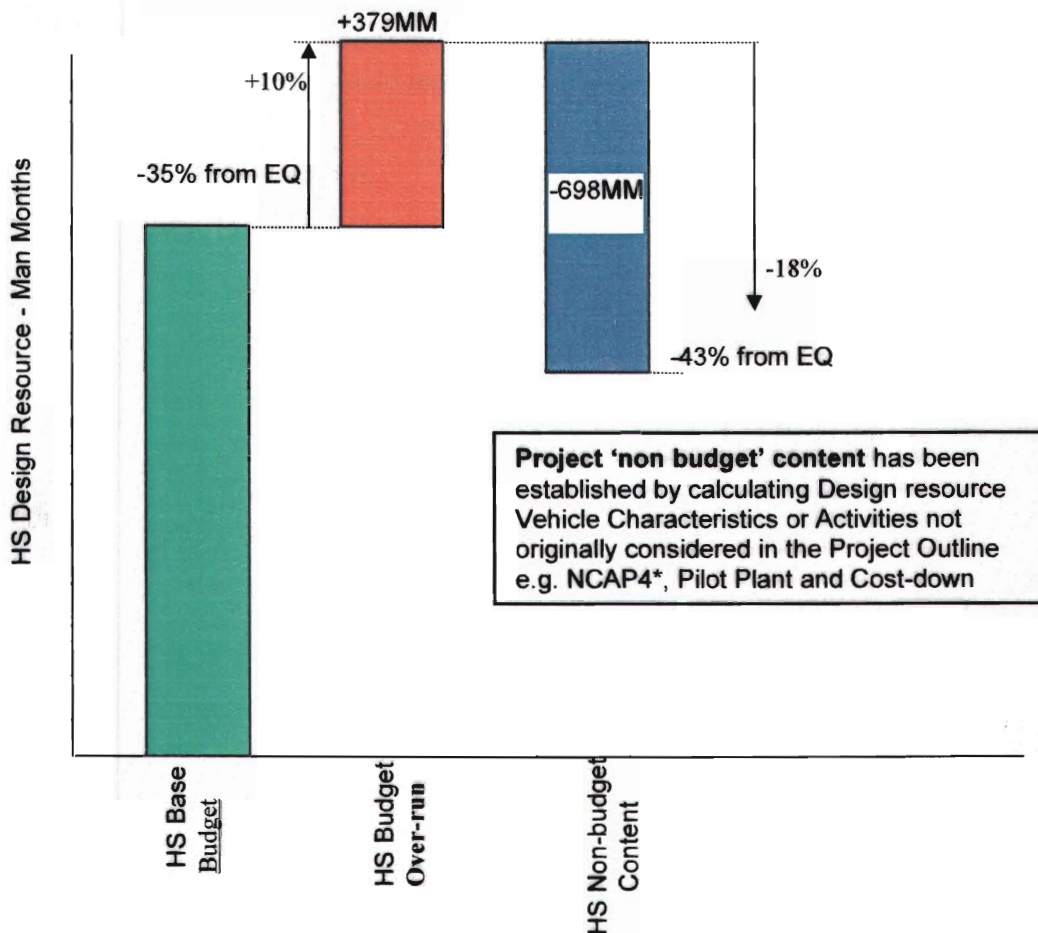


CHAPTER 6

The zero line is the budget set at -35% below that of EQ. The plot is the variance to budget by each department on a month-by-month basis within the direct Engineering departments for all works “booked” to HS.

In order to reconcile a like for like analysis, “non budget” content has been removed from the expenditure. The effect of doing this allows the direct budget to be compared with the actual result. The actual budget was set at a 35% reduction level compared with EQ, (although through-out this report a target of 40% assumed). Had the budget been set at 40%, then we can conclude that since a 43% in development resources was actually achieved, then the primary goal (See Chapter 4.3.2) of the Thesis has been achieved.

Figure 6.19: Corrected Resource Expenditure Analysis



CHAPTER 6

Notes on the Resources Spend analysis

Jan-Sept '96 - Overspend associated with pre planning, particularly setting up the FAST D standard practices. This is worthy of note, as often in similar projects, set-up costs are considered as "One-Time" costs and excluded from the costs of the first project and taken as a simple overhead (amortised across many projects). Since NTCE is funded directly from Projects, then no spare "Overhead" budget existed, thus the improvements to win the project had to be included within the project itself.

Jul '97-Mar '98 - Manpower spent during the C-Lot release phase of the project exceeded plans.

Sept - Dec '98 - Pilot Plant became a full vehicle build (primarily to support NTC Test). The PP releases require significant amounts of unplanned resource.

Jan -Mar '99 - Pilot Plant support and pre handover work off-set the peak planned for handover in April '99.

May - Dec '99 - The hand over condition did not meet targets, particularly cost and NCAP 4*. VK0 overspent resource to realign the project with these key target.

6.7 Reflections and Conclusions

The analysis in this Chapter demonstrates the over-achievement of the 80% reduction in Design Change and even its achievement at a more severe measurement level. While it's always necessary to achieve the primary target, one must always look at the evolution towards the target and in the context of RFT Design, the status of achievement of the secondary measurements and targets.

First and foremost, the achievement of the Design Change reduction was achieved in spite of some components / Suppliers actually changing the design more than 3 times. For the future, one must analyse the reasons for this and what actions can be taken to significantly resolve the drivers of design change. The author can provide anecdotal reasons at this stage, but in reality, the same analysis carried out under FASTD at the start of this research needs to be undertaken again as a result of HS, diving perhaps into this level of analysis.

CHAPTER 6

Reviewing the Secondary targets individually

a) Workability

Workability was always the “big” concern to solve, based on the previous analysis. The CUS reduction target achievement of 59.1% was finally short of the targeted 75%.

However, the following points should be considered:

- i) A total of 61 CUS were raised for NES parts commonisation. These are primarily fixings, such as screws, bolts and nuts to a given “Nissan Engineering Standard”. This was particularly important for HS because it had to share the NMUK production line with DC. This was not the case with original EQ development.
- ii) A total of 87 CUS raised by NMUK Engineering on NTCE were rejected for reasons that including quality and temporary part application.
- iii) 6 CUS were raised on NCAP 4* modifications (prior to inclusion in the HS NCAP programme).

It’s also worth noting the comments of the Manufacturing Engineering Director of NMUK, who stated at the completion of SOP that “HS was launched in a better condition than EQ” inferring that CUS raised on HS may not have been raised on EQ.

Some of the improvements that might be considered for the future include

- a) Further refine the planning process by feeding HS (and HM) concerns into future planning drawings.
- b) NES rationalisation CUS can be minimised by plant setting a clear policy on NES at the planning stage (e.g. DC=HS)
- c) Design mismatch and foul concerns should be further minimised by optimisation of the DMDR process. By that, it is meant the process of Design Reviews at the early Planning stage in combination with the 3D CAD Model (extension of CAPE methodology and reinforcement of Design Reviews - See Appendix)
- d) The factory could involve Material Handling to a greater extent during the planning phase to reduce part identification concerns.

CHAPTER 6

- e) The Factory could set up 'special activities' to enhance early feedback to repeat concern items such as water leak that are difficult to 100% predict by Design.

b) STRS

STRS really exceeded all expectations meeting the Clot target 6 months early and reaching 100% OK at Start of Production. The question for the future is really one of sustainability of the processes established at HS. There was a huge focus on "Test By Design" and these processes were embedded into the Purchase procedure. The risk for the future is in ensuring that these processes remain embedded as Nissan more closely integrates its development procedures in-front of the supplier, with those of Renault.

c) DCS – Vehicle Testing

- i) C-Lot - NTCE's C-Lot test schedule was delayed by late test vehicle and cut body delivery. The affects of these delays were minimised by overtime, shutdown working and 24hr body testing. This recovery should be considered as exceptional.

Test status did not meet targets around the original Kaihinkaku timing (93% complete 80%ok rate). At the Kaihinkaku follow up meeting timing (11/12) NTCE met the ok rate timing and almost met the completion rate timing.

- ii) ET and T1 Trial Builds- Did not achieve the targets at the time of the Kaihinkaku's primarily because of limited test time before the meeting. No significant concerns existed.

- iii) T2 Trial Build - Very slight misalignment to target due to safety and security items and delayed trim environmental testing.

Some of the points that should be highlighted both for comment and improvement for the future include.

CHAPTER 6

The number of NTIs raised on HS are significantly less than for EQ for the following reasons

- Clearer handover (both for test and design groups)
- Emphasis on recurrence prevention
- Simultaneous engineering activities e.g. planning drawing reviews with design, test and NMUK
- The large number of post handover EQ NTT's, were due to safety, security and marketability concerns (~300).
- EQ diesel development was neglected which created several concerns after handover.

Finally, for the sake of the measurement correctness, the resource evaluation makes correction to ensure that “Apples are measured with Apples”. This is right and proper in the rigours of this Thesis. However, one must note that the additional problems of NCAP target change for example, did indeed happen and created an overspend against the original development resource target. The effect of these “Surprises” clearly impacts on the bottom-line of the company and can be simply attributed to bad planning. They therefore also represent an area of opportunity for further improvements in the future.

In reflection, the quantitative measurements have shown that the headline targets set out for the research have been achieved. History repeats itself in the context of a stable process and we can use that fact to make reasonable predictions on how to avoid similar design changes into the future. In addition to the primary measurement, it's useful to have a number of secondary indices that allow one to judge the health of the project along the way and before it is too late to change it. What we can derive from these secondary targets are clues for further improvements. Especially if one views the areas of chronic concern, for example Headliners or Radio's, where many design changes can be observed as well as late deliveries and test failures. This underlines the need to continue with the COGENT initiative (a part of the Hoshin Kanri) to improve Supplier performance.

CHAPTER 6

Key Learning Points

- 1) Forecast methodology for predicting future design changes, based on historical analysis from the past is accurate at least on a macro level
- 2) Certain components and systems have a chronic concern and appear to need multiple design changes on every project
- 3) A reduction in design change does indeed correlate with a reduction in resources expended in a given project, but corrections for project content have to be carefully considered from the start to allow “Apples and Apples comparisons”.
- 4) Weekly Reviews on Primary and Secondary Measurements are mandatory to the successful implementation of RFT Design.

One must also note that any project review needs to investigate the qualitative aspects of the project as well as the quantitative and this aspect is explored in the next Chapter.

CHAPTER 7

Qualitative Findings

The research until now has relied heavily on analytical analysis, using statistics from previous history and quantitative records from the project. From the quantitative point of view, the targets were achieved, but it is also interesting to look from the qualitative perspective to discover how the people performing the project view the successes and to see whether the quantitative data is truly a reflection of success.

This analysis has been undertaken by a review with the Managers in the organisation and using a technique adapted by the author from Kano's T Matrix. In this instance, the author asked the Managers what they perceived as issues through the HS project and to analyse their issues on the T Matrix. Because the author had heavily influenced the direction of the project, a second researcher (Mr John Austin) was used (under the guidance of the author) to conduct the interviews and whiteboard analysis – parts of his report are re-printed here with his kind permission.

Transcripts of extracts from the Interviews are contained in the Appendices. To the author's best knowledge, the use of the adapted T Matrix for post project analysis is quite unique, but it is certainly useful in communicating results and has now been used to disseminate the project outcomes in several public forums.

CHAPTER 7

7.0 Qualitative Methods

The aims of the qualitative fieldwork were to support the quantitative findings and create a dynamic image of the organisational impacts of RFT. This view is supported by management research writers:

'...[T]he best way to elicit various and divergent constructions of reality that exist within the context of a study is to collect information about different events and relationships from different points of view.' [Ref 7.1. Erlandson et al 1993]

NTCE made it possible to interview a 47 of key managers and staff from different parts of the organisation enabling a deeper insight. After establishing the key issues, further Interviews were established with 4 key Managers to gain a deeper understanding of their experiences – the Transcripts of which are contained in the Appendix. It was felt that their experience and insights into RFT would be richer than those more passively involved.

The concern areas used as case studies were:

- New Car Assessment Programme (NCAP): Target change and countermeasure activity.
- Vehicle Attractiveness: Target change and the creation of Unique Selling Points (USP)
- Pilot Plant: A schedule change with the addition of another trial build.

The detail of these issues will be described in the results section of this chapter. It was felt that it was best to concentrate the qualitative research tool on these three areas in-order to give the author the best contrast to the apparent successes seen in the quantitative findings.

Individual and group interviews were held with an inclination towards open questioning followed by *'explanatory probing'* [Ref 7.2 Easterby-Smith et al 1991]. This was in an attempt by the author to limit interview bias. The style was chosen to maximise the informants' description of experiences with an emphasis on systemic issues, perceptions, values and attitudes. This semi-structured format also enabled the interviewees to discuss issues unanticipated by the author.

CHAPTER 7

The following interview agenda was loosely followed:

1. Presentation of the dissertation purpose and objectives
2. T- Matrix discussion:
 - a. Concern creation and incubation
 - b. Concern detection
 - c. Problem solving issues
 - d. Implementation of countermeasures

7.1 T-Matrix

The discussion of item 2 (a-d) was formalised and graphically represented on a whiteboard by the '*T-Matrix*'. This tool was adapted for use in this research context and is used to communicate the dynamics of concern creation and resolution. For the purposes of this study the matrix can be considered a '*topic guide*', a résumé of the main areas of interest [Ref 7.2 Easterby-Smith et al 1991].

CHAPTER 7

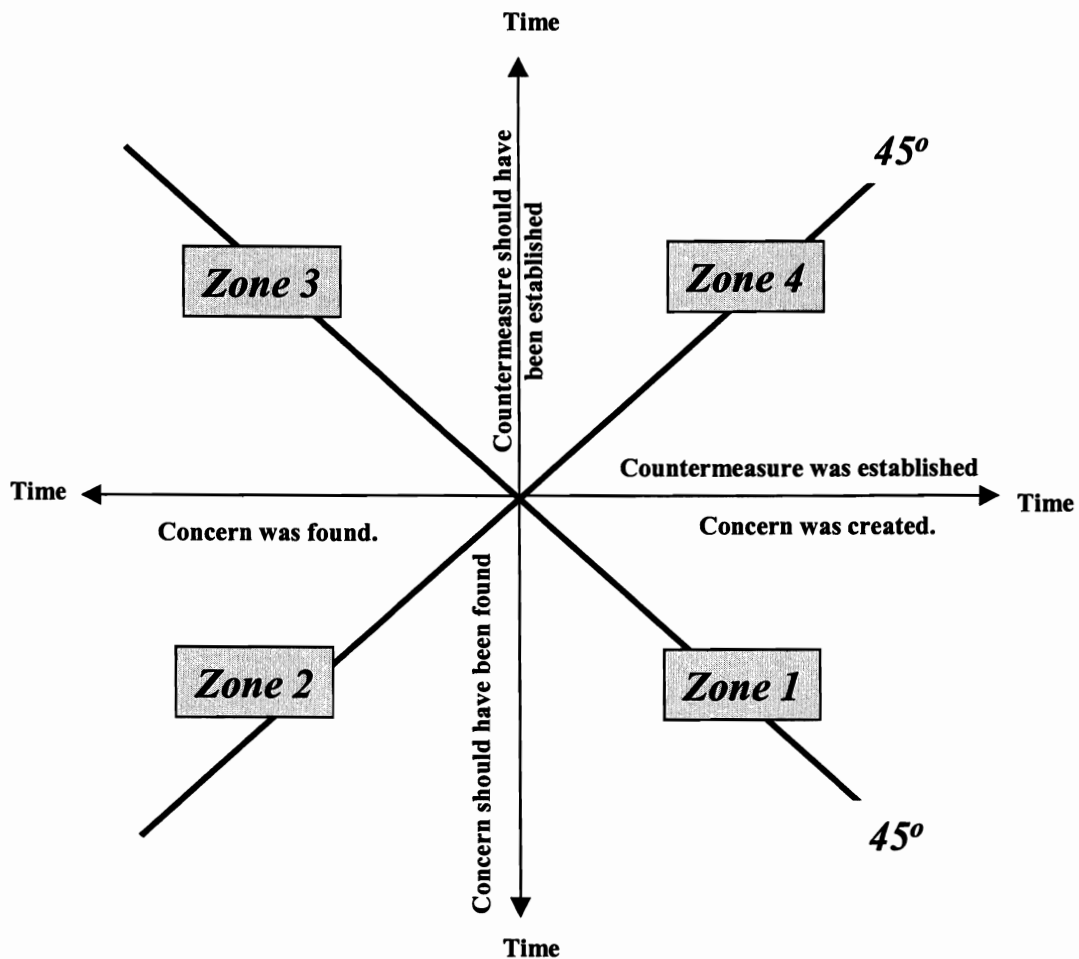


Figure 7.1 – The T-Matrix (Source: Nissan)

In effect the T-Matrix represents four time graphs, grouped together to split the concern resolution process up into four distinct phases (Figure 7.2)

The author notes the use of the term “**should**” (in the context of e.g. “The concern should have been found”) on the graph above. In theoretical abstract, the concern should be found at the same time that it is created (thus on the 45deg line). However, in this context, a pragmatic approach is taken, assuming that when an engineer creates a concern in design, the first time that it is usually found is at the first build or test where the concern is applied.

CHAPTER 7

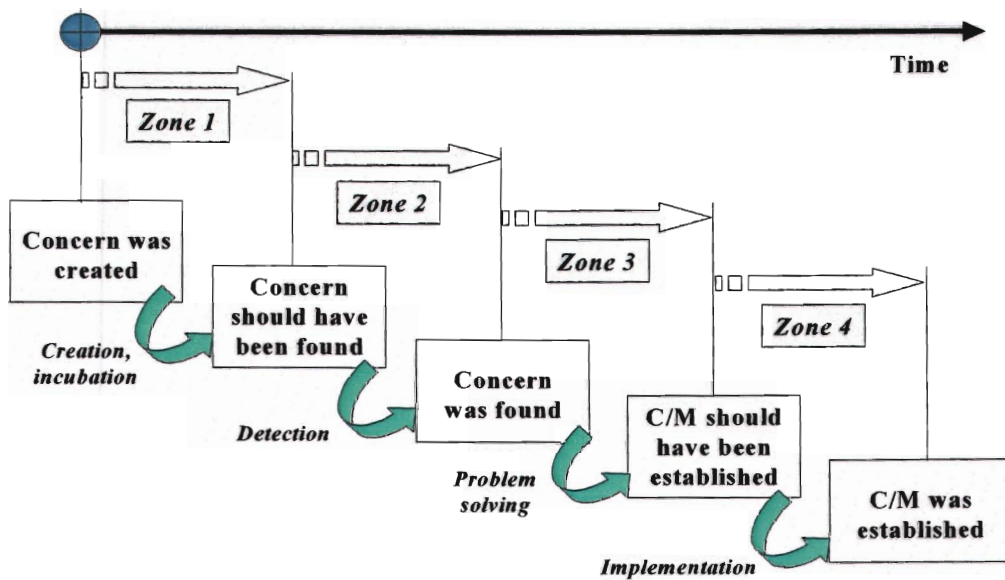


Figure 7.2 – The T-Matrix Zones

A completed T-Matrix represents any time delays in a concern resolution process as deviations from the ideal 45° lines, making them obvious and thereby encouraging discussion. Its use in Nissan is appropriate because of its fit to the culture of graphical presentation, inevitability in a combined Japanese and Western company.

A completed T-Matrix is shown in Figure 7.3. As a concern and resolution process develops, the key events (stars) appear to spiral outwards as the process faces inevitable delays. These delays are represented by the arrows in Figure 7.3 and present a point of discussion in the qualitative analysis of RFT.

CHAPTER 7

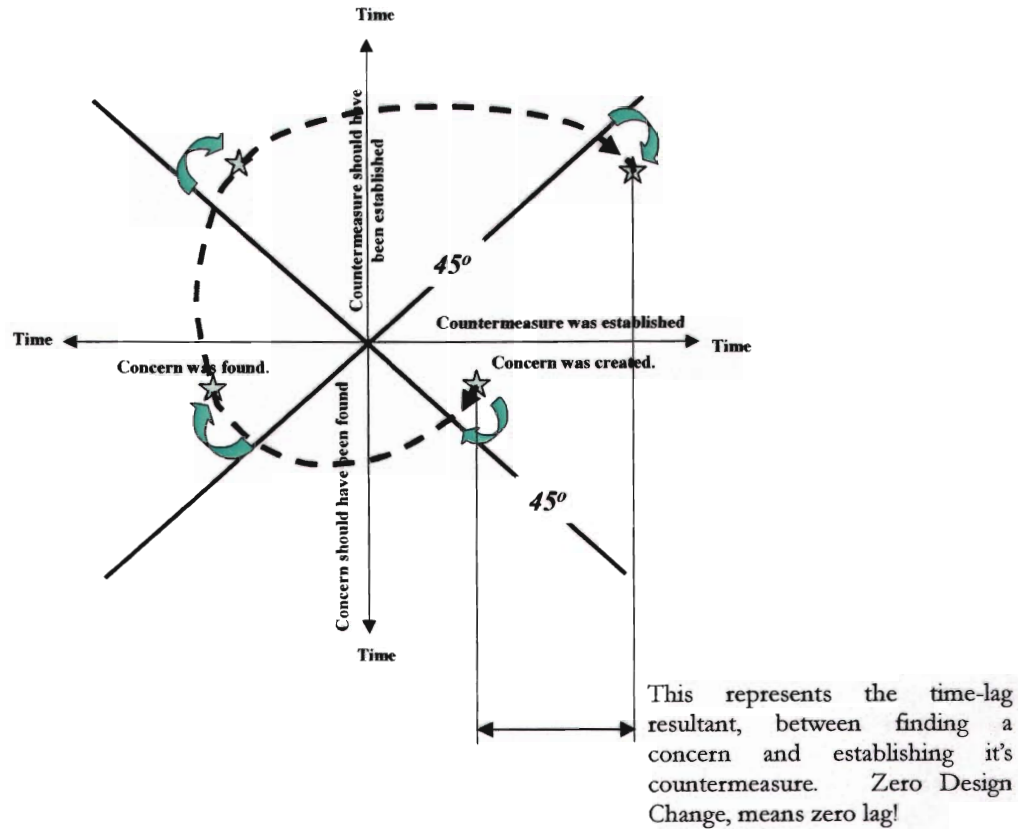


Figure 7.3 – The Dynamics of the T-Matrix

7.2 Qualitative Analysis – Interpretation and Limitations

Full transcripts were made of all the interviews (with the assistance of Mr John Austin). In addition, the T-Matrices generated were copied along with the issues recorded on whiteboards to stimulate discussion. The transcripts and whiteboard notes have been presented in tabular form in the Appendix. From this information the key points were extrapolated to enable summarisation in Chapter 6.

CHAPTER 7

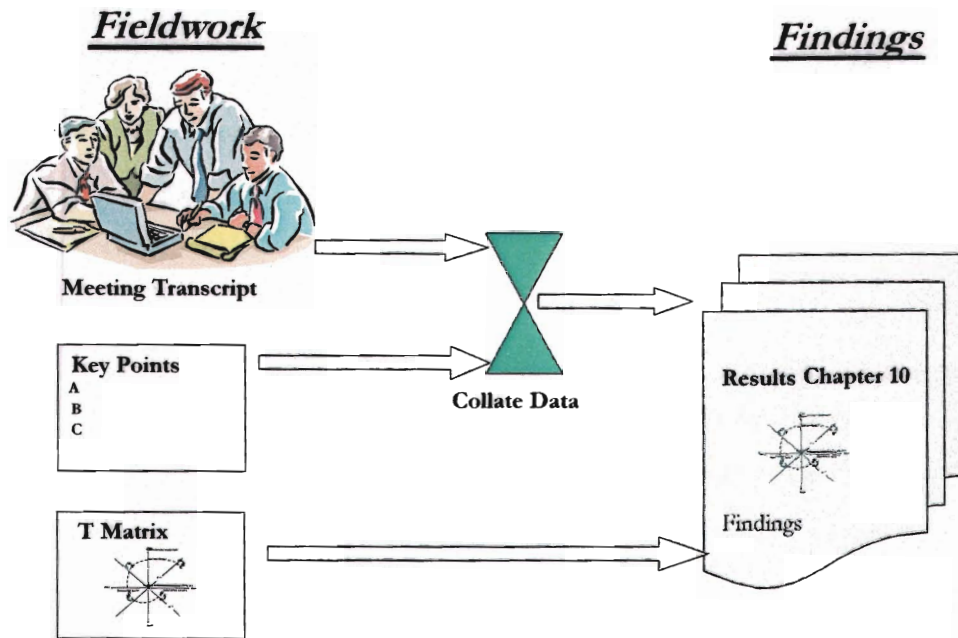


Figure 7.4 – Schematic of Results Collation

Although this interview process provided some excellent data, there are a number of possible limitations that should be borne in mind:

- The interviewees were primarily from the development part of the organisation and could only offer opinion in relation to other functions.
- The participants were selected because of their involvement in a concern process. Their opinions may have been clouded by some negative experiences.
- The analysis was retrospective and interviewees may not have remembered all issues.
- The study requested public access to private experiences, which may cause the interviewees to 'hold-back' [Ref 7.2 Easterby-Smith et al 1991].
- The influence of the author, (mitigated somewhat by use of independent researcher John Austin).

CHAPTER 7

7.3 Interview Investigations

The aim of this chapter is to present the results of the concern interviews used to review the impact of the *Right First Time* research at Nissan. The following three case study type topics were carried out at NTC and NMUK in July and August of 2001:

- NCAP
- Attractiveness
- Pilot Plant

Each section contains a brief description of the development concern before presenting the T-Matrix and summary of findings generated at the meetings. The findings are presented as bullet points for simplicity.

7.3.1 Case No.1 – “NCAP”



7.3.2 Concern Background

NCAP stands for New Car Assessment Programme, which is an independent (and unaccountable) body that tests the safety of popular new vehicles. The areas they test include front and side crash tests, pedestrian impacts and additional safety features. Based on the vehicle's performance in their tests, NCAP publish results in the form of a 'star rating'. '5 Stars' is an excellent safety test performance and '1 star' is a poor test performance. Higher ratings are more difficult for a manufacturer to achieve but can offer them marketing benefits. It should be stressed that these tests do not correlate with the legal safety requirements that all vehicles must meet.

Euro NCAP provides motoring consumers with a realistic and independent assessment of the safety performance of some of the most popular cars sold in Europe.'
(www.euroncap.com)

At the planning stage of Almera the product planners decided that '3 star' was an appropriate target for the car. Although the technical people requested a '4 star' target, '3 star' was judged to be a suitable compromise between difficulty and marketing benefit.

CHAPTER 7

In 1998 (around the C-Lot timing) NCAP tested the old model Almera with a poor result. This impacted on the vehicle sales and Marketing became aware of the importance of the NCAP rating. Because of the sales impact, the product planning department decided to change the target to '4 Star', prior to ET, the next trial. This target change required numerous changes to the body and trim parts.

An important facet of this target change is the way in which the technical changes were evaluated. In the absence of correlated simulation models, the company needed to develop the countermeasures by carrying out iterative crash tests with scarce prototype vehicles. The development was ultimately successful and the vehicle achieved a '4 star' rating when tested. This next section details the group interview results with the Nissan managers responsible for the body design and safety system development.

7.3.3 Summary Interview Findings and T-Matrix

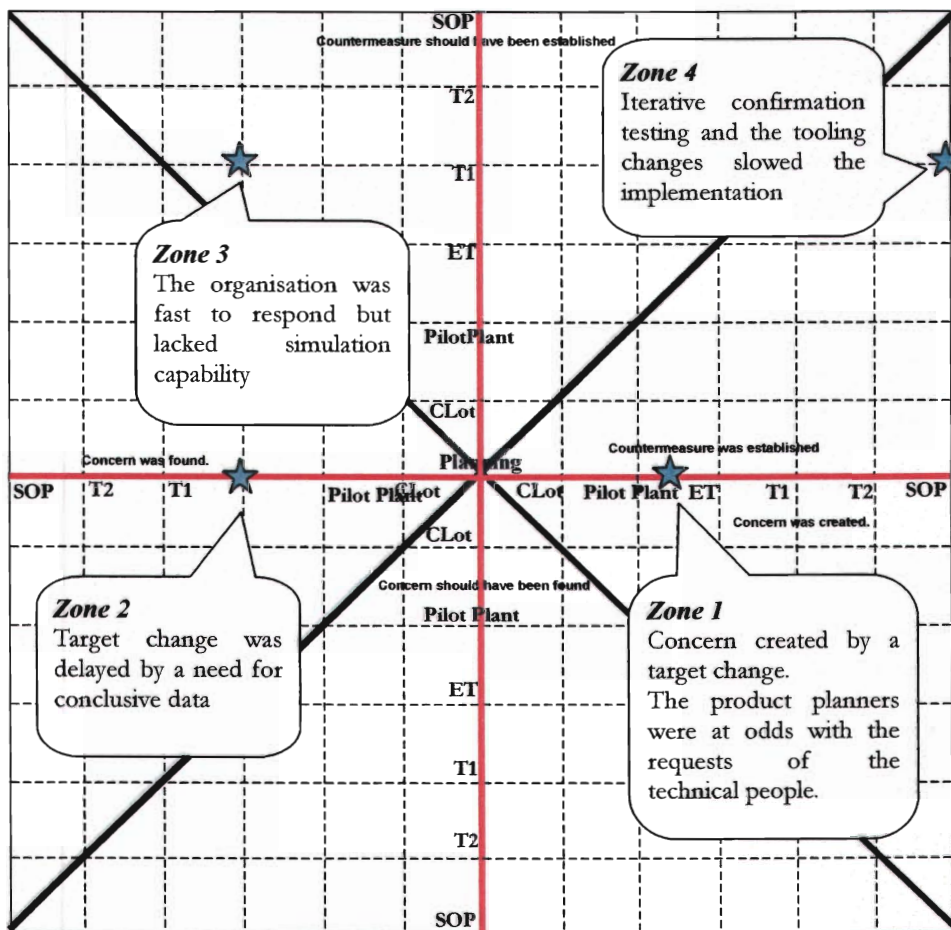


Figure 7.5 – NCAP T-Matrix

CHAPTER 7

From a pragmatic point of view, one cannot simply blame Product Planning for not recognising the importance of NCAP – The whole industry was caught out, notably Rover with Metro, who received a 1* award and subsequently had to stop production of the vehicle.

Zone 1 - Creation, Incubation

- The change of a major target caused disruption to the programme.
- A conservative level of competitiveness was selected despite some disagreement.
- The product planners were not expert at understanding the European market.
- Nissan was an engineering led, not market led organisation.
- The company is not resourced for research, it is resourced to be a product delivery company.
- Hard information was required to justify a change. Often this is difficult to get, delaying the decision.

Zone 2 - Detection

- The organisation was not expert at simulation; therefore it was difficult to predict if some items were right first time.
- This technique results in over engineering in some areas. Under engineering in others.
- Technical people lacked data to make informed decisions.
- Design techniques did not support design simulation techniques.
- The company was not resourced to do simulation work.
- Nissan has a flexible and committed workforce.

Zone 3 - Problem Solving

- An inability to predict meant iterative test loops that used up time.
- Production aggression to meet the schedule was evident.
- Technological progress was at odds with the culture of Kaizen. “If it didn’t work, its not the way forward”.
- Young /junior staff did not want to push risky things, deferential culture.
- Ultimately end up with one solution, the same as last time.
- Organisation (people) was very fast to respond.

CHAPTER 7

Zone 4 - Implementation

- The factory exerted strong influence on vehicle content (to meet the schedule and quality).
- The factory panicked, they were under pressure to deliver quality on time.
- Factory people displayed aggression.
- Design was in the middle. The Factory wants simplicity; the market wants complexity.
- The factory was stronger, but this is changing.
- The company emphasis was on delivery, not learning.
- The company is staffed to deliver, no slack
- There is a culture of 'busy, busy' does this stifle creativity?

7.4 Case No.2 – “Attractiveness”

7.4.1 Concern Background

Prior to the July 1997 model freeze, Nissan had benchmarked the New Almera against a number of vehicles from rival manufacturers. These included the *Volkswagen Golf*, the *Audi A3* and the *Peugeot 306*. Against these products Nissan had decided the vehicle concept was competitive. Mid-way through the programme (early 1998, prior to the C-Lot trial build) Volkswagen launched the *New Golf* and Ford launched the *Focus*. Both of these vehicles raised the bar in what Nissan would call “attractiveness”, a measure of how appealing the customer finds the vehicle and its features. Nissan was in the situation where it had a product for launch in 2000 that was uncompetitive in 1998. Clearly to assure sales, Nissan had to modify its original concept in spite of the RFT philosophy.

A team of engineers, stylists and marketers were tasked with developing features that would “lift” the car. The strategy employed was to introduce Unique Selling Points (USPs) to offer “super utility” to customers (Figure 7.6). The next section details the interview results with the project manager responsible for developing the ‘attractive’ features.

CHAPTER 7

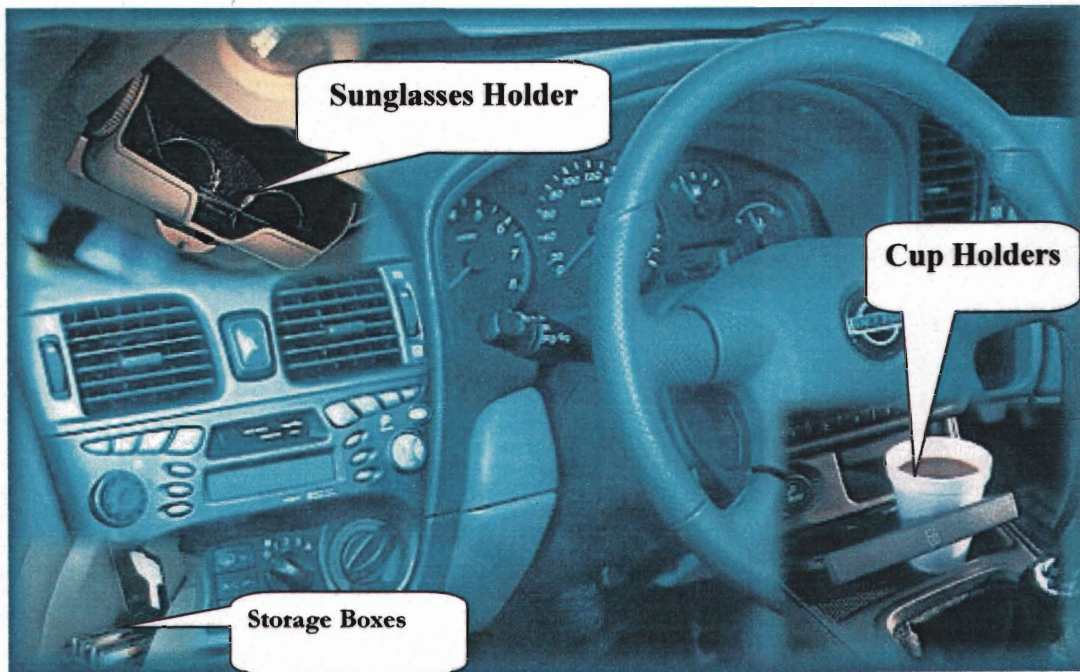


Figure 7.6 – Examples of 'Unique Selling Points' on Almera

CHAPTER 7

7.4.2 Summary Of Interview Findings and T Matrix

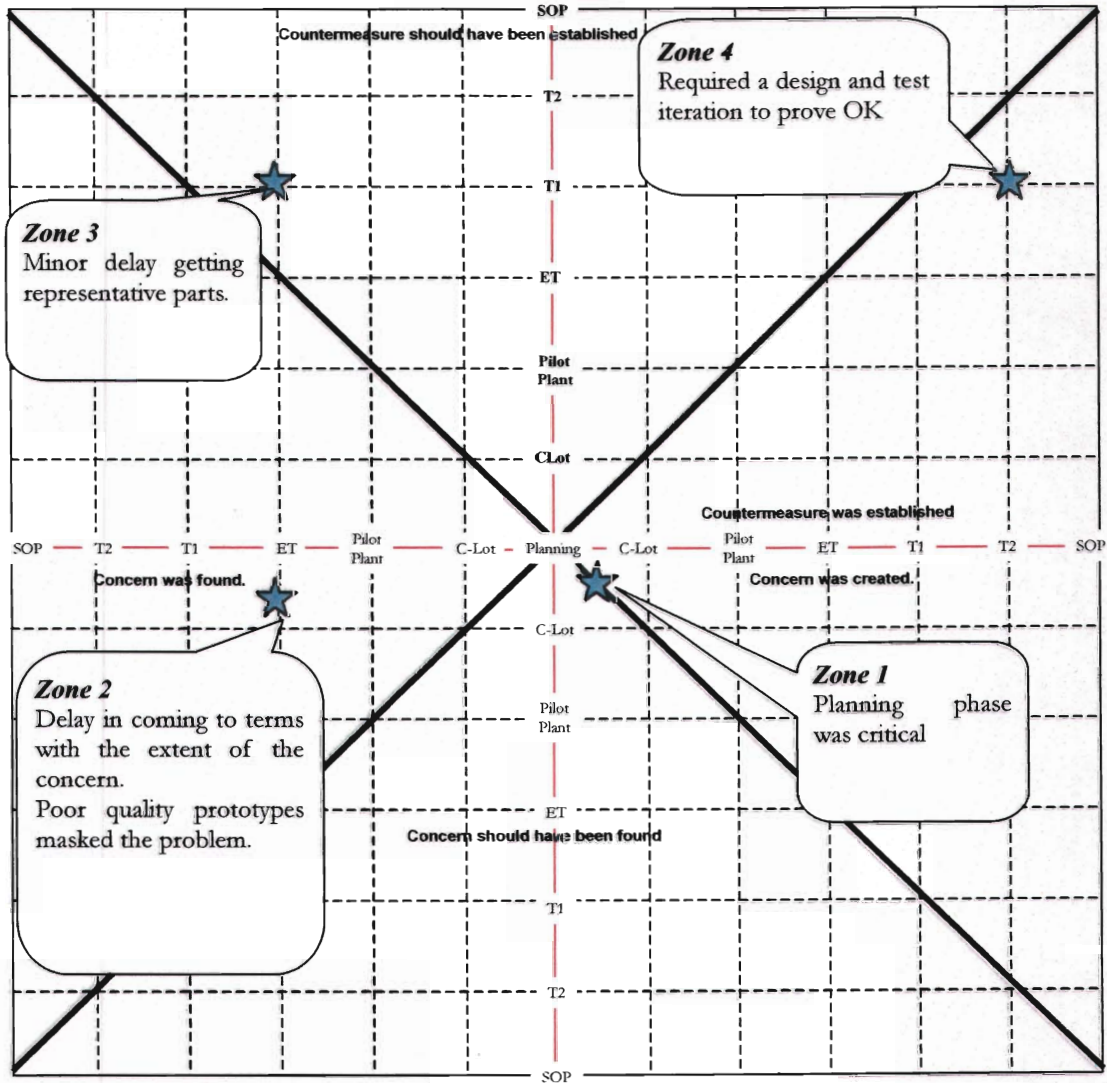


Figure 7.7 – Attractiveness T-Matrix

Zone 1 - Creation, Incubation

- Product planners accepted the vehicle concept, knowing it wasn't market leading.
- Marketing didn't anticipate the progress that the competition would make.
- The early styling renderings were not always truly representative of the finished product.
- Capital for production tooling was committed before Marketing saw representative vehicles.
- It wasn't an issue of national culture influence (often sighted as a cause of conservatism). European and Japanese staffs were involved.
- Meeting the schedule seemed to have priority over the design.

CHAPTER 7

Zone 2 - Detection

- The tools available to simulate the finished vehicle were limited.
- The first prototype cars were “rough” and masked the problem
- The culture encouraged progression of the schedule at all costs.
- Commitments meant that there was no option to go back to the drawing board.
- A company culture of “you signed it off, therefore it must be OK!”
- The culture encourages individuals to subdue opinions at odds with senior people.

Zone 3 - Problem Solving

- The team sought to identify customer needs.
- They considered how customers used their cars, what they valued.
- The focus was on what could be done, small things.
- Small changes were an easy way to pacify detractors

Zone 4 - Implementation

- Introduction of the countermeasures was delayed by getting representative parts that people could judge. A possible countermeasure to earlier problems with non-representative parts?
- If it is not *right*, it is very hard to change.

CHAPTER 7

7.5 Case No.3 - "Pilot Plant"

7.5.1 Concern Background

After the vehicle design has been approved the large body tools are manufactured in Japan. This stems from the long relationships Nissan has fostered with its Japanese tool manufacturers. These tools require shipping to the UK because they are too heavy to fly over, creating an inevitable delay. To minimise the effects of this delay, Nissan builds bodies to test the tools prior to shipping, it is then able to consider any concerns whilst they are on the water. This body build is called Pilot Plant.

At the planning stage of the Almera programme, this build had little influence on the schedule and little impact on the Design group. After the C-Lot trial the Test department of NTC decided it wanted a number of these bodies to build into working cars. Their objective was to confirm body durability by pounding them around a test track. Their quality was unimportant, they were just "bodies that ran".

At the same C-Lot trial, the manufacturing engineers had been unable to confirm some build and workability issues because of the extensive use of 'rapid prototype parts'.

These parts were frequently fragile and simulation of the production environment was not possible for fear that they would break. To countermeasure this the factory requested that Pilot Plant was re-designated a trial build and that problems from C-Lot be addressed in it. In effect it created an additional trial iteration.

The result was a logistical nightmare as parts were flown over to Japan without a firm procedure for confirming level and quality. Some parts had changed from C-Lot and some were the same, this meant the vehicles did not go together well and overall quality was poor. This caused 'phantom' concerns and possibly distracted resource from real issues.

This next section details an interview with the former Development Manager, now a Production Control Manager at the factory.

CHAPTER 7

7.5.2 Summary of Interview Findings and T Matrix

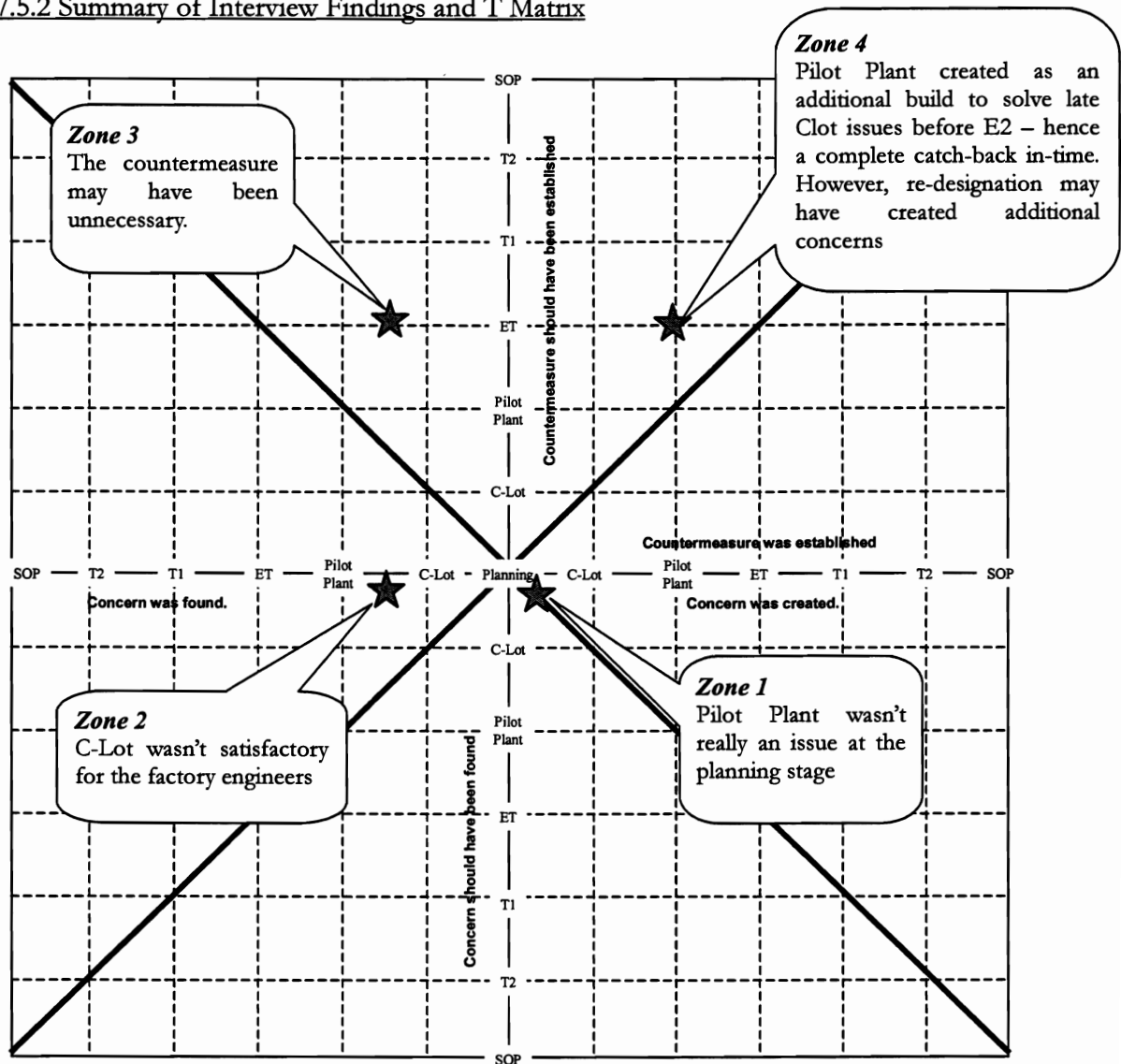


Figure 7.8 – Pilot Plant T-Matrix

Zone 1 – Creation, Incubation

- An unplanned change to the schedule caused disruption of the project.
- Production wanted another iterative loop. They were unhappy with RFT because it didn't give them enough opportunities to prove the process.
- Poor quality prototypes at C-Lot distracted attention from key issues.
- The factory's opinion took precedence over design. They were stronger.

The main priority was meeting the production launch date with the required quality.

CHAPTER 7

Zone 2 - Detection

- Rapid prototype parts broke at the C-Lot build. They were unrepresentative and production engineers were unable to consider the process issues.
- Rapid prototype parts were used to save time and cost, but they were not functional, a key issue with the C-Lot build is functionality.

Zone 3 - Problem Solving

- NMUK's revised schedule didn't fit into the programme, but the build still went ahead.
- Pilot Plant effort caused a serious disruption to the programme.

Zone 4 - Implementation

- The solution to the problem of parts procurement was unsatisfactory for both sides (NTC and NMUK).
- The value of all this activity is unclear. E2 Build was much better, but was it always going to be so?

7.6 Conclusions

These qualitative findings are useful in giving a complete evaluation of the research. The research achieved its aims, yet had 3 very significant concerns, which could easily have been overlooked by the author – simply discounting them as incomparable with the EQ and DC benchmark and target. Nevertheless, it is a fact that in any vehicle development, there are “Surprises”. In this case, we even allowed for them in the planning, under the auspices of “Attractive Quality”.

The T-Matrix is useful in the evaluation of these Qualitative areas. They help direct and guide conversations and jog memories. Moreover, they allow qualitative problems to become quantitative ones; and in an organisation that is underpinned with TQM, that is one huge step in creating a sustainable countermeasure for the future.

In a process in which delay / time is critical (not the same as Kaizen of the working Production System) the time dimension of the problem solving process is also critical. The T Matrix delivers this need in an accessible way.

CHAPTER 8

Conclusions from the Research in the Case Company and Applicability to Other Companies

The purpose of this Chapter is to consider the Quantitative and Qualitative results from the Case Project with a particular emphasis of areas for improvement by critical analysis. The author will then put forward “14 Rules for Right First Time Design and Development”, which could arguably be applied to any Product Development project

In support of this hypothesis, the 14 Rules will be “tested” in two alternative organisations of significant engineering reputation, outside of the Automotive Industry. This will assess their readiness to adapt the principles of RFT Design

The first company (ABC Co Ltd), is a global developer of Electro-Mechanical devices, deployed on the high streets around the world and required by their nature to be highly reliable and durable

The second company (XYZ Co Ltd), is a famous Engineering company employed in the development and manufacture of aero-engines. By their nature, these aero-engine components, must be highly reliable and durable, but also competitive.

CHAPTER 8

8.0 Introduction

Chapters 4 to 7 have described in some detail the culmination of the “Action Based Research”, through a whole vehicle development program between 1996 and 2001. The researcher, through this program was able to test his theories, based around the principle that a reduction in Design Change, or Right First Time Design, would ultimately lead to a more efficient and lower cost of development.

A number of unique and novel propositions have been highlighted, some listed below

- 1) A more detailed definition of the “glibly” used term “Right First Time Design”
- 2) A linkage between the key facets of TQM and RFT Design.
- 3) The usage of Hoshin Kanri as a tool for the “Change Agent” and the importance of analysing historical data to predict future improvements to be made through Hoshin Kanri deployment.
- 4) An illustration that there is no “one strategy” to implement RFT Design, but a continuum of tactic linked together by TQM methodologies and deployed by Cross-Functional Teams having a common objective.
- 5) Determining the importance of closed-loop development controls, to ensure that a robust history of previous project design changes are readily available for analysis.
- 6) Using Design Change as a financial tool, to demonstrate a Return on Investment for the tools required to actualise the reduction in design change. I.e. Using historical data to determine the cost of one typical design change.
- 7) Analysing, through a live project, the effectiveness of the tools determined necessary to reduce design change.
- 8) Analysis of the assumption failures on a “T Matrix”, to ensure a “Kaizen” approach to the next project

The results from this thesis have ultimately allowed the author to determine “14 Rules to Reduce Design Change in a Product Development Program”. However, before determining the rules, it is necessary to take a critical review of what was and was not achieved through the case project.

CHAPTER 8

The aim of this chapter is to review the implementation of *Right First Time Design* on the Nissan Almera using the findings of the fieldwork and the subject literature reviewed. The discussion will seek to determine RFT's effectiveness by exploring the attributes and limitations demonstrated throughout the project.

8.1 Right First Time – To Reduce Development Lead-times

Blackburn [Ref 8.1, 1992] described product design and development as a '*target rich*' area for time compression, and it is this evaluation that Nissan sought to apply with RFT. Through the application of TQM, knowledge management, and computer-aided engineering they were able to slash 9 months off the development period, representing a reduction of 22.5%. Simultaneously the company was able to reduce the number of design changes by a dramatic 80%. This not only saved development resource but also the costs that would normally have been incurred modifying tools. Perhaps most importantly, in a climate of great financial difficulty for Nissan, all this was achieved without significant capital investment.

Although the quantitative findings demonstrate a significant achievement, they also point to areas where the product delivery phase could be further improved. Firstly, an analysis of the individual design changes show that a significant percentage of them were caused by modifications to the original vehicle specification. This can be correlated to resource spend to show that 40% less manpower could have been employed if the specification had remained static. Another area of opportunity is the fact that the majority of the parts that changed also required three or more change iterations before production. This implies that once the 'RFT rules' were breached they ceased to be adhered to. This has parallels to Stalk & Hout's [Ref 8.2, Stalk, G.Jr.1990] third phase of time-based competition, namely '*sustaining the improvement*'.

A second area, highlighted for improvement during the T Matrix interviews, was the need to improve the company's ability to simulate, using computer aided engineering techniques (CAE). Nissan managers were critical of the company's CAE capabilities, indicating that it had fallen behind its major competitors. One explanation of this phenomenon has its roots in the company culture of Kaizen. Early technology trials had been unsuccessful, and the company had partially rejected their application:

CHAPTER 8

“...[T]hese systems have developed a lot in the last 5 years. There was a suspicion in NTC that if they didn't give you the answer you were looking for then it wasn't the way forward...This is a company culture issue, if something doesn't work, steps are taken to make sure the path is never trodden again.”

Nissan Manager (2001)

Carlos Ghosn [Ref 8.3, Ghosn. C, 1999] announced that the NRP (Nissan Revival Plan) includes the introduction of more effective and powerful CAE systems. But there may be an organisational issue that needs addressing. The Kaizen tenet of Plan-Do-Check-Action may need to have a *'Check Again'* step added in times of technological advance.

An analysis of the resource spend profile shows that the overspend generated by the changes from the original specification happened late on in the programme. This changed the shape, from the ideal 'front-loaded' profile, to a more conventional project shape. This deviation from plan was heavily influenced by the major concerns analysed in this dissertation: The target changes of NCAP and 'attractiveness', and the schedule changes caused by the re-designation of the Pilot Plant as a trial build.

The opinion within the development company, NTCE, was that these issues were outside their control. The marketing function should have specified the right targets at the outset, and the factory should not have forced a schedule change mid-way through the programme. What is evident though is that RFT was a development company led initiative and the implications of such a dramatic change were not fully appreciated or acted upon by Marketing and Production. This led to a situation where Design staff felt pressurised and *'in the middle'* - implementing late changes to satisfy market requirements or resist them in order that the factory could stabilise its process and quality. In essence, Stalk & Hout's [Ref 8.2, Stalk, G.Jr.1990] first phase, the *'development of a vision'*, was not complete, the concept was not universally accepted throughout the Nissan organisation. This lack of shared vision and common long-term planning was highlighted in the NRP by Ghosn as a key area for future improvement.

The roots of these internal differences of direction lie in the pressures that different parts of the organisation were under. As Robertson [Ref 8.4, Robertson, T.S. 1993] pointed

CHAPTER 8

out, product development speed was only half of the time-based competition picture, the other half was penetrating the market quickly. The monthly sales figures show that full sales potential of the car was reached within 3 months of launch, demonstrating the efforts of marketing, and in particular the factory staff. The factory had to ramp-up its production speed very quickly in order to fill these sales requirements and also build the stock levels to satisfy national distributors. This placed them under significant pressure to achieve their process and quality targets prior to launch, in spite of the reduced schedule and late changes.

It was partly because of these pressures that the factory pushed for a change in schedule, the re-designation of the Pilot Plant as a trial build. This schedule change fell outside standard processes and required significant efforts on the part of NTCE and NMUK to even build the cars. The quality of the trial vehicles was very poor because different levels of components were used, deviating from Turner's [Ref 8.5, Turner J.R. 1993] tenet of concurrency - *'strict change control.'*

"There should have been a retrospective analysis of what they achieved with all this effort at Pilot Plant. At ET [the next planned trial], miraculously the level of the cars got better and everybody patted themselves on the back."
Nissan Manager (2001)

This change of build schedule, instigated by the plant, demonstrated the influence and power of the factory throughout the programme. Meeting the production schedule and start of production date was of paramount importance, sometimes at the cost of the product. The product attractiveness T-Matrix analysis showed that changes were limited, partly because of these time constraints:

"We only made little changes, add-ons to the original concept. Little things to lift it up... There probably wasn't the time or money [to do anything more drastic]." Nissan Manager (2001)

All the managers interviewed for this dissertation point out that, post NRP, the strength of the factory is diminishing, the whole organisation becoming increasingly market focused.

CHAPTER 8

The changes proposed by Marketing in the late stages of Almera show that they had not taken cognisance of the implications of RFT. By definition RFT does not accommodate the design iterations of conventional programmes. It forces the Marketing function to get it correct, but it brings these critical decisions closer to the launch date. On this programme, Marketing agreed to a product that was *just* competitive based on the competitor vehicles in 1997. Progress in the market meant that significant target changes for NCAP and attractiveness were requested late on in the programme. This not only put the design and factory functions under great pressure, but also mitigated many of the benefits of RFT.

To apportion blame for the RFT concerns at the doors of Marketing and NMUK would not give a balanced view. The T-Matrix interviews raised some key issues with the development process that contributed to their problems. One of the first key decisions is for Marketing to accept the styling and product attractiveness based on drawings and clay models that are not always truly representative. This differs from some other manufacturers who build a completely representative model to base decisions upon. This of course costs additional money but should not impinge on the development lead-time because it is an up-front activity. An alternative stance is that taken by Toyota. They build several working prototype variants, allowing their product planners to decide which is best, based on current market information [Ref 8.6, Ward et al 1995]. This would present a significant development cost increase over Nissan's methods.

An additional concern was identified with the objective of the first working prototypes. Nissan builds these cars (at C-lot) with the primary purpose to evaluate the product's performance, not its aesthetics.

“Quite often the early cars are “quite rough”; its difficult for Marketing to judge them...parts aren't grained and some features are missing.”
Nissan Manager (2001)

The quality of the first prototypes was also raised as an issue for the factory's manufacturing engineers. For Almera development, Nissan made extensive use of 'rapid prototype parts'. These are components that can be manufactured quickly and cheaply (to assist RFT targets) but do not have the same properties as true prototype parts. Extensive use of resin components did not enable the factory engineers to confirm the

CHAPTER 8

true process for fear that they would break. This inability to check the process reduced confidence and influenced the factory's need for another iteration, Pilot Plant.

The development company's ability to get the design right first time was demonstrated by the spectacular reductions in the build and performance concerns raised on Almera. In spite of this, the qualitative analysis for NCAP showed that the company was not always able to simulate complex performance issues. This is not only related to the company's CAE capabilities, discussed earlier, but also its expertise and resource. The managers interviewed believed that the company was resourced to deliver the product, and insufficient effort was applied to organisational learning and the development of new competencies. This was demonstrated during the NCAP concern. An inability to analyse the root cause of the concern led to a step-by-step solution process.

"We do have a tendency to analyse individually each of the symptoms rather than the root cause... There has never been a good simulation model, there wasn't the resource or knowledge in NTC to carry one out."
Nissan Manager (2001)

This weakness in simulation capabilities will inevitably lead to cost penalties for the company in the long term. In some areas, the 'right' in right first time will include a safety margin, or over-engineering creating a penalty in the component costs. In the other areas where mistakes are made, costs will be incurred through delays and the additional costs to put it right. The NRP specifically identifies the weakness of over-engineering at Nissan and seeks to target this by improving design capabilities.

'Our target [NRP] is to develop and optimise our Research and Development capability...' (Ghosn 1999)

A weakness of creativity and innovation was raised by the managers involved in the NCAP and attractiveness issues. These were risks highlighted by Choperana [Ref 8.7, Choperana, A.M, 1996] and Cohen et al [Ref 8.8, Cohen, M.A., Eliashberg, J., Hua, T. 1996] in their evaluations of time-based competition and selective innovation. The Nissan managers blamed the way the programme was resourced with 'no slack', but it may also stem from aspects of the company culture:

'[Its] a culture of "busy, busy". If you're doing anything creative, people turn round and say "that guy hasn't got enough to do...you should be doing A,B or C"' Nissan Managers (2001)

CHAPTER 8

The 'stretch' method of resource allocation also created pressures later on in the project when the workload associated with changes started. Nissan expected, and received, significant commitment from its employees to achieve the targets and schedule. But Stalk & Webber [Ref 8.9, Stalk, G. Jr. & Webber, A.M 1993] warn that this cannot carry on indefinitely as the relentless pace can exhaust managers and workers. The pressures also manifested themselves in different ways. More than one manager talked about *'being caught in the middle, between Marketing and the factory,'* and on the receiving end of aggression because the schedule was in jeopardy.

'When you have X number of weeks to the launch of the product, you then have very angry men from production beating you over the head with a stick saying "what's the solution."' Nissan Manager

There are no easy answers, the factory have their own real pressures, but for the design engineer responding to a late Marketing request this is not very motivational.

The compressed schedule of an RFT development philosophy places the spotlight on the organisation's ability to make timely decisions. The interviewees felt that decisions were made quickly providing there was enough information to make an informed choice. This follows Eisenhardt's fourth decision-making paradigm [Ref 8.10 Prof Kathleen Eisenhardt 1990]. Where they did highlight a concern was with the availability of relevant information. This was not only the technical information discussed with reference to simulation capabilities, but also market information. With the NCAP [Ref 8.11 Euro NCAP Web Site] discussion it seemed that the target change was delayed because the product planners could not get conclusive proof of the market need. This may highlight a number of organisational weaknesses: A difficulty sourcing good market information, an organisational need for 'hard' facts when none exist or a 'market-follower' mentality.

Other aspects of the company's decision making was also analysed in the concern discussions. Decisions were deferred by an apparent reluctance to change. This is a complex issue because mid-project change is not catered for by RFT, but delaying an inevitable decision creates difficulties in the later stages of the project. This not only highlights the need for better original specification but also an organisation quicker on its feet to accept the inevitable.

CHAPTER 8

8.2 “14 Rules to Reduce Design Change in a Product Development Program”

In summary then, the Research hypothesis was a success, but not without further areas of improvement being determined. With these successes and failures in mind, the author has compiled “14 Guide lines to success Right First Time Development” to be further examined through subsequent projects. In brief these 14 Rules follow.

- 1) **R**igorous data capture from previous projects
- 2) **I**nvestigate the true causal factors of change
- 3) **G**enerate a clear objective from the outset and don't change it
- 4) **H**oshin Kanri structures the logical deployment of tactics
- 5) **T**QM 5 Pillars are paramount to success
- 6) **F**ind many tactics, there is no “one shot” solution in spite of consultant sales talk
- 7) **I**mprovements to the Hoshin Kanri should be encouraged.
- 8) **R**egister the cost of design change in your organisation
- 9) **S**ystematically monitor your results through early warning sub-measures
- 10) **T**eam-working and Cross-functional development and deployment of tactics
- 11) **T**enaciously and continuously pursue the objective through weekly reviews
- 12) **I**nvoke supporting organisations to participate and support
- 13) **M**easure the project successes and failures against the Objective
- 14) **E**mploy the learnings from the project on to the next one

CHAPTER 8

8.2.1) Rigorous data capture from previous projects: Chapter 5 shows us the importance of analysing historical reasons for Design Change. However, this is not possible if the systems are not in place to capture this data. Whilst to many engineers, the added bureaucracy of recording concerns and ensuring that their resolution is closed in a closed-loop fashion is an anathema; it is nevertheless a vital part of RFT Design. Most respectable development organisations control the “Design Level” and thus in most cases, rudimentary history can be analysed. The key question is whether these controls are sufficient to grasping

- a) The real number of design changes, especially if a number of changes have been bundled together
- b) The real reason behind the changes.

The author believes that causal factors should at least be able to establish in the categories of “Mistake”, “Testing Concern”, “Assembly Concern”, “Cost Reduction” and “Outside Factors” and that sub-control systems should be in place to support this level of data collection. Of course, supplementary to this, it is also vital that one determines the total cost of Design Change within the historic programs. The supposition of the author is that unless one has at least one data set from a previous project, then it is impossible to “Commit” to any kind of Right First Time objective without it being any more than a simple leap of faith.

8.2.2) Investigate the true causal factors of change

Once data exists from a previous project, it is important to analyse the data in such a way that one can fully understand the true causal factors of design change. The key word here is “True”. In releasing a design change, engineers and organisations in general are not good at recording the true motivation for a change. This can be that systems don’t support this level of recording, or it maybe that organisational culture simply doesn’t allow an engineer to admit to a mistake. These barriers need to be overcome, especially since, in the case company example, up to 50% of the changes could be considered as avoidable by the engineer himself. Data analysis tools in themselves are not imposed in these rules. The type of analysis will vary company to company and project type to project type. The author has no doubt that his analysis method could be

CHAPTER 8

improved upon, but propounds the necessity to reach the true reasons for design change, not just the apparent reasons that may result from superficial data sets.

8.2.3) Generate a clear objective from the outset and don't change it

A core virtue of working in a TQM manner is the necessity to Set Clear Targets. The simpler the objective, the better. It must be stretching yet achievable, but more importantly, it must be visible and fully endorsed by the highest levels in the company. The importance of setting an unambiguous target becomes even more profound if the Hoshin Kanri method is used in a Cross Functional nature. Every level in the company must understand the objective and the Hoshin Kanri principle means that a sub-part of the objective can indeed be deployed to every person in the development organisation as part of their annual objectives. This gives both ownership of the sub-objective and the overall corporate objective. It is also reasonable to suppose that the Objective and the subsequent deployment could be linked to a Balanced Score Card or similar type of Corporate Control Tool.

8.2.4) Hoshin Kanri structures the logical deployment of tactics.

The author propounds the use of the Hoshin Kanri tool as a logical and easily understood "Change Agent" Tool. The ability to incorporate the Clear Objective and then break it down in to Strategies and Tactics in a TQM manner is profoundly powerful. Couple this with the ability to assign tasks to individuals and for them, to use historical data to forecast the level of improvement that their proposal will make, the cost of the improvement and the Return on this Investment, makes the tool invaluable.

In the opinion of the author, one needs to continuously revisit the Hoshin Kanri during the development cycle. The purpose of this is to validate the forecasts on an on-going basis and adjust the Strategies and Tactics in the light of any re-forecast shortfalls to the objective.

CHAPTER 8

8.2.5) TQM 5 Pillars are paramount to success

The 5 Pillars of TQM represent a logical and powerful framework for any product development assuming that the TQM philosophy is embedded into the corporation. The Pillars

- 1) Set Clear Targets
- 2) Manage Using Facts
- 3) Improve Communications
- 4) Use the PDCA Cycle
- 5) Standardise Best Practice

are at the heart of both this project and the culture of Nissan. Three in particular are deeply embedded within the Case Company, these being “Manage Using Facts”, “PDCA Cycle” and “Standardise Best Practice”. With this embedded asset already in-place, the researcher’s work became much easier.

8.2.6) Find many tactics, there is no “one shot” solution in spite of consultant sales talk Engineering Management is notorious for flirting with the latest tools to solve its requirements. CAD, Concurrent Engineering, QFD, Simulation, are all fads claiming to make a Corporations development enterprise more efficient; and in many cases they do indeed add value. However, no single Tool can be purchased to buy Right First Time Design. One must address the type of development process in hand, the culture of the corporation, the geographical spread, the reasons for previous failures and all the other facets treated in this project. The author’s “FASTD” project had 48 separate Tactics, meshed together in one coherent strategy.

8.2.7) Improvements to the Hoshin Kanri should be encouraged.

But it should be remembered that these 48 Tactics were not born from the start, they evolved through iteration of reviewing reasons for previous failures, forecasts of new tactic efficiency, until finally the forecast of design change reduction reached 80%. That is to say, the Hoshin Kanri is a live tool and should change to reflect the success of individual Tactics and be used to drive compensating improvements, where a particular Tactic has fallen short of its objective.

CHAPTER 8

8.2.8) Register the cost of design change in your organisation

Knowing the cost of design change in a Corporation is a powerful weapon in the justification of expenditure on Design Change Reduction Tools. As expressed in Chapter 8, the calculation is relatively crude and simply. If the Corporation can count the number of Design Changes after Production Release and the Accountant can differentiate initial Tooling expenditure from that of modifications, then the bulk of the calculation is done. All that remains is to estimate the indirect time spent from Engineer to Buyer and supplier in progressing this change.

In the case of Nissan, publishing the cost of design change sent a tremor throughout the organisation, as it was much larger than had been imagined. It also put in front of the engineers a very tangible reason for reducing design change and contributing to the FASTD organisation.

8.2.9) Systematically monitor your results through early warning sub-measures

Having stated that the Hoshin Kanri should be continuously updated, reflecting the success or failure of particular tactics, it is also implicit that one cannot wait until the end of the development to take countermeasures against failed tactics. Therefore, early warning measurements are essential in ensuring that Design Change reductions are on track. In the case of Nissan, this for instance, drove the Planning Drawing focus, with Advanced CUS and NTI's being raised by the Test Engineers on potential concerns found through Design Reviews. Likewise, continuous monitoring of CUS, STRS, etc are all early warnings of potential design change. Different companies will have different measures, but what is essential, is that there are early indicators of design suitability prior to its production release.

CHAPTER 8

8.2.10) Team-working and Cross-functional development and deployment of tactics

It tends to be true of any initiative that successful deployment depends upon empowerment of the staff required to deliver it. The importance of Cross Functionalism is well documented and a central part of Nissan Financial recovery [Ref 11.12 Carlos Ghosn, Turnaround, 2003]. It is doubly true in the case of Engineering where one system has so many interactions on others. However here, we should also learn the lessons of the Nissan case, where the lack of good buy-in from Marketing and the inability to predict Market trends such as NCAP, led to higher than expected design change. Thus one can conclude that Cross Functionalism and Team Working must expand beyond the boundaries of Engineering and incorporate at least the functions of Product Planning / Marketing, Styling and Cost Management.

8.2.11) Tenaciously and continuously pursue the objective through weekly reviews

Once the project starts, it is important to keep focus on the Design Change reduction objective. In the Case Company, this was seen in the Weekly Operations Meeting held by the Engineering Director, where Design Change evolution on the HS project was measured weekly. No one was left in any doubt that this initiative was being led from the top and this constant attention undoubtedly contributed to the final achievement of the 80% reduction goal.

8.2.12) Invite supporting organisations to participate and support

To some extent reflected in the need for Cross Functionalism, but re-emphasised here because ultimately this was the one area of major failure in the Case project. It is already known from the Historical analysis that Workability, Marketing and Cost Reduction play a significant part in design change reduction. In the case of HS, NTCE and NMUK were fully engaged in the common objective. But as has already been demonstrated, the involvement or focus of Marketing was not enough. Since in most companies, Marketing/ Product Planning, Manufacturing and Finance tend to be different departments from Engineering, then the need for exceptional Cross Functional Team Working is vital.

CHAPTER 8

8.2.13) Measure the project successes and failures against the Objective

Central to the PDCA cycle, is the need to review a Project's success and/or failure upon completion. Whether one uses the T Matrix or another method is entirely optional. However, the post-Project review is the opportunity to embed learnings from the project into the next project. In so many cases, one can see the same mistakes being made in every subsequent project. The excuse for not doing post-Project reviews is of course, time. However, hopefully demonstrated through this Thesis, the time spent on the review will more than pay for itself within the next project.

8.2.14) Employ the learnings from the project on to the next one

.....and finally, from the TQM Pillar, Standardise Best Practice. The current fashion is to call this KM (Knowledge Management). It is essentially the Capitalisation of lessons learned through a Project and then using these lessons in the next project. Common sense really. In this case, the embedding was done through the issue of Standard Practice Processes, filed in each Engineers "Engineers Hand-Book" / Diary. More recently, intranet based access is probably more relevant, provided that Engineers are able to find and use the information without the need to go searching for it.

8.3 Application of RFT Design in other Industries

We can see that the Author's principles of how to achieve Right First Time Design were tested in enormous detail through the HS project at Nissan. This Action Based research methodology has the great advantage of allowing this depth to be reached. However, one must also recognise the weakness in this approach. That arguably being that we have only shown that the RFT principles can be adopted in Nissan. Whilst this may not be logically true, since Nissan uses the essentially the same science as any Engineering company, it was felt appropriate to test the 14 Principles and the RFT Design theory in the public domain and in two alternative and respected engineering companies and assess their readiness to introduce the concept of RFT Design.

CHAPTER 8

The testing in the Public Domain was undertaken through the publication of several papers and presentation at Peer conferences. These Presentations are explained in the Appendices.

The two companies tested were (Names changed for confidentiality)

The first company (ABC Co Ltd), is a global developer of Electro-Mechanical devices, deployed on the high streets around the world and required by their nature to be highly reliable and durable

The second company (XYZ Co Ltd), is a famous Engineering company employed in the development and manufacture of aero-engines components. By their nature, these aero-engine components, must be highly reliable and durable, but also competitive.

The author spent 2 Days with each company, working through a questionnaire to establish the extent of readiness that these two companies were to accept the principles of RFT Design

8.3.1) ABC Co Ltd

ABC is a global company involved in the design and manufacturing of electro-mechanical devices. As said, they are in an engineering/business field comparable with Nissan. ABC were selected as a means of checking and testing the theories and principles of RFT Design. As well as being in the same discipline, they are global, profit lead and open minded to new initiatives and hence are an excellent reference case.

8.3.1.1) Background

The ABC Corporation is a leading global provider of “relationship technology solutions” that enable business to drive growth and performance. ABC’s key solutions are retail store automation, financial self-service (Auto-Teller Machines-ATMs) and data warehousing, including the Teradata database and analytical software applications.

CHAPTER 8

The Facility visited concentrates on the design, development and manufacture of automated teller machines (ATMs). ABC has a strong ATM presence in all key regions of the globe – a distinct advantage given the under penetrated nature of large international markets such as India and China. The ATM business performed well in 2000 in spite of lingering Y2K effects and the significant impact of a weaker Euro during much of the year. Margins remained good as the Company augmented revenue growth with efficiency and cost reduction.

The ATM industry is in some respects a tale of two markets – the United States and the rest of the World. ATM sales among the major financial institutions slowed in the United States following a period of sustained growth. ABC realigned its sales strategy in 2000 to address specific growth opportunities such as community banks and the entry level cash dispenser market where independent sales organisations have adopted the use of traditional ATMs for new types of locations. Initiatives in these markets have enabled ABC to maintain strong volume, good market share and sound margins in the United States.

Internationally, while some markets are more established than others, the opportunities on the whole are dynamic and existing. ABC have already successfully entered into, and gained market share in, the important emerging markets of India and China, which collectively are home to over a third of the world's population. To facilitate cost efficient penetration and timely deployments, ABC continues to expand their Asian based manufacturing capabilities at their facility in Beijing, China.

ABC are also looking at outsourcing, to significantly enhance their market share and leverage their customer service capabilities. In January 2001, they announced their first North American outsourcing contract to service the ATM network of the Royal Bank of Canada, to provide help desk operations, cash replenishment, cash management and first line maintenance.

CHAPTER 8

8.3.1.2) “Guest Lecture”

In order to provoke a greater understanding and exchange, the author presented the finding of this Thesis to the Senior Management of ABC (approximately 20 people). Through dialogue and discussion the answers to the author’s “Questionnaire” were completed and this follows.

Questionnaire to Assess RFT Readiness of a Corporation

ABC Corporation 24th May 2001

No	Q+A	Question
1	Q	Do you measure the efficiency of your Design and Development?
	A	We are measured in terms of our Financial Spend, which is limited by a budget each year and which we are obliged to stay within. The Output per \$ is not measured by any direct indices, although it is natural that we are expected to react to Customer Orders as they come in
2	Q	How do you measure the efficiency of your D+D?
	A	Simply as achievement of R+D budget at year end
3	Q	Do you measure Design Change?
	A	Yes and no. We record updates of design level through re-issue of drawings as and when we need. However, we do not explicitly measure design change or the reasons for it in the manner that Nissan has explained to us. Engineers tend to analyse their own results from the Test department, we have no way to know or record how many modifications were made leading up to a design release - probably the engineers themselves no, but corporately we don't
4	Q	How do you measure Design Change?
	A	Other than raising the design level, we don't
5	Q	What were the results?
	A	N/A
6	Q	Did you identify a trend?
	A	N/A
7	Q	Have you a Strategy for Improvement?
	A	Yes we do. We are in the advanced stages of introducing our Corporate Six Sigma strategy. We have nominated staff from Design to become Black Belts, although at this moment we have no plan to undertake any 6 Sigma improvements in R+D
8	Q	How do you plan to implement the strategy?
	A	Obviously yes, 6 Sigma is driven from the very Top. We have had very many initiatives over the years, but we think 6 Sigma is our last and best chance to really improve efficiency across the organisation. There are some doubts whether 6 Sigma will work in D+D - some people say that you cannot measure the Design Process, but maybe Nissan experience demonstrates that you can
9	Q	Have you a Corporate level strategy?
	A	Six Sigma
10	Q	Are Design and Development efficiency improvements targeted in this strategy?
	A	No, the current thinking is that you cannot measure the efficiency of engineers, they are not in a process, although the Nissan experience will force us to re-consider that
11	Q	How do you justify Investment?

CHAPTER 8

	A	We have a Finance methodology, that requires us to demonstrate a Payback, but this would usually be justified in Engineer Headcount saving or the ability to do extra projects. Honestly, it's a bit subjective
12	Q	Do you track reasons for Design Change?
	A	No, but I suppose that we could find out some information retrospectively if we were to interrogate the Engineers
13	Q	Have you a historical record of design changes?
	A	Only from the Change level on the Drawing and in the Heads of the Engineers
14	Q	Have you analysed reasons for design change?
	A	No
15	Q	Does this form part of your improvement strategy?
	A	No
16	Q	How do you get your Managers to agree on a strategy
	A	Most definitely all Managers are supportive and a part of the need to make 6 Sigma work. As I've said, we have had a lot of initiatives in the past, but most people seem prepared to give 6 Sigma a chance, based on successes in other companies like GE
17	Q	Did you get your workforce to agree to the strategy?
	A	Well, we have certainly taken time to explain it to them
18	Q	What resistance did you encounter?
	A	Mainly that this is just another initiative. We really have to follow this through and demonstrate to our employee that we are serious about 6 Sigma
19	Q	Have you a Mission Statement?
	A	Yes
20	Q	Have you re-organised your organisation to meet the strategy?
	A	We are in the process of re-organisation, but I wouldn't say that it was led by a specific initiative. We have recognised the need to enhance Engineering Management as a Function and we are in the stages to appoint one.
21	Q	How do you capture Knowledge?
	A	We don't have a formal system for capturing Engineering Knowledge in the way described by Nissan. We don't undertake post Project reviews. Probably we should, because over half of our projects are delivered late - I think this is one of the reasons that we recognise the need for a Head of Engineering
22	Q	How do you Plan process development / creation?
	A	We get an RFQ from the Customer, an Engineer is assigned and he makes his Plan. There is no generic Master Schedule; it depends on the complexity of the request. Obviously we do Design Reviews and there are some specific Gateways for investment, the rest is left to the Engineer in charge
23	Q	How do you prioritise Investment?
	A	Hmm, difficult to say, we try to cope with all the Customer requests, provided they are profitable to the company, but there is no resource planning at the project level, hence at least part of the reason that we are late in the delivery of many of our programs
24	Q	Have you any tools to assist with reductions in D+D lead-times?
	A	Yes, we are continuously looking at new Engineering Tools, such as Simulation technologies, especially in the area of Software development. These obviously help with Lead-Time reduction, but I wouldn't say that there investment is strictly related to this aim
25	Q	Have you employed TQM principles?
	A	Well we went through the TQM initiative, but I wouldn't say that it is embedded, just another initiative
26	Q	Define Lead-time?
	A	From RFQ deployment to the Engineer in Charge, until its release to Sales
27	Q	Do you "Test by Design"?

CHAPTER 8

	A	No, except more so now in the area of Software development. The normal way is to build prototypes and then test them. The design engineer assesses the results and decides if countermeasure action is required or not
28	Q	What is the biggest reason for Design Change?
	A	We don't know
29	Q	Do you have sub-measurement systems to register reasons for Design Change?
	A	No
30	Q	Are they Closed Loop?
	A	N/A
31	Q	Have you a quantifiable technique for the cost justification of design tools?
	A	No, except any commitment made in the justification, such as reduction in Engineering Headcount, although in reality this is very difficult for the accountants to check!

8.3.1.3) ABC Co Ltd Reflection

ABC Co Ltd is a highly successful company and a competent Engineering organisation. Its improvement initiatives mainly revolve around 6 Sigma, but it is unclear at the time of Interview, how this would impinge on engineering efficiency improvements.

If we study ABC Co Ltd through the 14 Rules model;

1) Rigorous data capture from previous projects

Not done. Data exists in the rudimentary form of registration of upping the design level. There are no strict processes governing the closure of concerns. Test Failures are notified to the Engineer, but closure is up to his professionalism. In-order to meet the basic needs of RFT design, it would be necessary to go back over a recent project and “down-load” the Engineers knowledge into a form that could be analysed. This is obviously somewhat fraught as it relies on memory, but better than nothing and the prompt could be the Design Level notes.

2) Investigate the true causal factors of change

Reliant on Stage 1, but the capability exists.

CHAPTER 8

- 3) Generate a clear objective from the outset and don't change it
The key point for ABC Co is to get the needs for On-Time project delivery clearly part of their Six Sigma project. An ideal way would be to ask one Black Belt to lead a project into On-Time project deliver, starting with analysis of Design Change data using 6 Sigma Tools.
- 4) Hoshin Kanri structures the logical deployment of tactics
Not used, but ABC Co Management could see its merit
- 5) TQM 5 Pillars are paramount to success
Six Sigma used many of the TQM Tools and by rough assessment, it seems the culture in-side ABC Co is conducive to this way of working. A key improvement area would be employment of PDCA mentality structured around a clearer Development Administration System, promoting the use of Generic Master Schedules and Data Capture systems.
- 6) Find many tactics, there is no "one shot" solution in spite of consultant sales talk
Perhaps the weakness of ABC is that the staff are fed up by continuous initiatives. The latest solution is 6 Sigma. However, the advantage is that 6 Sigma could be the carrier for a sub Initiative on Engineering Efficiency Improvement through RFT Design.
- 7) Improvements to the Hoshin Kanri should be encouraged.
Should be no problem given the Culture and adoption of a Black Belt leader.
- 8) Register the cost of design change in your organisation
This is unknown, but there are sufficient information and skills in the organisation to let it be calculated.

CHAPTER 8

- 9) Systematically monitor your results through early warning sub-measures
An area where big improvements will be necessary. Too much reliance is placed on the professionalism of the Engineers and their duty to countermeasure problems. Since there are no systems to independently Police this, Management is unaware of development concerns and there are no statistical based early warning mechanisms in the company. This is a key area to be addressed before adopting a RFT Design policy.
- 10) Team-working and Cross-functional development and deployment of tactics
Cross Functional Team Working seems good, with out significant corporate politicking and with a good level of mutual trust across Functions. Since 6 Sigma is a Cross Functional edict, any improvements in the Engineering efficiency area would need to be logically linked to this.
- 11) Tenaciously and continuously pursue the objective through weekly reviews
Underlining the need for Step 9.
- 12) Invite supporting organisations to participate and support
Through the 6 Sigma organisation, it is possible to achieve this.
- 13) Measure the project successes and failures against the Objective
Not done to date, but at least ABC Co Engineering Management could see the benefit. However, they were concerned on how to implement RFT Design, without the necessary investment being seen as “a leap of faith” by their top management.
- 14) Employ the learning's from the project on to the next one
No done to date in any way other than the tacit knowledge of their Engineers.

CHAPTER 8

8.3.2 XYZ Co Ltd

XYZ Co Ltd is a UK company, selling on a Global basis and involved in the design and a manufacturing of aero-engine components. As said, they are in an engineering/business field comparable with Nissan. XYZ were selected as a means of checking and testing the theories and principles of RFT Design. As well as being in the same discipline, they are global, profit lead and open minded to new initiatives and hence are an excellent reference case. They are also a company with an awesome reputation for Product Quality and therefore an interesting example to view in terms of RFT Design.

8.3.2.1) Background

XYZ plc operates in four global markets - civil aerospace, defence aerospace, marine and energy. It is investing in technology and capability that can be exploited in each of these sectors to create a competitive range of products.

The success of these products is demonstrated by the company's rapid and substantial gains in market share over recent years. As a result, component deliveries have grown and the company now has many thousands of components and systems in service worldwide. The investments in product, capability and infrastructure to gain this market position create high barriers to entry.

XYZ has a broad customer base comprising of more than 4,000. XYZ employs around 36,000 people, of which 22,000 are in the UK. Forty per cent of its employees are based outside the UK - including 5,000 in the rest of Europe and 8,000 in North America.

Most of the components in service will have operational lives of 25 years or more, generating an assured aftermarket demand for the provision of spare parts and services.

The company's strategy is to maximise aftermarket revenues, which have increased by 60 per cent over the past five years due to the development of a comprehensive services capability.

8.3.2.2 "Guest Lecture"

In order to provoke a greater understanding and exchange, the author presented the finding of this Thesis to the Senior Management of XYZ (5 people). Through dialogue and discussion the answers to the authors "Questionnaire" were completed and this follows.

CHAPTER 8

Questionnaire to Assess RFT Readiness of a Corporation

XYZ Co Ltd - July 2001

No	Q+A	Question
1	Q	Do you measure the efficiency of your Design and Development?
	A	Yes, from a Financial Point of View
2	Q	How do you measure the efficiency of your D+D?
	A	We have an annual budget that has to be satisfied. We have a broad plan of the number of projects that we will throughput during the financial year and we build a Headcount budget around it. We are not challenged on output per Head directly, but obviously the Accountants put the squeeze on us and expect more for less
3	Q	Do you measure Design Change?
	A	We have a very strict tracking of Design Level Changes and any change has to be fully validated and proved prior to its release
4	Q	How do you measure Design Change?
	A	Only at the Drawing level, but you couldn't tell from this what where the real reasons for the change - you would have to look back at Test Reports and alike
5	Q	What where the results?
	A	We haven't analysed reasons for Design Change in the way that Nissan has. We probably could go back over a past project and by researching test reports, we could probably establish true cause
6	Q	Did you identify a trend?
	A	No
7	Q	Have you a Strategy for Improvement?
	A	We don't have a Strategy for Improvement, but we recognise that over 70% of our projects miss their delivery dates, so we are under pressure to come-up with something
8	Q	How do you plan to implement the strategy?
	A	No
9	Q	Have you a Corporate level strategy?
	A	We have the usual string of initiatives, but nothing specific in the case of Engineering
10	Q	Are Design and Development efficiency improvements targeted in this strategy?
	A	No, but we have to do something about our on-time delivery and that means improving development efficiency by some means
11	Q	How do you justify Investment?
	A	We have a very detailed process to go through to justify Capital expenditure. However, its very difficult to link improvements stated in these justifications into actions within the budget. To some extent, our investment is given by the budget we have. Each year we put forward our needs - if it seems like we have a big need, then we may or may not get the budget. Once we have the budget, we must spend within it, but the choice of best tool is pretty much lefty to Engineering to decide
12	Q	Do you track reasons for Design Change?
	A	No strictly speaking, but we could trace back through test reports by design level, so I guess we could do the same type of analysis as Nissan if we wanted to
13	Q	Have you a historical record of design changes?
	A	Only on the drawings and it isn't very explicit
14	Q	Have you analysed reasons for design change?
	A	No
15	Q	Does this form part of your improvement strategy?
	A	No
16	Q	How do you get your Managers to agree on a strategy

CHAPTER 8

	A	We don't have a strategy, but I guess pretty much all our Engineering Managers recognise the need to improve of their delivery to schedule
17	Q	Did you get your workforce to agree to the strategy?
	A	No
18	Q	What resistance did you encounter?
	A	N/A
19	Q	Have you a Mission Statement?
	A	For the company yes, for Engineering no
20	Q	Have you re-organised your organisation to meet the strategy?
	A	No, but obviously we change organisations to tune to new needs on a fairly regular basis
21	Q	How do you capture Knowledge?
	A	Yes, we do in terms of development standards. The tests that need to be satisfied are rigorous and well documented. In the context of RFT, no we don't do post-Project reviews, but maybe we should
22	Q	How do you Plan process development / creation?
	A	The Chief Engineer makes a Plan for each of the Projects brought before him. There are specific Milestone Gateways that need to be satisfied, but emphasis is very much on Quality and Reliability rather than the Schedule itself - however, we do get a lot of criticism from our Customers who are not happy when we deliver late as it effects their project. This is really a point of change, when we used to work for the Government projects; everything was Cost Plus, so there was no penalty for being late. This is all changing now and even Government projects want Fixed Prices with Lateness Clauses.
23	Q	How do you prioritise Investment?
	A	We set a budget at the start of the year and an assessment of the number of projects that we think we might have - we know the big ones, but we just put in contingency for the smaller unknown ones
24	Q	Have you any tools to assist with reductions in D+D lead-times?
	A	Directly speaking no, but we have a lot of investment in Engineering tools. We are really leading edge in the area of mechanical simulations. Obviously this improves the efficiency of our engineering and directly contributes to a RFT culture - but we couldn't say how much one tool contributes
25	Q	Have you employed TQM principles?
	A	We had a TQM initiative and I think we generally work in a TQM fashion
26	Q	Define Lead-time?
	A	Customer Spec being accepted by Engineering through to Delivery / Technical Sign Off
27	Q	Do you "Test by Design"?
	A	Yes, we do an enormous amount of Engineering simulation.
28	Q	What is the biggest reason for Design Change?
	A	I don't know
29	Q	Do you have sub-measurement systems to register reasons for Design Change?
	A	Yes we do, we have to record the result of all of our tests, but we don't do any kind of Post-Project Review
30	Q	Are they Closed Loop?
	A	Yes
31	Q	Have you a quantifiable technique for the cost justification of design tools?
	A	No

CHAPTER 8

8.3.2.2) XYZ Co Ltd Reflection

XYZ Co Ltd is a highly successful company and a competent Engineering organisation. Its main weakness today is the lack of on-time delivery against committed schedules. This has grown out of long-term relationships with Government agencies, where the pressure for being on time has not historically been felt – this is now changed.

If we measure ABC Co Ltd against the 14 Rules

1) Rigorous data capture from previous projects

XYZ Co does rigorously capture the necessary data during any given development. Their systems are robust and PL friendly. Their level of technical competence is second to none and their engineering capabilities world class.

2) Investigate the true causal factors of change

However, in spite of having the necessary data around them, they haven't analysed it and do not have any idea about what are the reasons and drivers of design change in their company. Naturally, this could be easily solved and it is likely that their analysis could be even deeper than that undertaken by Nissan. It could also reflect on trends over a period of years and would perhaps even give them a measuring stick for improvements made by the adoption of their new Simulation Tools.

3) Generate a clear objective from the outset and don't change it

It is clear that there is a need to improve on time delivery of projects and this is their biggest driver for looking at improvements. Therefore, a RFT Design initiative based around the target of, for example "80% of all projects to be delivered on-time within Fiscal Year X, would logically fit the Nissan Model.

4) Hoshin Kanri structures the logical deployment of tactics

Not used, but logically understood by the Engineering management of XYZ and seen as an excellent tool to tackle the aforementioned On-Time delivery problem.

CHAPTER 8

- 5) TQM 5 Pillars are paramount to success
TQM is not mentioned in discussions with XYZ Management, but it seems to sit well with their Culture. Perhaps the most lacking area is the one of “Set Clear Targets”, but all the other Pillars appear to be attainable.

- 6) Find many tactics, there is no “one shot” solution in spite of consultant sales talk
This is clearly understood by XYZ management. They have in the past seen the purchase of certain tools as the panacea solution and have seen that they are not. They are not lacking in anyway in the area of Test by Design, but more on the focus for improvement. Again, the author’s recommendation was one of “On-Time” delivery through the adoption of a RFT development principle.

- 7) Improvements to the Hoshin Kanri should be encouraged.
The culture exists and the management way exists.

- 8) Register the cost of design change in your organisation
XYZ stated that they thought they knew the cost of a Design Change and that some had calculated it in the past. However, it was not at the forefront of the Engineers minds and it was not even a certainty that the number was correct. However, the capability to calculate the correct number certainly exists.

- 9) Systematically monitor your results through early warning sub-measures
These exist, but should be made more transparent to the Engineering Management and certainly made into measurable statistics for presentation at Project Milestones. The question is how to get detailed reports initially made into quick problem reports and registered into the Engineering Administration Systems.

CHAPTER 8

- 10) Team-working and Cross-functional development and deployment of tactics
This seems more of a problem, with Departments outside of Engineering being viewed as not understanding. The relationship with their Sales team would need to be improved particularly in respect to the setting of SOP objectives. The good news is that the Engineering Management tends to be involved in Contract negotiations, thus the ability to effect the setting of SOP targets.

- 11) Tenaciously and continuously pursue the objective through weekly reviews
Possible within the environment witnessed, but needs to be supported by continuous and weekly statistical data on condition of projects within each department.

- 12) Invite supporting organisations to participate and support
As discussed in 10, it needs improving, but can be coped with even within the current unsatisfactory environment.

- 13) Measure the project successes and failures against the Objective
Post Project reviews are not currently undertaken, but sufficient data exists to allow a very detailed review to take place if directed by their management. By starting with the last project and with the project churn rate, within 12 months, XYZ co could amass a detailed and accurate array of data.

- 14) Employ the learnings from the project on to the next one
Not yet, but very possible.

CHAPTER 8

8.3 Conclusions

This Chapter has tried to reinforce two major points. The first is to underpin the 8 unique and novel propositions put forward through this research project. In establishing their merit inside Nissan, a very detailed analysis has been undertaken over the 4-year period of the development project of HS.

The author then goes on to develop 14 Rules to allow RFT Design to be introduced into any engineering company and then “tests” these rules through 4 days of interviews in two Global companies outside of the Automotive Industry. Whilst neither company has all the pre-requisites to introduce RFT Design today, they could if they followed the 14 step recommendations. Thus, the author suggests that the 14 rules are adequate to give access to the industry and allow it to embody the learning.

CHAPTER 9

OVERALL CONCLUSIONS

This is the concluding Chapter of this Thesis and aims to sum up the overall context of the research and its achievements. The author also aims to provide an insight into the up to date situation in design change reduction. The Chapter ends with the prediction that Right First Time practitioners will eventually reduce vehicle development lead-times down from the HS case of 31 Months to (an un-believable) 6 Months. Time reduction and the management of its implementation can become a huge competitive advantage for those that can do it.

This research set out to test the theory that a significant reduction in design change for a given development program, could directly impact upon development lead-time and development cost, without a negative impact upon Product Quality. Specifically, the Research Objectives were: -

- 1) To Test the hypothesis that a Policy of Right First Time Design will increase Product Development Efficiency.
- 2) That this could lead to a 40% reduction in development expense, combined with a 30% reduction in development lead-time (and incidentally a 30% reduction in manufactured cost)
- 3) That Front Loading development can result in an 80% reduction in design change and that the tactics to allow this to be achieved can be derived through Historical Analysis of previous projects and deployed through a modified Hoshin Kanri
- 4) To establish the cost of design change
- 5) To validate the authors hypothesis through a real project, using Action Learning Research principles and actually measure the results in a Qualitative and Quantitative manner
- 6) To establish rules for the dissemination of RFT Design Principles and “Test” them in alternative industries.

CHAPTER 9

The author was driven by the desire to win the development program for the host company, NTCE. To do so, demanded a 40% reduction in development costs compared to previous programs. This level of stretch demands creativity, but also demands risk management. The TQM culture of NTCE allowed for risk management, however, its Kaizen approach to improvement was a cultural barrier that had to be broken through.

In establishing the plan (FASTD) and delivering the product (The Almera) to market, the author was allowed privileged access to all parts of the development company, its data and its people. Various tools have been developed and referenced for novelty. These include:

- 1) A more detailed definition of the “glibly” used term “Right First Time Design”
- 2) A linkage between the key facets of TQM and RFT Design.
- 3) The usage of Hoshin Kanri as a tool for the “Change Agent” and the importance of analysing historical data to predict future improvements to be made through Hoshin Kanri deployment.
- 4) An illustration that there is no “one strategy” to implement RFT Design, but a continuum of tactics linked together by TQM methodologies and deployed by Cross-Functional Teams having a common objective.
- 5) Determining the importance of closed-loop development controls, to ensure that a robust history of previous project design changes is readily available for analysis.
- 6) Using Design Change as a financial tool, to demonstrate a Return on Investment for the tools required to actualise the reduction in design change. I.e. Using historical data to determine the cost of one typical design change.
- 7) Analysing, through a live project, the effectiveness of the tools determined necessary to reduce design change.
- 8) Analysis of the assumption failures on a “T Matrix”, to ensure a “Kaizen” approach to the next project

Most notable is the new hypothesis linking development lead-time reduction and development cost reduction to a reduction in design change – the heart of RFT Design. However, there are other innovations, which helped establish a successful change program and are relevant to learning in this area of engineering management:

CHAPTER 9

- The use of the Hoshin Kanri, underpinned with TQM and the Nissan Production Way, allows Policy, Strategy and Tactic deployment to be linked to a numerical target and forecasting tool. This forces the iteration and deployment of achievement tactics until the goal (in this case 80% reduction in design change) is met.
- The quantification of the cost of design change. This is not novel in itself. The novelty lies in its linkage to design change, the Hoshin Kanri and the ability to be able to forecast the design change reduction as a result of investment in a particular tactic. That means that the engineering management can determine the ROI and NPV of any given investment without the need to result to hypothetical Opportunity losses.
- Finally the quantification of design change reasons in past and current projects, evaluated from quantitative and qualitative perspectives, allows the author to draw-up a 14-step plan for the introduction of RFT Design into a given company.

The latter is the most subjective part, because for the recommendations to work, it is important that a culture of TQM exists and that sufficient records of past developments can be accessed. However, in both of the extra case companies investigated, these records did not fully exist – although, with the investment of time, sufficient data could be made available to allow a FASTD project to exist.

The author is convinced that the RFT Design tool is an important innovation and an important addition to engineering management knowledge. There are many references to the principles of Right First Time Design, but through the course of this project, the author has found minimal materials on how one might logically go about creating a company culture of RFT (Other than the unsubstantiated claims of consultancies trying to sell the next “tool”).

CHAPTER 9

As for the reliability of the author claims, the Thesis seeks to warrant this with:

- a) Access to an enormous quantity of quality research data (including every single Design Note raised on EQ, MM and HS Projects).
- b) A willingness to err on the side of cautious interpretations and try to look from multiple views, including qualitative and quantitative.
- c) The use of other non-quantitative methods such as independent interviews
- d) The use of additional external case studies (consuming two days of research in both cases).
- e) And in general, taking a rational approach at all stages.

It's worth reviewing where the project has taken NTCE too. Since the completion of HS development, the results have proven that design change can be sufficiently small, to allow progression, with sufficiently small risk, to a development without the need for Prototype tooling. Using the practices created through this research project, Nissan globally decided to delete the Clot build and go directly to off-tool parts. The first programs to undertake this in NTCE were the ED and MM projects – New Primera and New Micra, both of which were developed in a period of 25 months from Design Freeze to SOP. This may be compared with a NTC Japan standard lead-time of 21 months (given that the Press tools are made in Japan).

12.1 Attainment of Research Objectives

1) To Test the hypothesis that a Policy of Right First Time Design will increase Product Development Efficiency.

The work inside NTCE demonstrates quantitative data showing that on a “like for like” basis, an 80% reduction in design change postproduction design note release will reduce development expenditure (and thus increase Product Development Efficiency) by 43%.

Qualitative data backs this up, but also demonstrates room for improvement in future projects by better cross-functional target setting.

CHAPTER 9

2) That this could lead to a 40% reduction in development expense, combined with a 30% reduction in development lead-time (and incidentally a 30% reduction in manufactured cost)

The HS project demonstrated a 43% reduction in development expenses measured on a like for like basis. The project was also launched on-time and met all Quality and Cost targets, thus demonstrating that RFT Design can reduce development lead-times without necessarily having a negative effect on Quality or Cost.

3) That Front Loading development can result in an 80% reduction in design change and that the tactics to allow this to be achieved can be derived through Historical Analysis of previous projects and deployed through a modified Hoshin Kanri.

The combination of the Hoshin Kanri, linked to design change reduction forecasts validated from historical analysis of previous programs, allows a development program to be front loaded in a scientific way and without the “Leap of Faith” sighted by other companies as a reason not to challenge RFT Design.

4) To establish the cost of design change

Established in NTCE as £13000, knowing this allows each deployed tactic to be specific in its ROI (Return on Investment). Thus in determining tactics and strategies to reach the 80% reduction in design change, one can also ensure that financial efficient tools are chosen with a very specific target assigned to them.

5) To validate the authors hypothesis through a real project, using Action Learning Research principles and actually measure the results in a Qualitative and Quantitative manner.

The author’s hypothesis was validated in a series of manners, quantitatively, qualitatively and in depth through HS Project and superficially in two alternative Engineering companies. The research followed the best practices of Action Learning as described in the Thesis and allowed very detailed validation of the hypothesis to be made resulting in an established 81% reduction in design change against a Hoshin Kanri forecast of 75%.

CHAPTER 9

6) To establish rules for the dissemination of RFT Design Principles and “Test” them in alternative industries.

14 Rules were established for deployment of RFT Design principles and these were then “tested” in two alternative companies with a reputation for efficient and high quality development practices. The “test” showed both to be capable of RFT Design, but not yet ready to apply.

12.2 Future Work

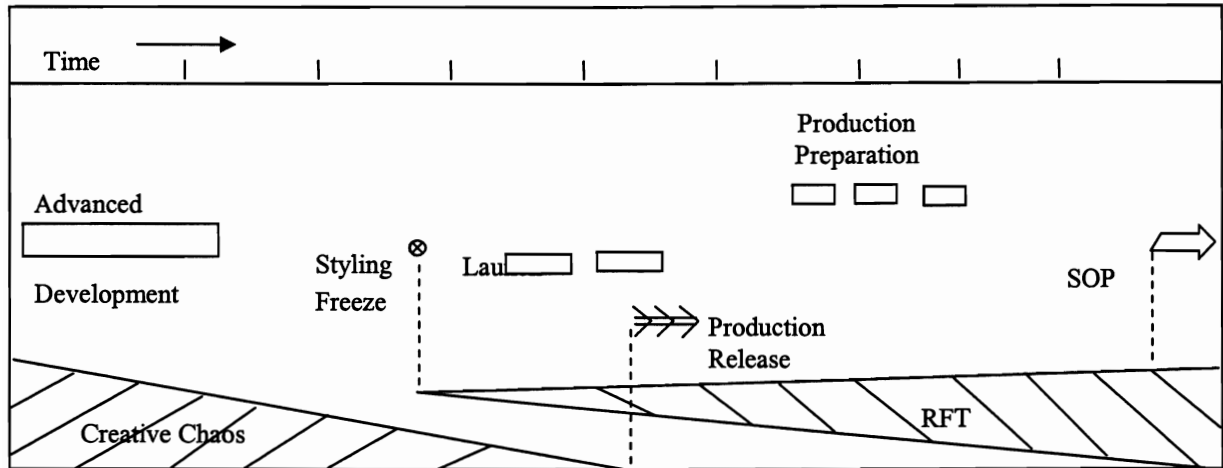
So what next? There is no doubt that reduction in lead-times is a competitive advantage to those companies that can manage it. Given the continuous improvements in Simulation capability and the emphasis on “Test-By-Design”, then further improvements, centred around the reduction, or elimination of design change become a reality. Nissan is already sighting it’s ambitions for a zero design change program, which sees the creation of digital build and test, then the creation of actual vehicles only at the T1 and T2 stages for Homologation. Theoretically, that means a lead-time of 10.5 months could be possible (excluding tool shipping time). So will that be it? – In the author’s opinion, no. Through his connections with Nissan Japan, the author has even muted the possibility of a 6-month development – a “Shinkansen” process. Impossible, I hear them say! Well in 1996, they said 31 months was impossible – No it’s not impossible, it’s just a matter of designing it Right First Time!

The author makes one hypothesis and one recommendation for future work

1) Staude 2001 [Ref 2.7 Staude 2001] sights the 4th wave of competitive marketing to be Time / Speed. This is consistent in thinking with Nissan and Toyota and is likely to remain the case until at least 2008. However, the author hypothesises that the maturation in development speed with result in a fifth wave of “Quality Experience”. With manufacturers able to quickly identify and follow fashions in the market, product differentiation will need to be underpinned by “quality” of the whole buying experience. In essence, that means a rethink in the way cars are marketed a sold across the world and in particular in mature markets. One might liken it to buying a Brand that you trust and which you know will deliver a great deal of satisfaction in service.

CHAPTER 9

2) Following on from the hypothesis above, the author recommends that further research is undertaken in the area of “Creative Chaos” with a view of validating the authors desire to create a “Schizophrenic” development process as outlined in Figure 4.1 and repeated below.



There are companies today capable of Creative Chaos. There are a fewer number of companies capable of RFT Design. Can the two be combined? If they can, innovative solutions, enhancing quality of ownership may be quickly brought to market. This would give companies capable of this schizophrenic process, huge competitive advantages in meeting changing customer desires.

References

References:

Chapter 1:

- 1.1 Pricewaterhouse Coopers Research, 2001 Earnings Before Tax & Interest,
As % of Revenue
- 1.2 Cothier,G. INSEAD 1999, Ford Ka, Breaking New Ground in the Small Car Market,
Lecture Notes from Nissan Training.
- 1.3 Kano Noriaku, University of Tokyo, Inhouse Nissan Material
- 1.4 Weinstein,D. INSEAD 2004, Lecture Notes from Nissan Training.

Chapter 2:

- 2.1 Peter Drucker 2001, The Essential Drucker, HarperBusiness Books
- 2.2 Dickens, P. (1998). Global Shift. London, Paul Chapman Publishing
- 2.3 Womack , J.R., Jones, D.T., Roos, D. (1990). The Machine That Changed theWorld.
New York, Rawson
- 2.4 Economist 2001. Downhill Racers. The Economist, Mar 31st 2001.
- 2.5 FT Auto Survey 1999, Financial Times Survey: FT Auto. Financial Times,
September 16th 1999.
- 2.6 Blair-Smith, Financial Times (1999), Newspaper Article.
- 2.7 Gavin Staude 2001 Strategic Marketing Elective. Uni of Durham Business School, 2001
- 2.8 Hamel & Prahalad. (1994). Competing for the future. Harvard Business
Review, July-August 1994, Vol.74, no.3, pp122-128
- 2.9 Vandermuwe 1995. The process of market driven transformation, Long Range Planning,
1995, Vol.28 No.2, pp79-91
- 2.10 Thompson 1997 Strategic Management: Awareness and Change. London, Thomson
Business press
- 2.11 Porter, Michael E. Competitive Advantage: Creating and Sustaining Superior Performance,
Free Press, 1985
- 2.12 Hamel (1998). Strategy innovation and the quest for value, Sloan Management Review,
Winter 1998, Vol.39, No.2, pp7-15
- 2.13 Beholav JA.1996 The evolving corporate paradigm. Business Horizons, March-April
1996 Vol.39 No.2, p11-20

References

- 2.14 Richard Bremner (Automotive World March 2000). Magazine Article
- 2.15 Hiroyuki Yoshino Honda CEO (2000), Interview notes
- 2.16 Dave Router, Ford 2000, Interview notes
- 2.17 Anthony Sheriff, Fiat 2000, Interview notes
- 2.18 George Stalk Jr (1990). Competing Against Time. New York, The Free Press
- 2.19 Tersine & Hummingbird 1995 Lead-time reduction: The search for competitive advantage. International Journal of Operations & Production Management, Vol.15 No.2, pp8-18
- 2.20 Stalk & Hout (1990). Competing against time. Research Technology Management, March-April 1990, pp19-24
- 2.21 Blackburn JD, 1991 Time-based Competition: The Next Background in American Manufacturing, Illinois, Irwin
- 2.22 Robertson T.S. (1993). How to reduce market penetration cycle times. Sloan Management Review, Fall 1993, Vol.35 No.1, pp87-97
- 2.23 Cohen, M.A., Eliashberg, J., Hua, T. (1996). New product development: The performance and time to market trade off. Management Science, February 1996, pp173-186
- 2.24 Hum S.H. & Sim H.H. (1996). Time-based competition: Literature review and implications for modelling. International Journal of Operations & Production Management, January 1996, Vol. 16, No.1, pp75-91
- 2.25 Kessler, K.H. & Chakrabarti A.K. (1996). Innovation speed: A conceptual model of context, antecedents and outcomes. Academy of Management Review, Vol.21, No.4, 1996, pp1143-1191
- 2.26 Bower, J.L. & Hout, T.M. (1988). Fast-cycle capability for competitive power. Harvard Business Review, November-December, Vol.67, No.6, pp110-118
- 2.27 Choperena , A.M. (1996) Fast cycle timedriver of innovation and quality. Research Technology Management, May-June 1996, pp36-40
- 2.28 Stalk , G. Jr. & Webber, A.M. (1993). Japan's dark side of time. Harvard Business Review, July-August 1993, Vol.71 No.4, pp93-102
- 2.29 Thomas M Hout. 1996. Time-based competition is not enough. Research Technology Management, July-August 1996, pp15-17
- 2.30 Von Braun, C.F. (1990) The acceleration trap. Sloan Management Review, Fall 1990, pp49-58
- 2.31 Manley.P, 2001 Corporate Finance Elective. University of Durham Business School.
- 2.32 Song X.M. & Parry, M.E. (1997). Japanese new product successes. Journal of Marketing Research, February 1997, pp64-76

References

- 2.33 Smith, P.G. & Reinertsen, D.G. (1991). Developing Products in Half the Time. New York, Van Nostrand Reinhold.
- 2.34 Wheelwright, S.C. & Clark, K.B. (1992). Revolutionizing Product Development. New York, The Free Press
- 2.35 Daniels, N.C. & Essaides, G. (1993). Time-based Competition. Economist Intelligence Unit, London
- 2.36 Carl Franklin, From Conception to Birth, virtual reality creates Immaculate Cars. Sunday Business (June 1998)
- 2.37 Alan Copps 1998. How to Gain Without Pain. Interface June 1998
- 2.38 Jesse Crosse 1998, The Krypton Factory, Autocar August 1998
- 2.39 David William 1998. It's Virtually a Whole New Way of Motoring. Evening Standard June 1998.
- 2.40 Les Oliver (July 1998). Future Nissans Designed by Virtual Reality. Sunderland Echo
- 2.41 Eureka (August 1998). Virtual Reality Suite will reduce Plant Design Time.
- 2.42 Pinto J.K. & Kharbanda O.P. (1996) How to fail in project management (without really trying). Business Horizons, July-August 1996, pp45-53.
- 2.43 M^cCormack, S.P., Lewis, K.J., Mink, O., Batten, J.D. (1992). TQM: Getting it right first time. Training & Development, June 1992 Vol.46 No.6, pp43-46
- 2.44 Burgess, R. & Turner S. (1999). Seven key features for creating and sustaining commitment. International Journal of Project Management, Vol.18, 2000, pp225-233.
- 2.45 Turner J.R. (1993). The handbook of project-based management. London, McGraw-Hill
- 2.46 Prof Kathleen Eisenhardt (1990). Speed and strategic choice: How managers accelerate decision-making. California Management Review, Spring 1990, pp39-54.
- 2.47 Brown, S.L. & Eisenhardt, K.M. (1995). Product development: Past research, present findings and future directions. Academy of Management Review, Vol.20 No.2, 1995, pp348-378.
- 2.48 Clark, K.B. & Fujimoto, T. (1991). Product Development Performance. Boston, Harvard Business School Press
- 2.49 Ward, A., Liker, J., Cristiano, J.J., Sobek II, D.K. (1995). The second Toyota paradox: how delaying decisions can make better cars faster. Sloan Management Review, Spring 1995 Vol.36 No.3, pp43-62.

References

- 2.50 Hauptman, O. & Hirji, K.K. (1996). The influence of process concurrency on project outcomes in product development. IEEE transactions on Engineering Management, May 1996, pp153-164.
- 2.51 Verespej, M.A. (1987). The R&D challenge: Getting it out of the lab. Industry Week, May 4 1987, Vol.233, pp32-37.
- 2.53 Robertson, D. & Ulrich, K. (1998). Planning for product platforms. Sloan management Review, Summer 1998, Vol.39, No.4, pp39-52
- 2.53 Flood R.L. (1993) Beyond TQM. Chichester, John Wiley & Sons.
- 2.54 Wickens, P. (1987) The Road to Nissan, Macmillan Press, London 1987.
- 2.55 Cusumano, M.A. & Nobeoka, K. (1998). Thinking Beyond Lean. New York, The Free Press.
- 2.56 Dumaine, B. (1989) How Managers Can Succeed Through Speed. Fortune, 13 February 1989, pp54-59.
- 2.57 Blackburn, J.D. (1992). Time-based competition: White-collar activities. Business Horizons, July-August 1992, Vol.35 No.4, pp96-102
- 2.58 Palmer, A (2001). Right First Time. Unpublished supporting documents.
- 2.59 Kotter, J.P. (1995). Why transformation efforts fail. Harvard Business Review, March-April 1995, pp59-67.
- 2.60 Tennant, C. & Roberts, P. (2001). A faster way to create better quality products. International Journal of Project Management, 2001 Volume 19, pp353-362.

Chapter 3:

- 3.1 Eden C & Huxham C, 1993. Distinguishing Action Research. Management Science Working Paper 93/18. University of Strathclyde.
- 3.2 Rowan R & Reason P, 1981. Human Enquiry. A source of New Paradigm Research. Wiley, 113-140
- 3.3 Glaser BG & Strauss AC, 1967. The Discovery Of Grounded Theory. Strategies for Qualitative Research. Chicago: Aldine.

References

Chapter 4:

- 4.1 Wheelwright, S.C. & Clark, K.B. (1992). Revolutionizing Product Development. New York, The Free Press
- 4.2a Auto Research Analysis “Designers & Engineers Play Cupid” – Internet result
- 4.2b Jeff Loughran, James Cook University 2002 – Internet result
- 4.2c Steve Evans, UK Symposium on Supply Chain Alignment 1996 – internet result
- 4.3 Charles Tennant, Paul Roberts, 2001 – The Creation and Application of a self-Assessment process for New Product Introduction, Warwick University.
- 4.4 Walton, M, 1992, The Deming Management Method, Management Books 2000
- 4.5 Jurow, S. & Barnard, S.B. (Eds) (1993) Introduction: TQM fundamentals and overview of concepts ‘Journal of Library Administration’ 18(1/2), 1-13 (EJ 469 099)
- 4.6 Sirkin, A F (1993). Customer service: Another side of TQM. ‘Journal of Library Administration,’ 18 (1 / 2), 71 – 83. (EJ 469 104)
- 4.7 Nissan – TQ Story – Internal NML Training Department
- 4.8 Prof A.Bendall (2001). What is six sigma? Internal paper from NCR Ltd.
- 4.9 J. Womak & D. Jones 1996 – Lean Thinking. Simon and Schuster
- 4.10 Ward, A., Liker, J., Cristiano, J.J., Sobek II, D.K. (1995). The second Toyota paradox: how delaying decisions can make better cars faster. Sloan Management Review.
- 4.11 Prichard (of Ideo) 1997 – Interview Notes
- 4.12 Kelley, Tom 2001 – The Art of Innovation, Doubleday
- 4.13 Bourton Group, ‘Still in Development, A Survey of the Management of Innovation in Manufacturing Business’, 11th Annual Survey of Trends and Attitudes in Manufacturing Industry, Rugby, 1999
- 4.14 The Design Council, ‘Successful Product Development Management Case Studies’, produced for the Department of Trade and Industry, HMSO, London 1994
- 4.15 Parker AG, ‘Engineering is Not Enough’, Manufacturing Engineer, Institution of Electrical Engineers, London, December 1997
- 4.16 Business Process Resource Centre, The University of Warwick, ‘Understanding Best Practice for Key Elements of the New Product Introduction Process’, produced for the Department of Trade and Industry, London 1998
- 4.17 Kidd PT, ‘Revolutionising New Product Development, a Blueprint for Success in the Global Automotive Industry’, Financial Times Automotive Publishing, 1997
- 4.18 Parker A, ‘What Will the Future Bring’ – Manufacturing Engineering 2001

References

- 4.19 Enstone, S. MBA (Un-published) Thesis, Warwick Business School 2002 (due for completion 2004 – Title not fixed)
- 4.20 'Proctor & Gamble, Jager's gamble', *The Economist*, 30 October 1999
- 4.21 Staley JL and Boche DG, 1998, 'Breaking the Downsizing Cycle with New Product Development', *The Mercer Management Journal* 1998-2004
- 4.22 Deschamp JP and Ronganoth Noyak P, 'Becoming a Product Juggernaut', in Arthur P Little, Prism, 2nd quarter 1996
- 4.23 Bourton Group, 'Annual Surveys of Trends and Attitudes in Manufacturing Industry', Rugby 1989-1999
- 4.24 PA Consulting Group, 'Manufacturing into the Late 1990s', produced for the Department of Trade and Industry, HMSO 1993
- 4.25 Balborter A and Pazdani B, 'New Product Development Survey 1998', Warwick Manufacturing Group, The University of Warwick, 1998
- 4.26 Jenkins S, Forbes S, Durrant TS and Bannerjee SK, 'Managing the Product Development Process (part I: An Assessment)', *International Journal of Technology Management*, Vol.13, No.4, 1997
- 4.27 James, P, 'How Can Concurrent Engineering Reduce Redesign in Uk Electronic Companies', MSc dissertation thesis, University of Bath, 1999
- 4.28 Burns, A. & Evans, S. 'Emphatic Design; A New Approach for Understanding & Delighting Customers', *International Journal of New Product Development & Innovation Management*, Vol3 No4, Dec/Jan 2002.
- 4.29 Ford – Author Unknown, Republished, Palmer, A., Temple, J., Jones, M., Evans, S., (1999) *Design for assembly - A strategy for right first time*, 32nd ISATA Proceedings, Croydon
- 4.30 Nissan – Almera Investment, NTCE Data
- 4.31 Curtis CC and Ellis LW, 1997, 'Balanced Scorecards for New Product Development', *Journal of Cost Management*, Vol 11, No3 May/June 1997.
- 4.32 Schaffer R. and Thomson HA, 'Successful Change Programs Begin with Results', *Harvard Business Review*, January-February 1992
- 4.33 Deming, W.E. (1986) 'Out of Crisis' Cambridge, MA: Massachusetts Institute of Technology, Centre for Advanced Engineering Study
- 4.34 Masters D.G. ERIC Digests ED 396759. 1996-00-00. ERIC Clearing House on Information and Technology Syracuse NY. 'Total Quality Management in Libraries' Internet 2001
- 4.35 Internet article MIT centre for Advanced Education Services. 'About W. Edward Deming' August 2001-08-19

References

- 4.36 Womack, J.R., Jones, D.T., Roos, D. (1990). The Machine That Changed the World. New York, Rawson.
- 4.37 Stalk, G.Jr. (1990). Competing against time. Research Technology Management, March-April 1990, pp19-24
- 4.38 D Reinertsen 1997, Managing the Design Factory: A Product Developer's Toolkit, Simon & Schuster Inc.
- 4.39 Smith, P.G. & Reinertsen, D.G. (1991). Developing Products in Half the Time. New York, Van Nostrand Reinhold.
- 4.40 Juran, Joseph (1998), Juran's Quality Handbook, McGraw-Hill Professional
- 4.41 Crosby, Philip (1979), Quality is Free, New American Library
- 4.42 Seymour, Richard and Powell, Dick. Better by Design series, Channel 4 (UK TV)

Chapter 5:

- 5.1 MCTS (Management Coaching and Training Services) – accessed March 04
<http://www.mcts.com/ERP-Hoshin-Kanri-Overview.htm>
- 5.2 Nissan – TQ Story – Internal NML Training Department
- 5.3 Hill, Terry (1999) – Manufacturing Strategy: Text and Cases. McGraw-Hill/Irwin
- 5.4 Genba Kanri Consultants, genba-kanri.com
- 5.5 Lanner Group, Case Study 3
- 5.6 Nissan Motor Manufacturing (UK) Limited – Copyright 1998.
- 5.7 QS9000 Third Edition (1998), superseded by ISO/TS 16949:2000
- 5.8 Kochan, Anna (1999). Key to Nissan's Productivity: Right First Time Design. Financial Times, World Automotive Manufacturing.
- 5.9 McGeough, J.A. and Venkatesh, V.C. (1991) 7th International Conference on Computer-Aided Production Engineering. Elsevier Science Ltd.

Chapter 6

- 6.1 Roethlisberger F J and Dickson W J, (1939) *Management and the Worker*, Cambridge MA: Harvard University Press

Chapter 7:

- 7.1 Erlandson, D.A., Harris, E.L., Skipper, B. L., Allen, S. D. (1993) Doing Naturalist Inquiry A Guide to Methods, London, Sage Publications.
- 7.2 Easterby-Smith, M., Thorpe, R. & Lowe, A. (1991). Management Research: An Introduction. London, Sage Publications.

References

Chapter 8:

- 8.1 Blackburn, J.D. (1992). Time-based competition: White-collar activities. Business Horizons, July-August 1992
- 8.2 Stalk, G.Jr. (1990). Competing against time. Research Technology Management, March-April 1990.
- 8.3 Ghosn, C. (1999) Nissan Revival Plan, Nissan Intranet
- 8.4 Robertson, T.S. (1993). How to reduce market penetration cycle times. Sloan Management Review, Fall 1993, Vol.35 No.1.
- 8.5 Turner J.R. (1993). The handbook of project-based management. London, McGraw-Hill
- 8.6 Ward, A., Liker, J., Cristiano, J.J., Sobek II, D.K. (1995). The second Toyota paradox: how delaying decisions can make better cars faster. Sloan Management Review, Spring 1995 Vol.36 No.3.
- 8.7 Choperena , A.M. (1996) Fast cycle timedriver of innovation and quality. Research Technology Management, May-June 1996
- 8.8 Cohen, M.A., Eliashberg, J., Hua, T. (1996). New product development: The performance and time to market trade off. Management Science, February 1996
- 8.9 Stalk , G. Jr. & Webber, A.M. (1993). Japan's dark side of time. Harvard Business Review, July-August 1993, Vol.71 No.4
- 8.10 Prof Kathleen Eisehardt (1990). Speed and strategic choice: How managers accelerate decision-making. California Management Review, Spring 1990
- 8.11 Euro NCAP Web Site: www.euronap.com - accessed June 03.
- 8.12 Ghosn, Carlos (2003) Turnaround : How Carlos Ghosn Rescued Nissan by David Magee. HarperBusiness

References

Other References of Interest:

1. Artto, K.A., Lehtonen, J.M., Saranen, J (2001). Managing projects front end: Incorporating a strategic early view to project management with simulation. International Journal of Project Management, Vol.19, 2000.
2. Baghai, M., Coley, S.C., White, D. (1996) Staircases to Growth. McKinsey Quarterly 4.
3. Doyle, P. (1998) Radical Strategies for Profitable Growth. European Management Journal, Vol.16,No.3 June 1998.
4. Bickman, L. & Rog, D.J. (1998). Handbook of Applied Social Research Methods. London, Sage Publications.
5. Buchanan, D. & Huczynski, A. (1997). Organizational Behaviour: An Introductory Text Third Edition. Harlow, Prentice Hall
6. Campbell, A., Yeung, S. (1991) Creating a Sense of Mission Long Range Planning, Vol.24
7. Collins, J.C., Porras, J.I. (1996) Building Your Company's Vision Harvard Business Review, September-October 1996
8. Cottrill, K. (1998) Reinventing Innovation, Journal of Business Strategy, March-April 1998
9. Denscombe, M. (1998) The Good Research Guide for Small Scale Social Research Projects.Buckingham, Open University Press
10. Dougherty, D., Hardy, C. (1996). Sustained Product Innovation In Large, Mature Organisations: Overcoming Innovation-To-Organisation Problems. Academy of Management Journal, Oct 1996 Vol.39 No.5
11. Ealey, L. & Soderberg, L. (1990). How Honda Cures design amnesia, The McKinsey Quarterly, Spring 1990.
12. Economist (1998). Nissan on its knees. The Economist, May 14th 1998.
13. Economist (2000). Faulty Towers? The Economist, May 11th 2000
14. Economist (2001). Downhill Racers. The Economist, Mar 31st 2001.
15. Economist (2001). Halfway down a long road, Aug 16th 2001
16. Economic Intelligence Unit (1999). Automotive Productivity, August 1999.
17. Evans, S. & Foxley, K. (1999). Co-Development: Lessons from a successful supplier / design initiative. 32nd ISATA Proceedings, Croydon, ISATA

References

18. Gill, J. & Johnson, P. (1991). Research Methods for Managers. London, Paul Chapman Publishing.
19. Hamel, G. (2000) Reinvent your Company, Fortune, June 12th 2000.
20. Hamel, G. (2000b) Leading the Revolution, Harvard Business School Press, Boston
21. Hamel, G. & Prahalad, C.K. (1990). The Core Competence of the Corporation. Harvard Business Review, May-June 1990.
22. Hamel, G., Prahalad, C.K. (1991) Corporate Imagination and Expeditionary Marketing, Harvard Business Review, July-August 1991.
23. Hamel, G., Prahalad, C.K. (1993) Strategy as Stretch and Leverage, Harvard Business Review, March-April 1993.
24. Hansen, M.T., Nohria, N., Tierney, T. (1999). What's your strategy for managing knowledge? Harvard Business Review, March-April 1999, Vol.77 No.2.
25. Javidan, M. (1998). Core Competence: What does it mean in practice? Long Range Planning, Vol.31, No.1.
26. Johnson, G. & Scholes, K. (199) Exploring Corporate Strategy Fifth Edition, Harlow, Pearson.
27. Kaplan, R.S., Norton, D.P. (2000) Having Trouble with Your Strategy? Then Map It, Harvard Business Review, September-October 2000.
28. Kharbanda, O.P. & Stallworthy, E.A. (1983). How to Learn from Project Disasters. Aldershot, Gower.
29. Kim, W.C. & Mauborgne, R. (1997) Value Innovation: The Strategic Logic of High Growth. Harvard Business Review, January-February 1997.
30. Kim, W.C. & Mauborgne, R. (1999) Strategy, Value Innovation and the Knowledge Economy, Sloan Business Review, Spring 1999.
31. Kim, W.C. & Mauborgne, R. (1999) Creating New Market Space, Harvard Business Review, January-February 1999.
32. Kim, W.C. & Mauborgne, R. (1999) Knowing a Winning Business Idea When you See One. Harvard Business Review, September-October 2000.
33. Lock, D. (1988). Project Management 4th Edition. Aldershot, Gower.
34. Lopes, M.D.S., Flavell, R. (1998). Project appraisal – a framework to assess non-financial aspects of projects during the project life cycle. International Journal of Project Management, Vol.16 No.4, 2000.
35. Muffatto, M. (1999). Building new product development capabilities. International Journal of Vehicle Design, Vol.21 No.1, 1999.

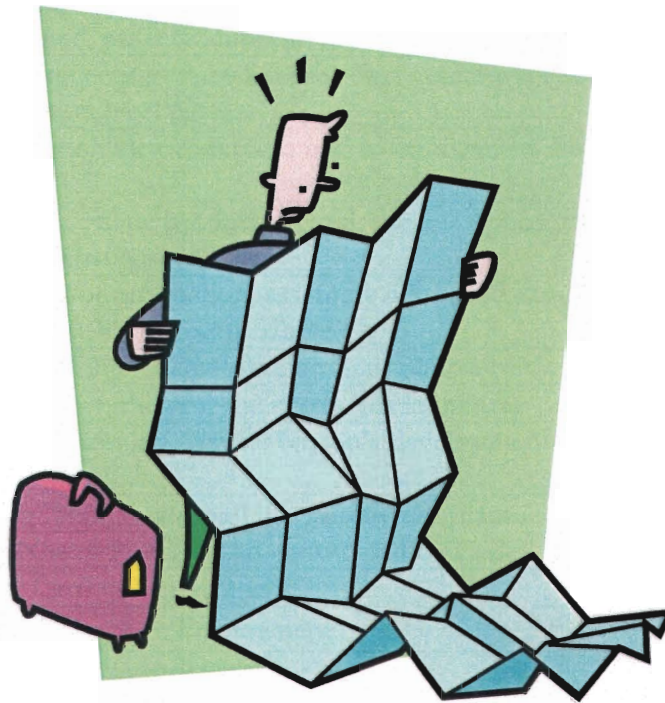
References

36. Nissan Web Site: www.nissan.co.jp
37. Olson, E.M., Cooper, R.M., Slater, S.F. (1998). Design strategy and competitive advantage. Business Horizons, Vol.41 No.2, March-April 1998
38. Palmer, A., Temple, J., Jones, M., Evans, S., (1999) Design for assembly – A strategy for right first time. 32nd ISATA Proceedings, Croydon, ISATA.
39. Platje, A.& Wadman, S. (1998). From Plan-Do-Check-Action to PIDCAM: The further evolution of the Deming Wheel. International Journal of Project Management, Vol.16 No.4, 2000.
40. Price, F. (1990). Right Every Time. Aldershot, Gower.
41. Seurat, R. (1999) Sustained Profitable Growth, Business Strategy Review, Spring 1999 Vol. 10 No.1.
42. Slack, N., Chambers, S., Harland, C., Harrison, A., Johnston, R. (1998) Operations Management Second Edition, Harlow, Prentice Hall.
43. Smith, P.G. (1996). Your product development process demands ongoing improvement. Research Technology Management, March-April 1996
44. Sobek II, D.K., Liker, J.K., Ward, A.C. (1998). Another look at how Toyota integrates product development. Harvard Business Review, July-August 1998, Vol.76 No4.
45. Stalk, G.Jr. (1988) Time – the next source of competitive advantage. Harvard Business Review, July-August 1988, Vol.67 No.4
46. Stringer, R. (2000). How to Manage Radical Innovation. California Management Review, Summer 2000, Vol. 42 No4.
47. Tampoe, M. (1994). Exploiting the core competencies of your organisation. Long Range Planning. Vol. 27 No 4.
48. Tushman, M.L. & O Reilly, C.A. (1997). Winning Through Innovation. Boston, Harvard Business School Press
49. Werner, B.M. & Souder, W.E. (1997). Measuring R&D performance: State of the art. Research Technology Management, March-April 1997.
50. Wright, I.C. (1997). A review of research into engineering change management: implications for product design. Design Studies, Vol.33 No.2, 1997

APPENDIX

Appendix One

Glossary of Terms



APPENDIX

<i>Model Freeze</i>	A point in time when the design concept and styling is fixed.
<i>D-Lot</i>	The first development build. It uses prototype parts to create a fully working vehicle (deleted from Almera programme)
<i>C-Lot</i>	The confirmation trial build. Modifications from the D-Lot build are included to ensure the vehicle performs to target prior to production release.
<i>Production Release</i>	Approval for the design is given and finances are committed on the production tooling.
<i>Pilot Plant (PP)</i>	Primarily a body build where the first-off production panels are built and confirmed, prior to shipping the tools from Japan to the European factory.
<i>ET</i>	The engineering trial where the first vehicles are built using the first production level parts.
<i>T1</i>	The first online production trial to confirm the design and manufacturing process.
<i>T2</i>	The final online production trial, the last opportunity for any design or process changes.
<i>SOP</i>	The start of production, assembly line speed ramps up rapidly to provide a stock of vehicles for distributors.
<i>RFT</i>	The Right First Time development philosophy.
<i>MY</i>	Model Year, the year the product is launched.
<i>NTC</i>	Nissan Technical Centre: Nissan's development company has sites in the UK, Japan and USA
<i>NMUK</i>	Nissan Manufacturing UK: Production plant in Washington Tyne & Wear.
<i>NRP</i>	The Nissan Revival Plan announced by Carlos Ghosn on October 18 th 1999.
<i>TQM</i>	Total Quality Management
<i>QFD</i>	Quality Function Deployment
<i>Kaizen</i>	Continuous improvement.
<i>CAPE</i>	Computer Aided Production Engineering
<i>CAE</i>	Computer Aided Engineering
<i>IT</i>	Information Technology
<i>IS</i>	Information Systems
<i>Design Change</i>	A modification to the original design of a component.
<i>PDCA</i>	Plan-Do-Check-Action - Quality Cycle
<i>Trial Build</i>	A prototype build, in which the vehicle assembly is made from temporary parts.
<i>Off Tool</i>	A vehicle assembly or parts that are manufactured using the production tooling
<i>C/M</i>	Countermeasure, a solution to a concern.

APPENDIX

Appendix Two

Design for assembly - A strategy for right first time (Abstract)

**Palmer, A., Temple, J., Jones, M., Evans, S., (1999)
32nd ISATA Proceedings, Croydon, ISATA**

APPENDIX

DESIGN FOR ASSEMBLY – A STRATEGY FOR RIGHT FIRST TIME DESIGN

**Mr A Palmer, Mr J Temple, Mr M Jones:
Nissan Technology Centre
Professor S Evans: Cranfield University, UK**

99ME026

ABSTRACT

Customer demands and intense competition have resulted in the need for shorter development lead times. The problems with shorter lead times have been well documented. Mistakes are costly and the need for a sustainable and efficient new product development process has become paramount to a successful product.

Vehicle Manufacturers (VM's) have had their choice of a variety of tools and philosophies to assist in reducing lead times. Amongst others, the use of Quality Functional Deployment (QFD), CAD/CAE, cross-functional teams and simultaneous engineering have each been mooted as being the panacea for efficient design and development.

The authors argue the need for a Right First Time (RFT) design policy and state that this can be delivered through the "Hoshin Kanri" method of policy deployment. The resultant strategies are achieved through the tactical use of the most appropriate tools, integrated into the new development process. Performance is measured against agreed targets.

A worked example of this theory, where one of the strategies for RFT design is to reduce assembly errors in a Simultaneous Engineering Environment is discussed. It will also show that further enhancements can be derived through the use of CAPE (Computer Aided Production Engineering) in a Virtual Manufacturing Environment.

APPENDIX

Appendix Three

Almera (HS) Sales Brochure

APPENDIX

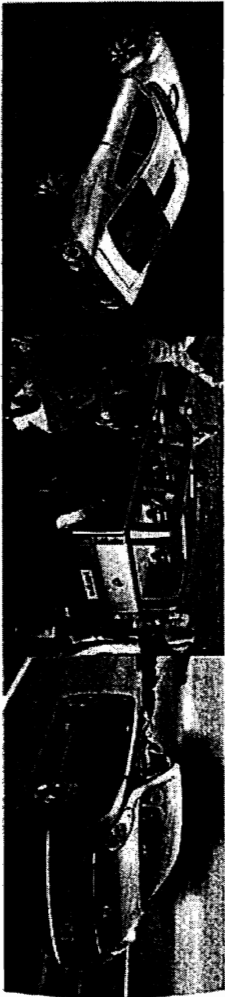
A CAR FOR YOUR DAY

Your individuality gives you a character which adapts to the demands and opportunities of each day. At Nissan, we are focused on designing cars which offer that same individuality: cars that are adaptable, personal and have a character that complements yours.

You can see this approach in our latest concept cars: the phenomenal GT-R, a 21st century sports car devoted to driving passion, the amazingly versatile and adaptable Yanya and the sensational Micra C+C, which is both elegant coupe and sophisticated cabriolet. And now you can experience it with the latest Almera. The Almera is created for individuals who appreciate how its dynamic performance and user-focused technology match the freshness of its distinctive styling.

CONTENTS

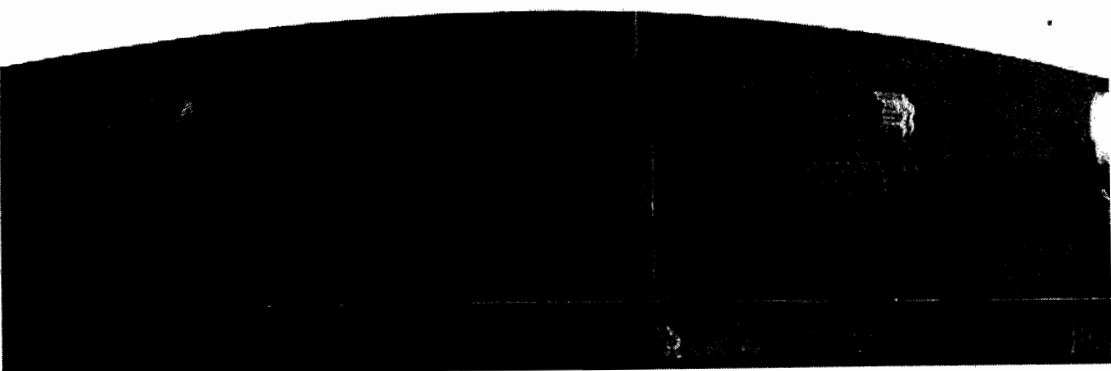
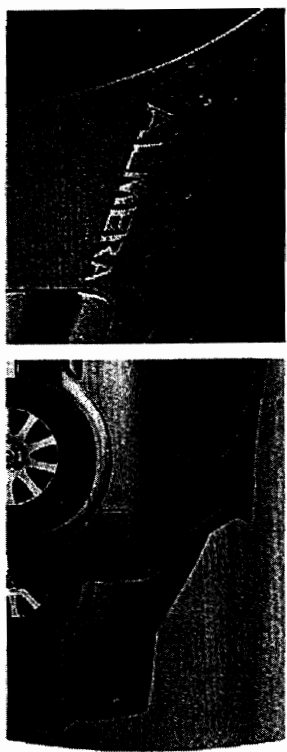
REFRESHINGLY DIFFERENT	.04
CALM AND PRECISE	.10
EXTRA ENERGY	.14
FACTS & FIGURES, CENTRE SECTION	
FUEL CONFIDENT	.20
DEFINE YOUR IDEAL	.24



PREPARE FOR A FRESH EXPERIENCE

The Almera now looks sleeker than ever. Our designers have sculpted its styling to create a streamlined, wind-smoothed shape that's accentuated by the high efficiency projector lens front and rear lights.

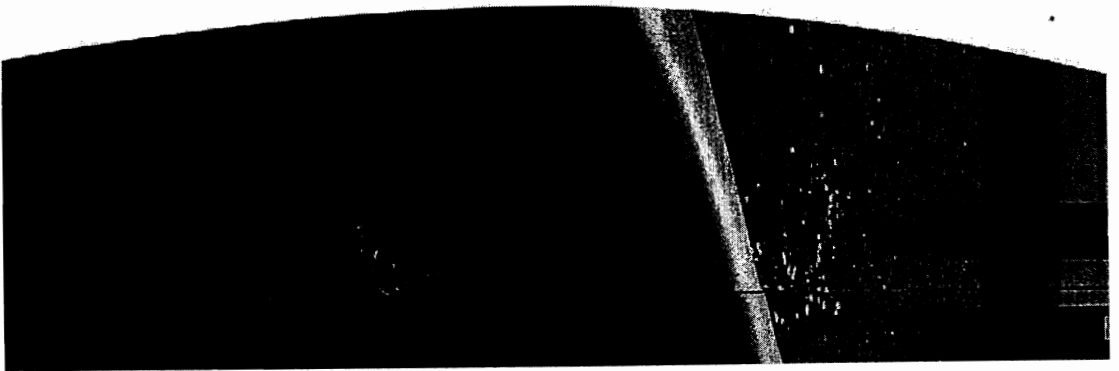
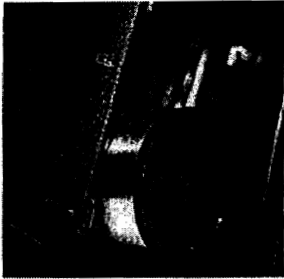
To match its sporting appearance, the Almera has genuine performance and sophistication. To satisfy the enthusiast driver, there's a high output 2.2 dCi 136 diesel engine. And in the cockpit, a command centre that uses unique Nissan technology to make control easier and more natural.



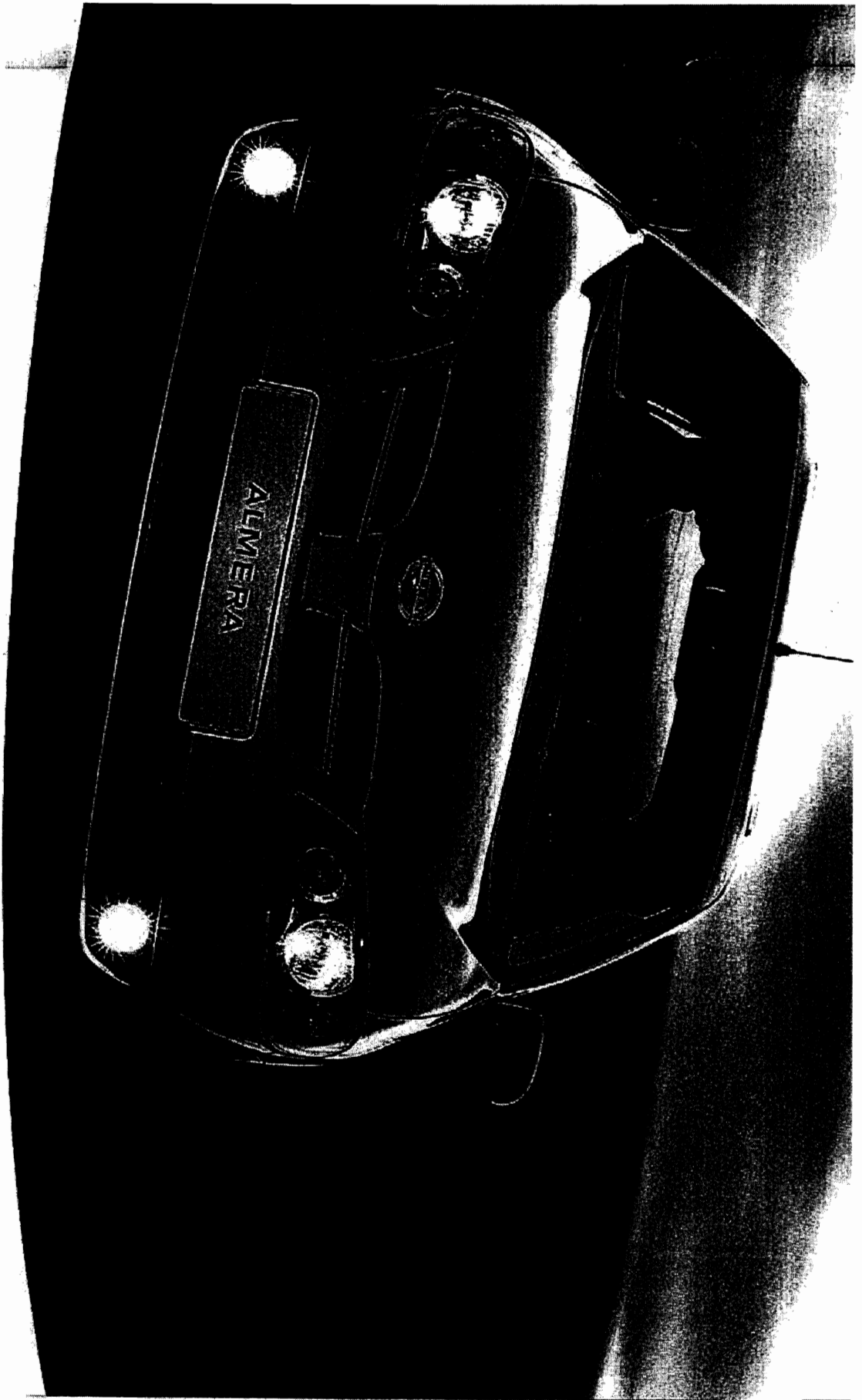
OPEN SPACE, CLEAR MIND

The Almera has an uplifting sense of spaciousness, achieved by large windows, fresh interior decor and useful storage spaces. Sensible details such as the slide-out cupholder help to make the whole interior feel open and uncluttered.

Keeping a clear mind helps you make better decisions and feel in total control. So we've minimised potential distractions by putting remote audio controls on the steering wheel, where you can reach them easily. When you need your sunglasses, you'll find them quickly and easily in the the softy-lined, roof-mounted sunglasses holder.



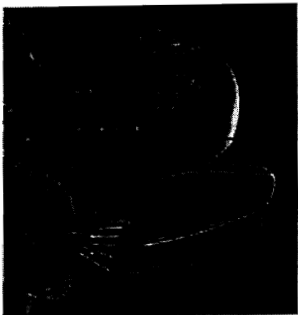
APPENDIX



APPENDIX



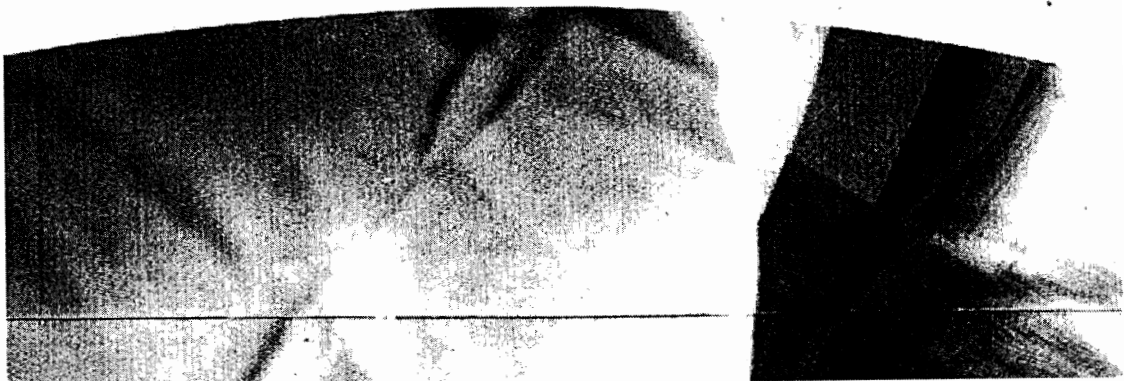
APPENDIX



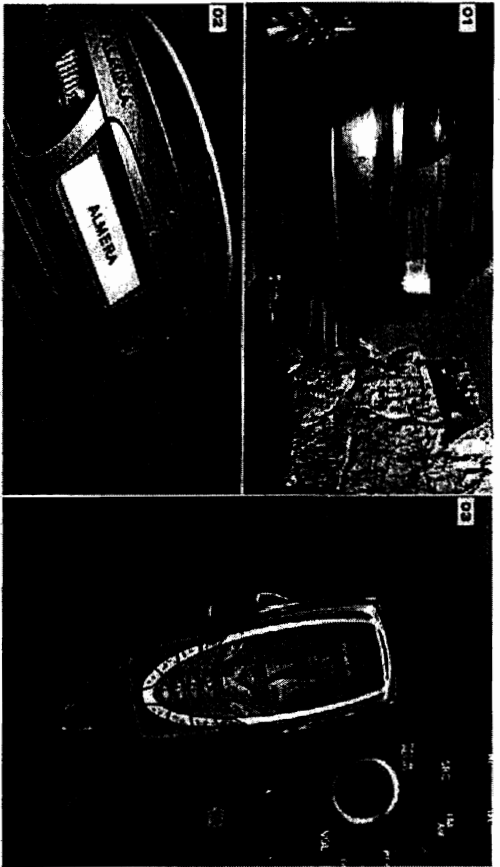
BECAUSE YOU LOVE LIFE

Safety is one of the Almera's great strengths. Its energy absorbing upper body structure and rigid safety cell helped it score four stars in the Euro NCAP impact resistance tests, so you can be sure of well-engineered, effective protection.

Both the driver and front passenger benefit from front airbags, filled as standard on all models; Most grades have front seat mounted side airbags and anti-whiplash Active Head Restraints to ensure optimum protection. Life is fun, but like you we're serious about safety.



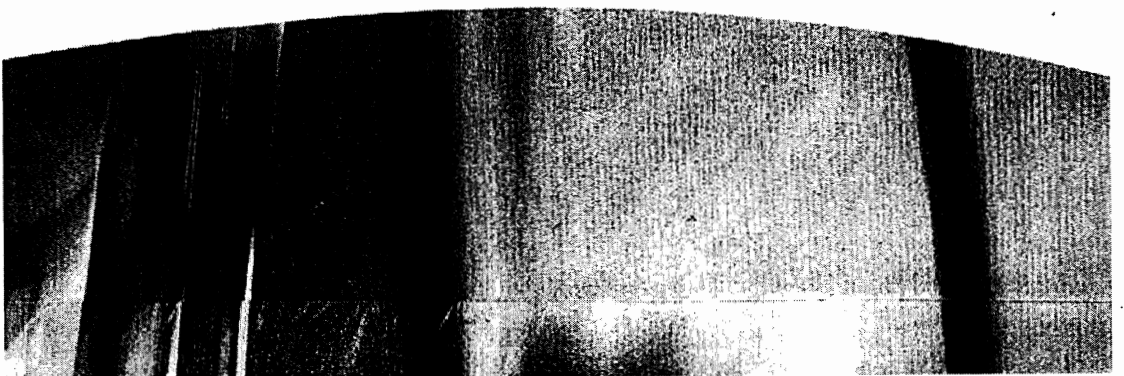
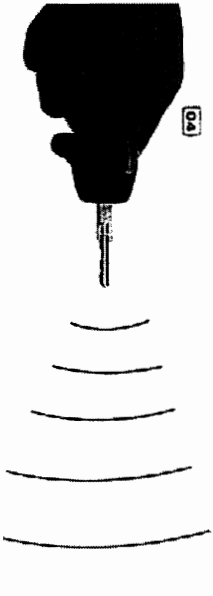
YOU HAVE THE LAST WORD



We've designed, engineered and built the Almera to offer you a blend of pleasing, practical and attractive features. Including a long list of standard equipment.

Now it's time you took over. Ask your dealer about the wide range of accessories that have been specially designed to enhance the Almera. Enjoy making your choices. And create a unique Almera that's the last word in individuality.

- 01 - Ultrasonic Rear Parking System
 - 02 - Rear spoiler, saloon
 - 03 - Handsfree telephone kit
 - 04 - NATS 2000 alarm upgrade
- Accessories featured on opposite page:
Large roof spoiler, roof bars,
Evolution 100 roof box,
Jade 16" alloy wheels and fixed towbar
(fitment requires cutting into bumper)



APPENDIX

Appendix 4

An example of a “Design Guide”

APPENDIX

Title: <p style="text-align: center;">Design Review</p>	No: 06 01 DES Page: 1 of 11 Date: 10/05/99 Issue: VKO	Approved: <p style="text-align: center;">General Manager - VKO</p>

1. Purpose

To improve development quality (right first time design)

To improve development efficiency

To manage DR activity systematically

2. Scope

All of developments for which NETC issue drawings.

Carry over parts on new model. (no drawing issued)

3. Responsibility

DR activities are categorized as 2 types (Section DR and Department DR) depending on the degree of newness, seriousness, customer sensitivity, and warranty exposure.

Section DRs are managed by each section (chaired by manager) and Department DRs are managed by VKO (chaired by general manager).

These DRs are not duplicated.

3-1. Action guideline

DR	Timing	Purpose	Level	Chairman	Reviewer	Tool
#1	-45 to -35	Review of basic idea (concept sheet review N & 1. Decide Category (Section or Dept DR). Review cost, weight, and trend. Confirm that advanced development has finished.	A	Director or GM	GM, Mgr of Design, Test	#1DR procedure guide, categorisation checklist
#2	-31	Review of planning drawing prior to c-lot release. Review/o, cost, weight, open concerns.	A	Director or GM	GM, Mgr of Design, Test	#2DR procedure guide, tool like FMEA/FTA
			B	Mgr	Senior, Sokatsu of Design, Test	
#3	-21	Review of planning drawing prior to c-lot release. Review/o, cost, weight, open concerns.	A	Director or GM	GM, Mgr of Design, Test	#3DR procedure guide, tool like FMEA/FTA
			B	Mgr	Senior, Sokatsu of Design, Test	
#4	-16	Review of planning drawing prior to c-lot release. Review/o, cost,	A	GM	Mgr of Design, Test	#4DR procedure guide, tool like

APPENDIX

			B	Mgr	Senior, Sokatsu of Design, Test	
#5	-9	Review of planning drawing prior to c-lot release. Review/o, cost, weight, open concerns.	A	GM	Mgr of Design, Test	#5DR procedure guide, tool like FMEA/FTA
			B	Mgr	Senior, Sokatsu of Design, Test	
#6	-6	Review of planning drawing prior to c-lot release. Review/o, cost, weight, open concerns.	A	Director or GM	GM, Mgr of Design, Test	#6DR procedure guide, tool like FMEA/FTA
			B	Mgr	Senior, Sokatsu of Design, Test	

4. References

4-1. Timing guideline

4-2. Guideline for Department DR

Fill in the categorization check list and categorize the system as A or B according to the criteria below.

Categorisation Checklist

5. Introduction (Notes)

5-1. DR1~DR6 should be considered as a guideline.

5-2. Considering difficulty of development for each system, each design manager to decide at which stage DR meeting to be held at. (For example extra DR (like a DR3.5) could be held if necessary. Some DR could be skipped if they are judged not necessary.)

5-3. Each engineer to make a DR schedule for his/her parts and to be approved by manager after DR1 (after categorization).

5-4. DR schedule for the department DR items to be copied to the Deputy shatan and managed by the DR status management rule.

6. Procedure

See 'How to manage design review'. (Common for all DR1~6): page 2

7. Appendices

DR categorization check list (for DR1) and how to.

DR minutes format and how to.

DR status management rule (for department DR)

APPENDIX

6.0.0 How to manage design review (Common for DR1~6)

6-0-1. What is a Design Review ?

A 'Design Review' (DR) is a formal checkpoint in the development process. It is a meeting led by the design engineer to review the status of the development from a design point of view. It is an opportunity for the design engineer to;

- * Explain the status of the parts according to the development targets
- * Point out any concerns
- * Get feedback
- * Request information or actions from other areas
- * Get judgement where necessary

6-0-2. Preparation

1.) Decide the Attendees

The level of the attendee (GM, Manager etc) is determined by the category A or B as decided in the DR1. The people who will run the DR (Chairman, Reviewer, Secretary) must of course attend along with the relevant nominees from the other design sections, test department, NMUK and the Supplier. Invite the people who need to hear your information or from whom you need feedback or judgement.

2.) Schedule the DR

The key point to consider when scheduling the DR is the each Spec Tender timing. The DR must be held with enough time to modify the Spec Tender contents based on the feedback (remember the purpose !). Two weeks before the S/T is a good guide.

3.) Decided what needs to be reviewed (Agenda)

See the example agenda. This is the minimum that should be included. It should be added to considering the purpose of the each DR and depending upon the part/system being reviewed.

4.) Prepare and issue the Agenda

Provide an opportunity for the interested parties to 'preview' the DR information. This should make the DR itself more efficient. Issue the agenda about 1 month before the DR.

5.) Gather information

The key point is to identify as early as possible what information you do not have. Then you can decide how to get it. If you need information from other people ask them early. Make a rough checklist and personal schedule to work to. However well you plan it there will always be a last minute rush, however there should be no reason to delay the DR once the agenda is issued.

APPENDIX

6.) Prepare a 'DR Summary Sheet

This should be an A3 sheet which will summarize the key points of the DR. It will be the focus of the DR itself - to be used by the Presenter. The format of the summary sheet is flexible.

7.) Prepare Yourself

As well as the obvious task of gathering the information, you will need to take some time to prepare yourself. Remember, this is a key checkpoint in the development. The DR is for the Design Engineer's benefit. Consider what you want to get out of it - What are the key points you need to get across ?

What do you need others to do for you ? Which sticking points need a judgement from GM or Director ? etc.... An effective DR will make your life much easier in the future !

8.) Ensure Attendance

Although you have pre-checked availability and issued the agenda it is a good idea to telephone the attendees one or two days before to confirm their attendance. If for some reason they cannot attend then insist they send a suitably briefed representative - not just a 'messenger'

6-0-3. Holding the Design Review

1.) Timekeeping

Start on time - do not waste the time of 20 people for the sake of 1 latecomer !
Finish on time - remember many of the attendees will have other meetings, coaches to catch etc. You must conclude before people start 'drifting off'. The meeting itself should last no more than 3 Hours otherwise it will not be effective. It is the responsibility of the Chairman to ensure the meeting keeps to schedule.

2.) Responsibilities

Decide before the meeting who will do what (according to the Category). The Chairman should make clear the roles to the attendees as part of the introduction. Remember your role/responsibility and stick to it. A Senior/Engineer will usually be acting as the 'Presenter'.

3.) The Role of the Presenter

It is the Presenter who will do most of the work in the Design Review, but remember - it is for your benefit. The Presenter must first of all outline what will be reviewed. Then the actual 'reviewing' takes place. Using the Summary Sheet as a guide as a focus explain the status of the development.

Remember, although you are the presenter it is your job to promote discussion. Ask people if they agree, understand, what their opinion is etc.

*At first briefly explain the key 'already decided' items but remember the main purpose is to discuss/conclude the concern items. The purpose of the DR is not to show how clever you are !

APPENDIX

*Next, explain the open concerns which you have encountered during the development. After each concern make a proposal for how to progress then have a discussion - this is very important. The Chairman should control the discussion and make clear the agreed actions. Some items may need discussion outside the DR. The Secretary should record the concern, action, responsibility and date on the whiteboard.

*After all of your concerns have been discussed then review in the same way each of the 'pointed out' concerns which have been raised by the attendees (post-its etc.). Each concern should have a name attached to it. In this case the person who raised the concern should propose a possible countermeasure - it is very easy but not constructive to just point out concerns.

*Next, explain clearly your requests to other areas. What exactly do you want who to do and by when ?

*Finally you should briefly explain your future schedule to Design Note release.

It is of course essential that the Presenter is the person most familiar with the system.

4.) Concluding the Meeting

The conclusion of the meeting should be a brief summary of the minutes from the whiteboard. This will give people a chance to disagree before it is too late. In any case it is a good idea to check agreement before pressing the 'Print' button while the actions are clearly visible. The Chairman should conclude the meeting.

6-0-4. Follow Up

If the Design Review is to be successful it is essential that there is effective follow up activity;

1.) Prepare and Issue the DR Minutes

As time is of the essence it is important to issue the Minutes as quickly as possible. The minutes themselves will already have been prepared on the whiteboard. It is simply a case of transferring them to the Minutes proforma. In any case the minutes should be issued to everybody who needs to see them within 2 days.

2.) Progress your own Responsibility Items

Unfortunately it is likely that most of the actions from the DR will be fully or partially your responsibility. It is vital that you progress these actions as keenly as possible.

3.) Collect and Chase-up all Actions

Make sure that the attendees are doing what they committed to - especially the key items.

APPENDIX

4.) Modify the Spec Tender Contents

Remember the purpose of the DR. The Spec Tender contents should be modified according to the result of the DR.

5.) Issue the Spec Tender

Some items may not be resolved in time for the initial Spec Tender. In that case issue a follow-up Spec Tender as soon as possible once the item is concluded. Try to make this the exception.

6.) Schedule the next DR

To review the result of your excellent activity !

APPENDIX

6-1-1 DR1 process- 'How to carry out a DR1'

Purpose of DR1: 'To confirm the contents of the concept sheet is what NISSAN wants'

'To define difficulty of development and agree category of DR'

Remember this is the spirit of the activity (bear this in mind when unclear how to proceed)

Basic process:

To present to all the relevant parties, your basic design intent for the system, to get feedback on that idea and to get agreement of development based on the idea presented (concept sheet).

Timing:

Considering kick off timing of development (when you need to start detail planning and feed it into NTC design). Of course it should be held before PPD hearing.

Shown below is the detailed timing for the DR1.

-4 weeks prior to DR1: Book a room, Issue agenda. (4 weeks to prepare summary)

-1 day prior to DR1: Pre review (check if all of contents covered)

0 : DR1 meeting

+2 days latest, Issue minutes

Preparation checklist:

1.)Confirm availability of attendees who must attend.

2.)Ensure all relevant information is available for the DR. Summarize them on a concept sheet or additional sheet which should include the following:

*Customer benefit from the system.

*Cost, Weight, Packaging size.

*Competitor trend in Europe.

*Requirement to other areas.

*Advanced development status (if new).

*Open concerns

3.)Book a room (at least 4 weeks before the DR).

4.)Issue an agenda at least 4 weeks before the DR.

APPENDIX

Who to invite:

This depends on the category of DR, but it must include representatives from: related test sections, materials dept, NMUK engineering, VQA and Specialist for the system (even from other dept.)

What must be presented:

- 1.) The concept sheet (Refer concept sheet procedure)
- 2.) Categorisation Checklist
- 3.) Target performance (including customer requirements)
- 4.) Development timing plan including the plan for each DR(2~6) following.
- 5.) Make request to other sections/departments

How to run the DR:

1.) Make sure all parties have an opportunity to review the information prior to the DR. One way is to allow an informal review of the concept sheets one day before the DR.

2.) Timing: Start on time. The review should last no longer than 2 hours and keep to the schedule.

3.) A team of three people should run the DR:

Chairman: who should manage the meeting.

Presenter : making the explanation and should be the expert on the parts.

Secretary : to take the minutes

4.) Minutes should be clearly shown on a white board (remember to check agreement before printing).

Common mistakes:

1.) Don't forget to remind people to attend 2 days before the review.

2.) Make sure you have enough time to make change to your design concept and include them in the final concept sheet which will be issued to OPPD following the DR.

3.) The DR should not be in the form of a presentation. It should be in the form of: inform, discuss, conclude the chairman should control this.

Follow up actions:

DR1 minutes should be issued 2 days following the DR.

1.) Modify concept sheet if necessary.

2.) Timing plan for department DR items must be copied to vehicle shatan.

APPENDIX

6-2-1 DR2 process- 'How to carry out a DR2'

Purpose of DR2: 'To confirm the contents of the Clot spec tender is what NISSAN wants'

Remember this is the spirit of the activity – (bear this in mind when unclear how to proceed)

Basic process:

To present to all the relevant parties, your design detail for the parts, to get feedback on that design and to get agreement.

Timing:

The key point to consider when scheduling the DR#2 is the C-lot Spec Tender timing. The DR must be held with enough time to modify the Spec Tender contents based on the feedback (remember the purpose !). Two weeks before the S/T is a good guide. Propose a date and check the availability of the key members. The date for the DR should be decided at least 2 months before the C-lot Spec Tender - if not you will have no time to prepare it ! Shown below is the detailed timing for the DR2.

-4 weeks prior to DR2: Book a room, Issue agenda. (4 weeks to prepare summary)

-1 day prior to DR2: Pre review (check if all of contents covered)

0 : DR2

+2 days latest, Issue minutes

Preparation checklist:

1.) Confirm the category of the DR. This defines the level of the DR and confirm who should attend.

2.) Ensure all of relevant information is available for the DR. Summarize them on a sheet which

should include the following:

*Basic concept (a reminder)

*Planning assumptions (part category, key development objectives, etc)

*Status Vs Target

*Open concerns (with planned action)

*Request to other area

*Short term schedule (up to design note release)

3.) Book a room (at least 4 weeks before the DR).

APPENDIX

4.) Issue an agenda at least 4 weeks before the DR.

Who to invite:

This depends on the category of DR, but it must include representatives from:

all related design sections, related test sections, materials dept, NMUK engineering and VQA.

What must be presented:

- 1.) The design concept (planning drawing, refer planning drawing procedure)
- 2.) Target performance (including customer requirements)
- 3.) The design (most important items), CAD layout drawings showing your and related parts.

Remember- One of the objectives is confirming that the data you have used is accurate.

4.) Explain and re-confirm any assumptions that you have made including those for related and

processes.

5.) Make request to other sections/departments

How to run the DR:

1.) Make sure all parties have an opportunity to review the information prior to the DR. One way is to

allow an informal review of the planning drawings day before the DR.

2.) Timing: Start on time. The review should last no longer than 2 hours and keep to the schedule.

3.) A team of three people should run the DR:

Chairman: who should manage the meeting.

Presenter : making the explanation and should be the expert on the parts.

Secretary : to take the minutes

4.) Minutes should be clearly shown on a white board (remember to check agreement before printing).

Common mistakes:

1.) Don't forget to remind people to attend 2 days before the review.

2.) Make sure you have enough time to make change to your design and include them in the c-lot

Spec tender following the DR.

APPENDIX

3.) The DR should not be in the form of a presentation. It should be in the form of: inform, discuss, conclude the chairman should control this.

Follow up actions:

- 1.) DR2 minutes should be issued 2 days following the DR.
- 2.) All actions to be followed up prior to the Spec tender release.

APPENDIX

6-3-1 DR3 process- 'How to carry out a DR3'

Purpose of DR3: 'To confirm the contents of the production spec tender is what NISSAN wants'

Remember this is the spirit of the activity –(bear this in mind when unclear how to proceed)

Basic process:

To present to all the relevant parties, your design detail for the parts, to get feedback on that design and to get agreement.

Timing:

The key point to consider when scheduling the DR3 is the production Spec Tender timing. The DR must be held with enough time to modify the Spec Tender contents based on the feedback (remember the purpose !). Two weeks before the S/T is a good guide. Propose a date and check the availability of the key members. The date for the DR should be decided at least 2 months before the production Spec Tender - if not you will have no time to prepare it ! Shown below is the detailed timing for the DR3.

-4 weeks prior to DR3: Book a room, Issue agenda. (4 weeks to prepare summary)

-1 day prior to DR3: Pre review (check if all of contents covered)

0 : DR3

+2 days latest, Issue minutes

Preparation checklist:

- 1.) Confirm the category of the DR. This defines the level of the DR and confirm who should attend.
- 2.) Ensure all of relevant information is available for the DR. Summarize them on a sheet which should include the following:
 - *Clot result (CUS, NTI, STRS)
 - *Countermeasure for production release
 - *Open concerns (with planned action)
 - *Request to other area
 - *Short term schedule (up to design note release including tooling timing)
- 3.) Book a room (at least 4 weeks before the DR).
- 4.) Issue an agenda at least 4 weeks before the DR.

APPENDIX

Who to invite:

This depends on the category of DR, but it must include representatives from:

all related design sections, related test sections, materials dept, NMUK engineering and VQA.

What must be presented:

- 1.) The c-lot parts.
- 2.) All of C-lot concerns (concern memo, CUS, NTI, test report....)
- 3.) QCD info. (Target performance, cost, weight, timing....)
- 4.) Minutes of DR2
- 5.) Make request to other sections/departments

How to run the DR:

1.) Make sure all parties have an opportunity to review the information prior to the DR.

2.) Timing: Start on time. The review should last no longer than 2 hours and keep to the schedule.

3.) A team of three people should run the DR:

Chairman: who should manage the meeting.

Presenter : making the explanation and should be the expert on the parts.

Secretary : to take the minutes

4.) Minutes should be clearly shown on a white board (remember to check agreement before printing).

Common mistakes:

1.) Don't forget to remind people to attend 2 days before the review.

2.) Make sure you have enough time to make change to your design and include them in the production spec tender following the DR.

3.) The DR should not be in the form of a presentation. It should be in the form of: inform, discuss, conclude the chairman should control this.

Follow up actions:

1.) DR3 minutes should be issued 2 days following the DR.

2.) All actions to be followed up prior to the Spec tender release.

APPENDIX

6-4-1 DR4 process- 'How to carry out a DR4'

Purpose of DR4: 'To confirm the contents of the production spec tender is what NISSAN wants' based on the results from trial/test with modified c-lot parts.

Remember this is the spirit of the activity – (bear this in mind when unclear how to proceed)

Basic process:

To present to all the relevant parties, your design detail for the parts, to get feedback on that design and to get agreement.

Timing:

The key point to consider when scheduling the DR4 is the timing of modification for the production Spec Tender. The DR must be held with enough time to modify the Spec Tender contents based on the feedback (remember the purpose !). Propose a date and check the availability of the key members. The date for the DR should be decided at DR3 - if not you may have no chance to change production spec tender contents ! Shown below is the detailed timing for the DR4.

-2 weeks prior to DR4: Book a room, Issue agenda. (2 weeks to prepare summary)

-1 day prior to DR4: Pre review (check if all of contents covered)

0 : DR4

+2 days latest, Issue minutes

Preparation checklist:

1.) Confirm the category of the DR. This defines the level of the DR and confirm who should attend.

2.) Ensure all of relevant information is available for the DR. Summarize them on a sheet which should include the following:

*Specific purpose of DR4 activity for the system

*Result of trial with modified Clot parts.

*Proposal of specification for the production parts(E2 parts)

*Request to other area

*Short term schedule (up to production tool completion)

3.) Book a room (at least 2 weeks before the DR).

4.) Issue an agenda at least 2 weeks before the DR.

APPENDIX

Who to invite:

This depends on the category of DR, but it must include representatives from:

all related design sections, related test sections, materials dept, NMUK engineering and VQA.

What must be presented:

- 1.) The C-lot parts modified.
- 2.) C-lot concerns (concern memo, CUS, NTI, test report....)
- 3.) Results from trial/test using modified c-lot parts.
- 4.) Minutes of DR3
- 5.) Make request to other sections/departments

How to run the DR:

1.) Make sure all parties have an opportunity to review the information prior to the DR.

2.) Timing: Start on time. The review should last no longer than 2 hours and keep to the schedule.

3.) A team of three people should run the DR:

Chairman: who should manage the meeting.

Presenter : making the explanation and should be the expert on the parts.

Secretary : to take the minutes

4.) Minutes should be clearly shown on a white board (remember to check agreement before printing).

Common mistakes:

1.) Don't forget to remind people to attend 2 days before the review.

2.) Make sure you have possibility to make change to your design and include them in the production design note following the DR.

3.) The DR should not be in the form of a presentation. It should be in the form of: inform, discuss, conclude the chairman should control this.

Follow up actions:

1.) DR4 minutes should be issued 2 days following the DR.

2.) All actions to be followed up prior to the Spec tender release.

APPENDIX

6-5-1 DR5 process- 'How to carry out a DR5'

Purpose of DR5: 'To confirm the specification of the production parts is what NISSAN wants'

Remember this is the spirit of the activity – (bear this in mind when unclear how to proceed)

Basic process:

To present to all the relevant parties, your design specifications for the parts, to get feedback on that design and to get agreement.

Timing:

The key point to consider when scheduling the DR5 is the timing of modification for T1. The DR must be held with enough time to modify the T1 Spec Tender contents based on the feedback (remember the purpose !). Propose a date and check the availability of the key members. Shown below is the detailed timing for the DR5.

-4 weeks prior to DR5: Book a room, Issue agenda. (4 weeks to prepare summary)

-1 day prior to DR5: Pre review (check if all of contents covered)

0 : DR5

+2 days latest, Issue minutes

Preparation checklist:

1.) Confirm the category of the DR. This defines the level of the DR and confirm who should attend.

2.) Ensure all of relevant information is available for the DR. Summarize them on a sheet which should include the following:

- *E2 result (CUS, NTI, STRS)

- *Countermeasure for T1 release

- *Open concerns (with planned action)

- *Request to other area

- *Short term schedule (up to design note release including tooling timing)

3.) Book a room (at least 4 weeks before the DR).

4.) Issue an agenda at least 4 weeks before the DR.

APPENDIX

Who to invite:

This depends on the category of DR, but it must include representatives from:
all related design sections, related test sections, materials dept, NMUK engineering and VQA.

What must be presented:

- 1.) The off tool parts (E2).
- 2.) All of E2 concerns (concern memo, CUS, NTI, test report....)
- 3.) QCD info. (Target performance, cost, weight,....)
- 4.) Minutes of DR3 and DR4
- 5.) Make request to other sections/departments

How to run the DR:

- 1.) Make sure all parties have an opportunity to review the information prior to the DR.
- 2.) Timing: Start on time. The review should last no longer than 2 hours and keep to the schedule.
- 3.) A team of three people should run the DR:
Chairman: who should manage the meeting.
Presenter : making the explanation and should be the expert on the parts.
Secretary : to take the minutes
- 4.) Minutes should be clearly shown on a white board (remember to check agreement before printing).

Common mistakes:

- 1.) Don't forget to remind people to attend 2 days before the review.
- 2.) Make sure you have enough time to make change to your design and include them in the T1 modifications following the DR.
- 3.) The DR should not be in the form of a presentation. It should be in the form of: inform, discuss, conclude the chairman should control this.

Follow up actions:

- 1.) DR5 minutes should be issued 2 days following the DR.
- 2.) All actions to be followed up prior to the Spec tender release.

APPENDIX

6-6-1 DR6 process- 'How to carry out a DR6'

Purpose of DR6: 'To confirm the specification of the production (T1) parts has no concerns'

Remember this is the spirit of the activity – (bear this in mind when unclear how to proceed)

Basic process:

To present to all the relevant parties, your design specifications for the parts, to confirm and to get agreement.

Timing:

The key point to consider when scheduling the DR6 is the timing of modification for T2. The DR must be held with enough time to modify the T2 Spec Tender contents based on the feedback (remember the purpose !). Propose a date and check the availability of the key members. Shown below is the detailed timing for the DR6.

-2 weeks prior to DR6: Book a room, Issue agenda. (2 weeks to prepare summary)

-1 day prior to DR6: Pre review (check if all of contents covered)

0 : DR6

+2 days latest, Issue minutes

Preparation checklist:

- 1.) Confirm the category of the DR. This defines the level of the DR and confirm who should attend.
- 2.) Ensure all of relevant information is available for the DR. Summarize them on a sheet which should include the following:
 - *T1 result (CUS, NTI, STRS)
 - *Countermeasure for T2 release (if necessary)
 - *Open concerns (with planned action)
 - *Request to other area
 - *Development timing plan up to SOP.
- 3.) Book a room (at least 2 weeks before the DR).
- 4.) Issue an agenda at least 2 weeks before the DR.

APPENDIX

Who to invite:

This depends on the category of DR, but it must include representatives from:
all related design sections, related test sections, materials dept, NMUK engineering and VQA.

What must be presented:

- 1.) The T1 parts.
- 2.) All of T1 concerns (concern memo, CUS, NTI, STRS, test report....)
- 3.) QCD info. (Target performance, cost, weight.)
- 4.) Minutes of DR5.
- 5.) Make request to other sections/departments

How to run the DR:

- 1.) Make sure all parties have an opportunity to review the information prior to the DR.
- 2.) Timing: Start on time. The review should last no longer than 2 hours and keep to the schedule.
- 3.) A team of three people should run the DR:
Chairman: who should manage the meeting.
Presenter : making the explanation and should be the expert on the parts.
Secretary : to take the minutes
- 4.) Minutes should be clearly shown on a white board (remember to check agreement before printing).

Common mistakes:

- 1.) Don't forget to remind people to attend 2 days before the review.
- 2.) Make sure you have enough time to make change to your design and include them in the
T2 modifications if necessary following the DR.
- 3.) The DR should not be in the form of a presentation. It should be in the form of: inform, discuss,
conclude the chairman should control this.

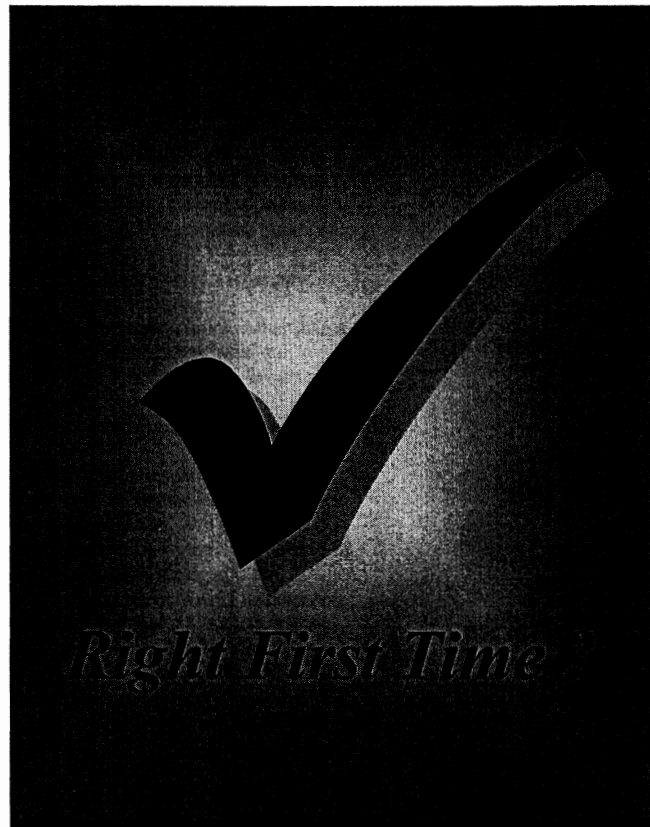
Follow up actions:

- 1.) DR6 minutes should be issued 2 days following the DR.
- 2.) All actions to be followed up prior to the Spec tender release.

APPENDIX

Appendix 5

Verbatim Interviews With Nissan Managers



APPENDIX

Interview No.1
Almera - Right First Time
New Car Assessment Programme (NCAP)
Target Achievement

Place: Nissan Technical Centre Date: Wednesday 25 th July 2001 Time: 3.00pm – 5.00pm

JA: John Austin
 M1: Senior Engineer Vehicle Safety Group
 M2: Senior Engineer Body Design Group.

Transcript	Whiteboard Notes	Issues Raised
<p><i>Zone 1 The concern was created. The concern should have been found.</i></p>		
<p>JA: [Presentation to explain the dissertation process]</p> <p>JA: I want to focus on the organizational aspects. M1: A critical issue for NCAP was the change of target (3* to 4*). A key failing was that the original target was not OK for Europe. This was the concern creation, between Pilot Plant (PP) and ET. The concern should have been found before C-Lot at the beginning. M2: It was a marketing feature and should have been in the target setting of the vehicle. M1: There was a problem, achieving 3* at this stage as well. JA: Why was it a concern that 3* was specified as against 4* M1: My understanding is that the European side recommended 4* NCAP but 3* was selected as an average but competitive level. It was not understood that NCAP was becoming a big issue. M2: The marketing trend was unclear. JA: Why was that? M2: At that time the European voice had little influence on the target setting of the vehicle, it was mainly centred in NTC Japan. The UK arm of NTC is resourced to deliver a concept that is generated in Japan. We were not resourced to research the market. Now that's changed somewhat. M1: As a countermeasure we're getting involved earlier now. JA: Are there any other issues? M1: We seem to be an engineering led organization rather than a marketing led organization. We don't understand what our customers really want. We only have 1 or 2 weeks to investigate concept sheets. There is not the time in the process. M2: That's because we are resourced to deliver. We are a delivery company. JA: Do you know of the Marketing department's involvement? M1: They were pushing for 4*. It was a combined effort that got the target changed. We have another concern. We set the specification based on the best information we have at the time. It takes a great deal of effort to get the target changed if the competition have moved on, we need a great deal of justification. M2: It would be difficult to track every feature, but key features should be prioritised and tracked in the market. They are the fundamentals you are trying to sell the vehicle on. Nissan needs a rapid response mechanism. M1: We also need to have marketing information to hand rather than search for the information. JA: Is the marketing information available now? M1: It needs to be hunted for. A general issue is getting marketing requirements into something that can be understood by the technical people and delivered. There is a gulf at the moment. M2: QFD is used for that. We can't expect the marketing guys to get to this level, but at least they should be getting part of the way. JA: The programme is 31 months, will there be marketing changes? M1: Its lack of information. There was a big fight from C-Lot to get the target changed. M2: The new organizational structure (Chief Product Specialist) should monitor that.</p>	<p>Do not have good data Do not have simulation capability Renault and others crash lots of cars to compare with simulation NTC – bare minimum crash testing Only use simulation for a problem C/m use Renault platforms Now doing simulation validation work (building expertise) Nissan vehicle structure, not simple for crash analysis. Good understanding – concern immediately apparent Flexible workforce</p>	<p>The change of a major target caused disruption to the programme</p> <p>A conservative level of competitiveness was selected despite some disagreement.</p> <p>The product planners were not expert at understanding the European market.</p> <p>Nissan is an engineering led, not market led organization</p> <p>The company is resourced for research it is resource to be a product delivery company.</p> <p>Hard information was required to justify a change. Often this is difficult to get, delaying the decision.</p>

APPENDIX

Zone 2 <i>The concerns should have been found</i> <i>The concern was found</i>		
<p>JA: Onto the next quadrant, concern should have been found, concern was found.</p> <p>M2: An issue of simulation. We do very little crash testing and therefore there is little correlation to or simulation. Little resource to extend into that area. We may be over cooking the design in some areas and undercooking in others, we don't know.</p> <p>M1: We adopt a belt and braces attitude to design, adding lots of cost to make sure it works.</p> <p>JA: Is that because you don't fully understand so therefore add a safety margin?</p> <p>M2: We have the understanding, but our process is not robust enough to give us enough data.</p> <p>M1: The outcome was quite good, considering the amount of data that was available.</p> <p>JA: Where does the issue sit on the T Matrix?</p> <p>M1: We should have been able to find the crash performance concern at C-Lot. We confirmed we had the problem, probably at ET.</p> <p>M2: Yes, we should find it at the correlation stage, at C-Lot.</p> <p>M1: We have a fundamental problem with our design process to support crash testing. Right at the beginning we do not have particularly 3D CAD data, which is needed for the simulation models. Also at the moment we do not have the resource or expertise to do a particularly good crash test job at the moment.</p> <p>M2: We now know that Renault and our competitors crash a lot of cars.</p> <p>M1: Yes, they are correlating aspects of their model ...early on in the programme. Nissan, tends to reach for the simulation when there is an actual problem.</p> <p>M2: You would anticipate that the platforms should be correlated against the simulation.</p> <p>JA: Do competitors develop simulation competencies during a development, or by crashing production vehicles outside a programme?</p> <p>M1: I believe they do both. And this is now starting in NTC (Japan).</p> <p>JA: Were there delays in deciding if there was a concern?</p> <p>M2: It was apparent immediately, it was just a lack of data. We are good at countermeasuring when we have data. We are good at that, we have a flexible workforce that will move heaven and earth to solve the concern, its just the tools don't give us the concern up front.</p>	<p>Decision to manage separately</p> <p>Solution:</p> <p>Simulation ability</p> <p>Evaluation of c/m attributes and difficulty</p> <p>Knowledge – simulation</p> <p>Pressure – delivery</p>	<p>The organization was not expert at simulation; therefore it was difficult to predict if some items were right first time.</p> <p>This technique results in over engineering in some areas. Under engineering in others.</p> <p>Technical people lacked data to make informed decisions.</p> <p>Design techniques did not support design simulation techniques.</p> <p>The company was not resourced to do simulation work.</p> <p>Nissan has a flexible and committed workforce</p>
Zone 3 <i>The concern was found</i> <i>The countermeasure should have been established.</i>		
<p>JA: Next one, the countermeasure should have been established...</p> <p>M1: It took 2 or 3 iterative loops before it was finally resolved.</p> <p>M2: A problem was that we were increasing the vehicle weight with countermeasures and making the problem worse. When the size of the issue was apparent, there was a decision to manage it separately.</p> <p>M1: The individual countermeasures were actually found quickly, but an overall solution took time to implement.</p> <p>M2: The issues could be evaluated on an individual basis.</p> <p>M1: We do have a tendency to analyse individually each of the symptoms rather than the root cause.</p> <p>JA: Why do you think these countermeasures weren't evaluated together?</p> <p>M1: There has never been a good simulation model, there wasn't the resource or knowledge in NTC to carry one out.</p> <p>M2: When you have x number of weeks to the launch of the product, you then have very angry men from production beating you over the head with a stick saying "what's the solution".</p> <p>JA: That's pressure for a solution?</p> <p>M2: Yes, what's the priority, Quality, Cost or Delivery.</p> <p>M1: Because we don't have a simulation model baked into the process, we don't have the time to create a model, so we return to iterative testing.</p> <p>M2: I have the view that the crash IT software is not driven by Japan, its usually American, so there are language issues.</p> <p>JA: Why does that present a problem?</p> <p>M1: There is another level, these systems have developed a lot in the last 5 years. There was a suspicion in NTC that they if didn't</p>	<p>No design by test – costs money / skills</p> <p>Development investment</p> <p>Software technology is not Japanese</p> <ul style="list-style-type: none"> - Language - NTC suspicious of worth <p>Culture – Kaizen, needs a jump to accept risk</p> <p>NTC – now c/m – Renault alliance</p> <p>Things rejected because they didn't work in the past</p> <p>In spite of technical changes</p> <p>One solution – "same as last time"</p> <p>Cannot get c/m – time to make the parts</p> <p>Flexibility – Quick reaction</p>	<p>An inability to predict meant iterative test loops that used up time.</p> <p>Production aggression to meet the schedule was evident.</p> <p>Technological progress was at odds with the culture of Kaizen. "If it didn't work, its not the way forward".</p> <p>Young /not senior did not want to push risky things, deferential</p> <p>Ultimately end up with one solution, the same as last time.</p> <p>Organization (people)</p>

APPENDIX

<p>give you the answer you were looking for, then it was decided that this wasn't the way forward.</p> <p>M2: This is a company culture issue. We have the Kaizen culture, to use this type of system represented a risk. The young managers would not push it because they would get knocked down.</p> <p>M1: The company culture was at work, if something goes wrong or doesn't work steps are taken to make sure that path is never trodden again. This was the case with simulation. "It will never work". Even though the technology is changing, the markets are changing and people's expectations are changing. It is better now and simulation is used (as a result of Renault).</p> <p>M2: There are these cultural restrictions. Ultimately you end up with one solution, the "same as last time". But it is getting much better.</p> <p>JA: In terms of the T Matrix?</p> <p>M1: Countermeasure should have been established at T1.</p> <p>JA: Why was the delay?</p> <p>M2: It takes time to make the new parts.</p> <p>JA: You've highlighted speed of response</p> <p>M1: Yes thing happened faster than I expected.</p>		<p>were very fast to respond.</p>
<p>Zone 4 Countermeasure should have been established. Countermeasure was establish</p>		
<p>JA: Lastly, when was the countermeasure established?</p> <p>M2: Full countermeasure was at SOP.</p> <p>M1: This was mainly due to the factory, they wouldn't accept changes and wanted a package of changes. It was established in 2 parts, confirmed by test at T2 but full validation was not until after SOP.</p> <p>JA: Why was it not on the T-matrix line?</p> <p>M1: A loop was required.</p> <p>JA: You mentioned the factory, what was their role?</p> <p>M1: Sheer Panic to start with!! Because of the list of change parts.</p> <p>M2: They were concerned because of confusing communication from the Japanese manager. That was why I was brought in to assimilate data and explain it to the plant. This helped their internal planning.</p> <p>M1: It helped Design because we weren't bombarded by questions from the factory, M2 was the focus of their aggression.</p> <p>JA: You mentioned aggression, was it an issue?</p> <p>M2: They got quite aggressive, beating the table and shouting. My approach was data and facts, this is the situation we in.</p> <p>JA: Why were they getting aggressive?</p> <p>M2: They want a design freeze and then they try to stabilize their process to achieve a quality level. This went against the principles of their management processes.</p> <p>M1: This is where in Nissan the plant and the market are totally at odds. The factory wants a simple product, the Design frozen 1 year before production. The market wants to meet consumer demands. We're in the middle, meet these demands whilst keeping the plant happy. Almera NCAP was out of their expectation, we said we cannot keep your schedule (factory) please add new parts while you are preparing for production.</p> <p>M2: With compressed programmes they're having to become more flexible.</p> <p>JA: They need to become more flexible?</p> <p>M2: To be fair they have to meet their own internal targets.</p> <p>M1: They delivered what was asked of them. We need to understand each other's requirements. Its fair to say the plant is stronger than Design, although the balance of power is shifting to the market, NTC is finding its feet.</p> <p>M2: Now cost, including cost of process is a key-deciding factor.</p> <p>JA: Any other relationship issues?</p> <p>M2: The plant must have been exasperated, frustrated because we had to change after the tests.</p> <p>M1: Now we're better able to simulate, and give them more confidence. Japan side now trusts the European side more. We achieved 4* but they're struggling.</p> <p>M2: I felt quite exposed in the relationship with plant.</p> <p>M1: So did I because there were things happening I didn't know about in the "Japanese side of the organization". But at times it may have been the most efficient way, but it was risky.</p> <p>M2: Its an interesting point, how many areas of excellence do you have? Europe Japan...</p> <p>M1: Or Renault. My feeling we need expertise here.</p>	<p>Additional loop Need confirmation 'gut feeling'</p> <p>Plant Panic (70/80 parts) Japan staff communication – c/m Colin D to give confidence Help internal planning Aggression – Support with data and facts Went against processes (quality) Plant requirement – simplicity NTCE/NMUK mutual understanding needed NMUK stronger – not shifting Shift to market demands</p> <p>"At all costs must achieve" Evaluate costs at the end C/m now must achieve cost</p> <p>Plant relationship – exasperated by changes Colin exposed, not controlling the design but has to sell to NMUK Things happening in the Japanese side of the organization (Euro side not briefed or involved) - may be efficient but with some risk. How many areas of excellence? Cost impact (Japan, Europe or now Renault) High workload throughout Requirement for organizational learning – no money funded by programme There is no slack to be creative Culture of "busy/busy" should be busy all the time</p>	<p>The Factory had strong influence on vehicle content (to meet the schedule and quality)</p> <p>The Factory panicked, they were under pressure to deliver quality on time.</p> <p>Factory people displayed aggression aggressive.</p> <p>Design were in the middle. The Factory wanted simplicity, the market wants complexity.</p> <p>The Factory were stronger, but this is changing.</p> <p>The company emphasis was on delivery, not learning.</p> <p>The organization is learning from the Almera experience.</p> <p>The company is staffed to deliver, no slack There is a culture of 'busy, busy' does this stifle creativity?</p>

APPENDIX

<p>M2: That becomes a company direction and cost issue. Of course it can be done.</p> <p>M1: With shortened development lead-times, simulation requires lots of loops, how do you manage it? The company is currently overloaded.</p> <p>M2: We could do a retrospective study of Almera and use it as a training experience.</p> <p>JA: An organizational learning activity?</p> <p>M2: But currently we are funded by programme</p> <p>M1: We are currently staffed to 100% with no slack.</p> <p>JA: Does this cause concerns?</p> <p>M1: It stifles creativity I think.</p> <p>M2: If you're doing anything creative, people turn round and say "that guy hasn't got enough to do...you should be doing A, B or C".</p> <p>M1: A culture of "busy, busy"</p> <p>JA: Did you find the T-Matrix a useful discussion tool?</p> <p>M1: It helps to formalise the process that you take.</p> <p>M2: I'd normally do the review, based on the schedule and historic data. It's a different way of thinking about it.</p> <p>JA: Is it a good communication tool?</p> <p>M2: It doesn't jump out at me! It fits with Nissan ways of communicating.</p> <p>M1: The definition can be confusion. Also the danger is engineers are worried about exactly where the point lies.</p>	<p>T Matrix</p> <p>Helps to formalise – gives a process</p> <p>Not obvious as a descriptive tool</p> <p>Congruent with the Nissan way of communicating</p> <p>Limited- tied up with semantics</p> <p>Danger of technical people too concerned about where the mark should go exactly</p>	
---	---	--

APPENDIX

Interview No.2 Almera - Right First Time Product Attractiveness Target Change

Place: Nissan Technical Centre
Date: Thursday 26th July 2001
Time: 9.00am – 10.30am

JA: John Austin

M3: Styling Engineer – Nissan Europe Styling Group.

Transcript	Whiteboard Notes	Issues Raised
<p>Zone 1 <i>The concern was created.</i> <i>The concern should have been found.</i></p>		
<p>JA: [Presentation to explain the dissertation process]</p> <p>JA: When was the concern created? M3: Probably when they created the master model for that car. The development probably continued to the first prototype, the powers that be slightly thinking, "its not the most gorgeous of cars but its OK". The timing plans seem to take precedence over design...that's changing slightly now. Maybe they hadn't realised the jumps the competition were going to make. That car got too far with not enough substance. When the product planners and marketing saw the car [C-lot] they realised it needed something else but the changes were limited because the metal etc. was committed.</p> <p>JA: So the concern was created at the planning stage? M3: Yes and the concern should have been found at the same time. But the styling drawings can sometimes be misleading, big wheels and black glass etc., but its their expertise to know this. JA: Was it a cultural issue? M3: I don't think so. We're not alone, we're the same as Honda or Toyota. The European side is at the meetings. Probably the competition was just stiffer than they thought.</p>	<p>Can't write a formula for some things Creative need at the 'front end' Base vehicle under the European expectation. Marketing people should have rejected the original model.</p>	<p>Product planners accepted the vehicle concept knowing it wasn't market leading.</p> <p>Marketing didn't anticipate the progress that the competition would make.</p> <p>The early styling renderings were not always truly representative of the finished product.</p> <p>Capital for production tooling was committed before Marketing saw representative vehicles.</p> <p>It wasn't an issue of national culture influence (often sighted as a cause of conservatism). European and Japanese staff were involved.</p> <p>Meeting the schedule seemed to have priority over the design.</p>
<p>Zone 2 <i>The concerns should have been found</i> <i>The concern was found</i></p>		
<p>M3: Quite often the early cars are "quite rough"; it's difficult for marketing to judge. Often the parts aren't grained and some features are missing. JA: When was the concern raised? M3: The concern was probably found when we saw the first good cars, getting on for ET. And at that time a load of new cars had just come out, the A3 and the latest Golf...it was "oh sh*t!". They thought they had something reasonable, but they were beginning to realise it wasn't as good as they thought. JA: Did they feel they could change it? M3: By the time they realize it...production tooling is kicked off before you know it. Do you persevere with it or just "can it". Ford canned their people carrier when the 7 seater Zafira came out. And its [the market] now moved on again. JA: Why did they wait until they saw cars, what was their reaction to the clay model? M3: I don't know exactly. But I'm not very senior so I can feel a little awkward in that situation. Its difficult to say "I don't like this or that" in front of senior people. They are beginning to question the design a lot more now.</p>	<p>Early prototype cars are not representative Limited tools to analyse. How relevant were attractiveness points Do something – USP. Realised competitor progress Realised the problem when it was too late. Don't question the design</p>	<p>The first prototype cars were "rough" and masked the problem</p> <p>The tools available to simulate the finished vehicle were limited.</p> <p>The culture encouraged progression of the schedule at all costs.</p> <p>Commitments meant that they were there was no option to go back to the drawing board.</p> <p>Culture discourages individual to subdue opinions at odds with senior people.</p>

APPENDIX

<p>Zone 3 <i>The concern was found</i> <i>The countermeasure should have been established.</i></p>		
<p>M3: They used a point system for attractive features. They thought the car was better than it was [score wise] but ultimately the features weren't that highly valued. The dealers rate them once the customer is in the showroom, but it doesn't pull the punters in. Now with have moved to a method that judges what the customers' first impression of the car. People like Audi are very good at this. They make it an attractive product without spending money on features.</p> <p>JA: If it wasn't the right countermeasure, why wasn't it right?</p> <p>M3: Arguably it was an easy way to pacify the marketing people without doing anything too drastic.</p> <p>JA: Why wasn't anything more drastic done?</p> <p>M3: There probably wasn't the time or money. The likes of the Programme Director would say "you bought the thing off at the time, tough luck, flog it".</p> <p>JA: Why was there a reluctance to change?</p> <p>M3: No one wanted to put their hand up. The very senior people had agreed its OK, so why change it. You don't change it because a couple of engineers don't like it. Once its signed off it goes, you're committed to production.</p> <p>JA: But Nissan made changes?</p> <p>M3: We only made little changes, add-ons to the original concept. Little things to lift it up, to make it competitive. All we were really allowed to do is little changes. We did surveys, looked at what people did, what the competitors were doing.</p> <p>JA: When should the countermeasure have been established?</p> <p>M3: The next iteration after the problem, T1 I suppose.</p>	<p>Market had moved on. It was an easy way to pacify detractors.</p>	<p>The team sought to identify customer needs.</p> <p>They considered how customers used their cars, what they valued.</p> <p>The focused was on what could be done, small things.</p> <p>Small changes were an easy way to pacify detractors</p> <p>A company culture of "you signed it off, therefore it must be OK!"</p>
<p>Zone 4 <i>Countermeasure should have been established.</i> <i>Countermeasure was establish</i></p>		
<p>M3: It took time to develop the prototypes to a stage where they could be shown to key people. They looked tacked on and it was late on before they were acceptable. The countermeasure was established at T2. But it's a complex issue...the attractive features couldn't possibly solve the total product attractiveness problem. We got overtaken, we had to re-think.</p> <p>JA: Anything to do with RFT?</p> <p>M3: Is it right first time or a shortened development programme. If you haven't got it right its very hard to change, your assuming you're going to be right first time, not right second time. These features were applied them to overcome something missing. They mis-judged the level of the competition...they were taken by surprise. But you have to be careful, if you launch something too radical customers won't buy it.</p> <p>JA: When were the countermeasures finally introduced?</p> <p>M3: It was late by the time that things were formalised, getting on for T1 and then on the car by T2</p>	<p>Is it RFT or shortened development programme? If not RFT, it is very hard to change It has got to be right.</p>	<p>Introduction of the countermeasures was delayed by getting representative parts that people could judge. A possible countermeasure to earlier problems with non-representative parts?</p> <p>If it is not <i>right</i> it is very hard to change.</p>

APPENDIX

Interview No.3 Almera - Right First Time Pilot Plant – Build Purpose Change

Place: Nissan Manufacturing UK
Date: Tuesday 21st August 2001
Time: 4.00pm – 5.15pm

JA: John Austin

M4: Senior Engineer - Production Planning – Nissan Manufacturing UK
(Formerly Senior Engineer - Test Planning- Nissan Technical)

Transcript	Whiteboard Notes	Issues Raised
<p>Zone 1 <i>The concern was created.</i> <i>The concern should have been found.</i></p>		
<p>JA: [Presentation to explain the dissertation process]</p> <p>JA: When was the concern created? M4: I suppose at the planning stage. Then Pilot Plant was just a factory confirmation activity. In effect it was hidden to Design, whose actions were geared around the ET trial. Pilot Plant's purpose was to prove out the body tools prior to shipping. It was subsequently modified to include the major body fit parts, for example lights and bumpers. In the RFT schedule it became a limited vehicle build for body durability test cars. The production people saw this as an opportunity and latched on to it as another confirmation build.</p> <p>JA: Why did the factory want to change the schedule? M4: Manufacturing wanted to build full vehicles at Pilot Plant to gain additional process experience. And wanted countermeasure parts for them.</p> <p>JA: What caused the problem? There was no planning for the trial, it was outside the standard process. There were no vehicles specifications and no design control. The quality level of the vehicle went down because there was a mismatch of part levels. There was no system to confirm the part levels. Pilot Plant cars were visually worse than C-Lot! Different levels of part didn't fit together.</p> <p>JA: Why did the plan for Pilot Plant change? M4: The factory was strong, getting its way, Design fell in with this plan.</p> <p>JA: Was the plant's priorities an issue? M4: At Nissan we are always driven to achieve the schedule, and achieve the quality. Now there is much more flexibility to change.</p> <p>JA: When should the concern have been found? M4: In principle at the planning stage.</p>	<p>Pilot Plant was just a factory confirmation activity. Hidden to Design Manufacturing wanted to build full vehicles. Additional process experience wanted Outside the standard process. The quality level of the vehicle went down because part mismatch – diverted attention. The factory was stronger</p>	<p>An unplanned change in the schedule disrupted the project.</p> <p>Production wanted another iterative loop. They were unhappy with RFT because it didn't give them enough opportunities to prove the process.</p> <p>Poor quality prototypes distracted attention from key issues.</p> <p>The factory's opinion took precedence over design. They were stronger.</p> <p>The main priority was meeting the production launch date with the required quality.</p>
<p>Zone 2 <i>The concerns should have been found</i> <i>The concern was found</i></p>		
<p>JA: When was the concern found? M4: After C-Lot. For the first time on Almera, the C-Lot build used rapid prototype parts. They were OK for appearance checks but no good for workability or function checks because they just broke.</p> <p>JA: Why were they used? M4: They were used at C-lot to save cost and time in the process. The rapid prototype parts were breaking, plant reacted by wanting another iteration, a further build.</p> <p>JA: Are these parts unique to Nissan? M4: These rapid prototype parts were used elsewhere in the industry, but for aesthetic purposes, not vehicle testing.</p>	<p>Rapid prototype parts. OK for appearance but no good for function Used to save cost</p>	<p>Rapid prototype parts broke at the C-Lot build. They were unrepresentative and production engineers were unable to consider the process issues.</p> <p>Rapid prototype parts were used to save time and cost, but they were not functional, a key issue with the C-Lot build is functionality.</p>

APPENDIX

<p>Zone 3 <i>The concern was found</i> <i>The countermeasure should have been established.</i></p>		
<p>JA: When should the countermeasure have been established? M4: I suppose you could say that the countermeasure already existed, later on at ET. All the concern documentation raised at C-lot had planned resolution at ET. The factory now wanted the build concerns to be solved by Pilot Plant. JA: Wasn't an enhanced Pilot Plant a plus for Design? M4: NMUK's plan was to find the concerns and for them to be resolved for ET, but this resolution plan didn't fit with Design's schedule. It also disrupted the suppliers preparations for ET. Test vehicles were always going to be built at Pilot Plant but their level was unimportant. They were just latest level bodies that ran and could be durability tested. They were going to be built for test and the build issues ignored.</p>	<p>Countermeasure already existed, ET Caused disruption Some additional information.</p>	<p>NMUK's revised schedule didn't fit into the programme, but the build still went ahead. Pilot Plant effort caused a serious disruption to the programme.</p>
<p>Zone 4 <i>Countermeasure should have been established.</i> <i>Countermeasure was establish</i></p>		
<p>JA: When was the countermeasure established? M4: Depending on your definition, ET or Pilot Plant. At Pilot Plant NTC [Design] had to procure trial parts for the factory [NMUK]. They were reluctant to support because there were no processes. The factory was unhappy when there was no mechanism to control the delivery of parts. Several different levels of parts were shipped with no way of identifying which was which. The build still happened though. JA: And ET? M4: There should have been a retrospect review to analyse what they achieved with all this effort at Pilot Plant. At ET, miraculously the level of the car got better, and everybody patted themselves on the back.</p>	<p>Design procured parts for factory Neither satisfied Was it worth it? Unknown</p>	<p>The solution to the problem of parts procurement was unsatisfactory for both sides. The value of all this activity is unclear. ET was much better, but was it always going to be so?</p>

APPENDIX

Appendix 6

Nissan in the UK – A brief history



APPENDIX

Nissan in the UK

- In February 1984 Nissan and HM Government signed an agreement to build a car plant in the UK at Sunderland. In April 1984 Nissan Motor Manufacturing (UK) Limited (NMUK) was established.
- In July 1986 production of the first vehicle (the Bluebird) for commercial sales began.
- In 1990 Nissan stopped production of the Bluebird and launched production of its replacement model, the Primera. Annual production was raised from 100,000 to 120,000.
- In 1991 Nissan opened its European design centre, NTC, in Cranfield.
- NMUK production rose to 175,000 in 1992 with the launch of the Micra, which was voted European Car of the Year in 1993.
- In January 1995 NMUK produced its one-millionth vehicle.
- In 1995 NTC initiated its study into shorter development schedules.
- In May 1999 Renault purchased a 36.8% stake in Nissan to form a strategic alliance. Nissan had a significant presence in Asia and the US, Renault was strong in Europe.
- In October 1999 the Nissan Revival Plan was announced by Carlos Ghosn.
- In January 2000 the plant started production of its third model, the Almera, making it Britain's biggest carmaker for the second consecutive year.
- The NTC organisation employs around 400 people at its Cranfield offices. This includes Product Design, Development (Test), Product Planning and support staff.
- The NMUK organisation currently employs just under 5000 people in its Sunderland plant – approximately 4400 are within the Production department and 600 are indirect administrative staff covering the Production Control, Engineering, Purchasing, Finance and Personnel.
- The NE Marketing operation was in Amsterdam and is now reforming in Paris (with Renault) following the Alliance.
- The NTC organisation has a relatively flat structure with seven levels below director (from general manager to administrative assistant). The company philosophy is built around teamwork, flexibility, continuous improvement and communication.

APPENDIX

Appendix Seven

Nissan Press Releases

+

Samples of Press Material about RFT Design

reduce plant design time

Nissan has taken virtual reality head-on and incorporated it into the simulation of both car and plant designs.

A special suite is now available to designers at the company's European Technical Centre in Bedfordshire, which can be used to assess the impact of designs on both components and the manufacturing process. By employing all members of the design and manufacturing process, in a multi-disciplinary team, the company believes it can slash the development times of future automotive projects.

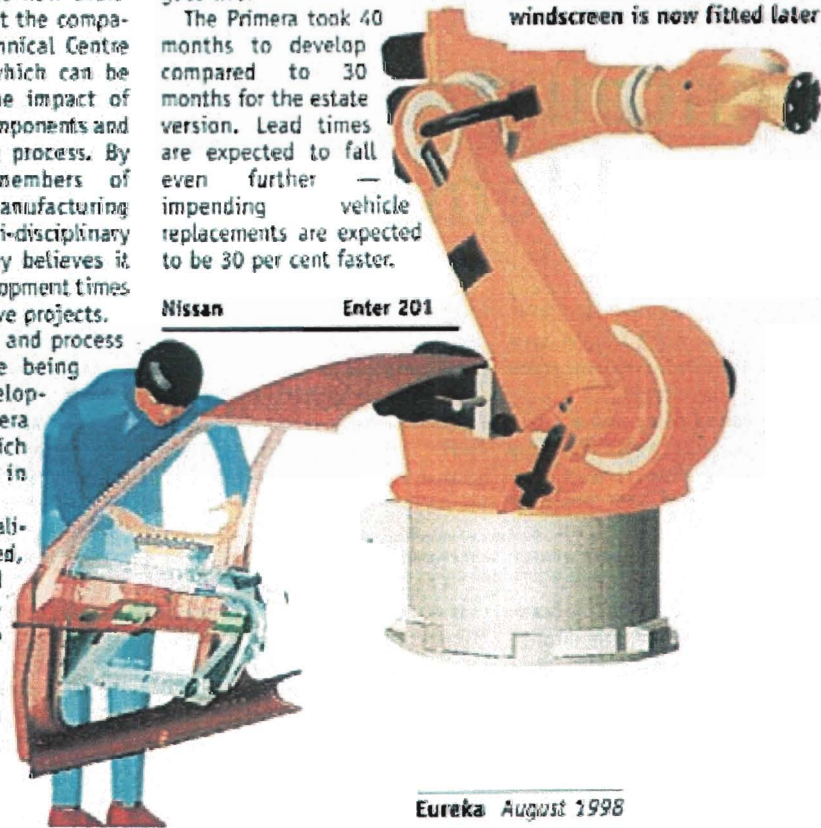
Both the design and process testing suites are being used on the development of the Almera replacement - which will be produced in the year 2000.

Before virtual reality was introduced, vehicle parts and production processes were subject to many changes before the optimum configuration could be reached.

With this new process, possible conflicts can be identified earlier in the design process and ironed out before any project goes live.

The Primera took 40 months to develop compared to 30 months for the estate version. Lead times are expected to fall even further - impending vehicle replacements are expected to be 30 per cent faster.

Nissan's 'virtual factory' sees potential problems. In this case, fitting an airbag module meant workers hit their heads on the windscreen - so the windscreen is now fitted later



Nissan Enter 201

From conception to birth, virtual reality creates immaculate cars

THE first Nissan car designed using virtual reality will roll off the production line some time in 2000, setting a new record for the shortest development time of any mass-production car the Japanese giant has ever built.

The new Almera is expected to come out of the Nissan plant in Sunderland after just 25 months of design and testing, beating the company's previous best - the Primera Estate - by six months.

The difference between the two models is the amount of virtual reality used along the way. With the Primera, VR was used to turn the existing saloon into an estate. With the new Almera, the designers have started from scratch, employing VR techniques to conceive, design and test the car. Even the production line will be built using virtual reality to help Nissan's manufacturing engineers create the perfect production line.

"It used to take around five years to develop a car with traditional techniques," explains Andy Palmer, who runs the vehicle design and test department at Nissan's European Technology Centre in Cranfield, near Milton Keynes. "Now it takes around 40 months, and we need to reduce that time even further. Customers are changing their demands and if we can reduce our lead times we can respond even quicker."

The centre has been using VR techniques for the past year, and has set itself ambitious targets for increasing productivity and reducing development times by harnessing the power of VR.

The Primera Estate was built in 31 months, the Almera is expected to take 25, and within

a few years, Palmer believes the time from conception to birth could be as little as 12 months.

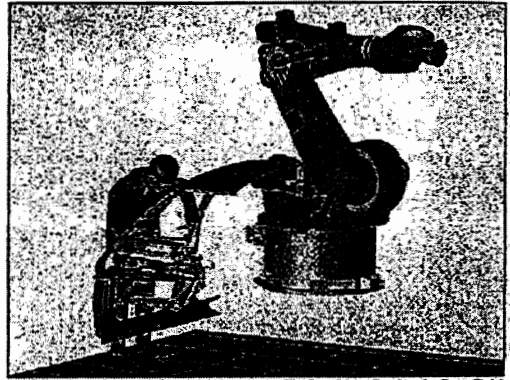
Such dramatic savings in time come through using VR to take out the "design-test-modify" steps that motor manufacturers have used since the Model T rolled off the production line in 1913.

"We can get things right the first time and this will reduce the design problems by 80%, so we can eliminate all but the final trial build," Palmer says. By combining 3-D modelling with virtual reality techniques, the designers can create components for the car and check that they fit in with what's around them. Potential clashes are spotted immediately and rectified simply by tweaking the design in the computer.

Previously, such problems were not usually spotted until a prototype had been built from the design blueprints. The designers had to go back to the drawing board so a new prototype could be built. This could take weeks, or even months, Palmer says.

Apart from cutting down on time, computer-aided design helps to reduce manufacturing costs because the 3-D models can be used to create the moulds that are used to make the parts.

Although such techniques have been used for the past few years, VR helps to speed up the design process by making it easier for designers to collaborate. Each designer uses 3-D modelling software, but views it on a 2-D screen most of the time. By donning a special set of glasses, which alternately blank the left and right lenses, they enter the VR world: the 3-D effect is generated by



A virtual worker at Nissan's European Technology Centre in Cranfield

flashing up separate left- and right-eye perspectives in time with the blanking of the glasses, and the designer's brain is fooled into combining the images of both eyes to form a single picture with depth and perspective.

Nissan's designers regularly meet in a specially equipped room to view the same image at the same time and discuss modifications that need to be made.

The VR system will also be used to design the production line on which the Almera will be built. Assembly techniques can be tested using 3-D models of the car and production machinery, while computer-generated humans are programmed to perform simple tasks, such as fitting parts.

"When you've got robots and people working together you have to be sure you have sufficient clearance," Palmer says. He cites the example of an airbag

module being fitted into the car's dashboard. An animated VR model revealed that the windscreen got in the way of the virtual worker's head as he leaned down to fit the part. Engineers watching the simulation in the viewing room quickly realised that the solution was to fit the airbag before the windscreen.

Before VR, they would have stood around a specially built pilot assembly line with a model car and watched a real engineer try to fit the airbag. Palmer says: "It would have been 12 months before we realised there was a problem, but with virtual reality it took about three days."

"The aim is to find ways to make assembly as easy as possible. The easier a car is to assemble, the higher quality and more reliable it will be, and the less time it will take to produce."

CARL FRANKLIN

How to gain without pain

The production line worker in his neat blue overalls picked up an airbag assembly ready to fit into the dashboard of the Nissan Primera.

As the car moved almost imperceptibly along the line, he put his arms out to line up the assembly with the correct aperture in the frame of the car. Then he leaned forward and cracked his head against the windscreen.

His head and the screen turned red to indicate the impact but he didn't recoil in pain. For this was a virtual worker in a virtual factory, not at the company's plant in Sunderland but at Nissan's European Technology Centre (NETC) at Cranfield, Bedfordshire.

His image was generated on a screen in a room off what would once have been called a drawing office and I was looking at his efforts to insinuate the airbag assembly into the unreachable dashboard through a pair of virtual reality spectacles.

He wasn't a totally convincing specimen of mankind, but his joints articulated in an unmistakably human way. What's more he was programmed to signal not just conflict with his surroundings but to avoid painful twisting movements, any actions that might

lead to repetitive strain injuries (and legal actions) or any other motion that would fall foul of company or Government health and safety regulations.

The use of Computer Aided Design (CAD) techniques in cars has been around since the 1970s. Its ability to translate the stylist's pen into an engineering drawing has helped cut the development time of new models from up to seven years to less than three years.

But the Nissan simulation showed how, with the help of virtual reality, not just the car but the whole production line could be built and assessed in virtual form before anything was installed at the real factory. The answer to our virtual pal's headache was simple: the robotised arm that positioned and sealed the windscreen was

moved down the line. So at the point where the airbag was fitted there was no screen to bump his head against.

In the "old days", 25 per cent of development time was lost on assembly problems and 15 per cent through component failures. Prototypes were built by hand before any testing could take place and production sequences could be assessed only on full-scale factory mock-ups. The use of virtual reality can eliminate 80 per cent of those time losses and tests can be carried out for a fraction of the cost in a fraction of the time.

Andy Palmer, general manager for vehicle design and testing, says: "The aim of the virtual factory is to make assembly as easy as possible. The easier a car is to assemble, the higher quality and more reliable it will be and the less time it will take to produce."

The virtual reality suite can marry components from different CAD systems to build the virtual factory. While the virtual workers are off-the-peg models, the car was constructed on Nissan's own system, the airbag assembly had been e-mailed in from the component-supplier's system and the robotised arm came from another supplier's system. The virtual factory is based

on a tool set from software company Tecnomatrix, while the work stations for both factory and testing facilities are Hewlett-Packard C200 machines, with about ten times the power of a top-of-the-range personal computer. The whole facility can be linked to a Cray supercomputer to provide the huge power required for simulating stress-testing of components, something previously only possible through the destruction of expensive, hand-built prototypes.

But the virtual factory is far from the end of the line.

The next step is to combine virtual reality software with holograms to produce computer-generated prototypes which engineers can walk around, or perhaps at a later stage sit in and even drive.

'The aim of the virtual factory is to make car assembly as easy as we possibly can'

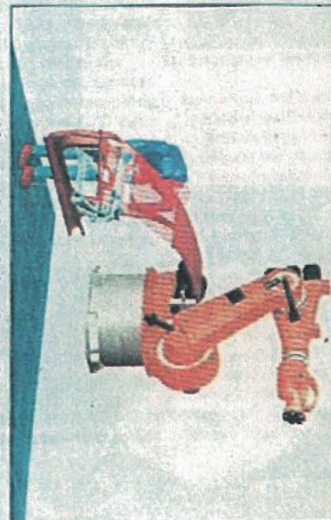
The robot fits the windscreen



The worker prepares to fit the assembly ...



...and bangs his head sharply on the screen



A virtual car factory can build and assess everything before reality takes over. Alan Coppis looks at a smart future

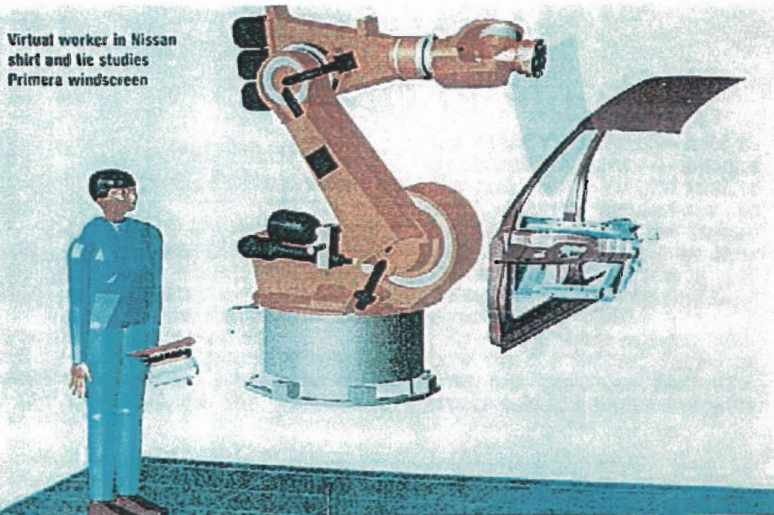
Inter//face//

The Krypton factory

TECH ANALYSIS VIRTUAL FACTORIES Nissan's engineers will soon use virtual reality to help them save time and money by solving complex production problems before they arise

Computer-aided design (CAD) is old hat in the car industry. But Nissan has developed the process so that it can be used to design not just cars but also the production lines that build them. This way, Nissan can spot manufacturing problems before they arise, potentially saving millions of pounds in the process. Things have moved on from the Disney-style animation used by Ford to fashion the Puma, Cougar and Focus. Now, the virtual factory has arrived. Engineers at the Nissan European Technology Centre in Cranfield in Bedfordshire are finishing work on new virtual reality (VR) systems which enable production line processes to be simulated. The simulations use virtual models,

Virtual worker in Nissan shirt and tie studies Primera windscreen



3D is moving on from system used by Ford for Focus

Virtual robots and virtual employees - neatly dressed in the standard Nissan blue shirt and tie worn by real workers, drawing on a database of existing CAD information, Nissan can animate a virtual production line to highlight problems in various processes. Without the new technology, the job of working out the correct sequence of events for production line can be a

nightmare. Some components have to be fitted before others, in ways that are often far from obvious. For instance, a process might seem perfect until the simulation reveals that it is impossible to remove an airbag module from a dashboard once the windscreen is in place, or that assembly line workers will bang their heads.

The same software can be used to check the practicality of components like the reversible tray in the boot floor of the Nissan Primera estate. The simulation is a "reach out and touch" 3D experience that allows the clearances to be checked in VR.



Flaw revealed as worker hits head

The virtual reality tag was first applied to systems in which users wear fully enclosing headsets, allowing them to see and interact with a virtual world. The Nissan system is better described as animated, an idea pioneered at the movies decades ago. Then, cinema goers would don 3D glasses enabling them to get involved in the action. Now, Nissan's engineers can, 10 at a time, do something similar with Crystal Eyes stereo projection glasses from Stereo Graphics in California.

Images are projected onto a screen by a Hewlett Packard C200 personal computer fitted with an FX6 graphics adaptor,



Computer fills in rear light details

500Mb RAM and 9GB hard drive. Nissan reckons the PC has 10 times the power of the average desktop PC. It needs it. Pulling the massive files across a network and modelling stereo images is a hefty task, so the animation happens slowly. But it's effective. In the simulation,



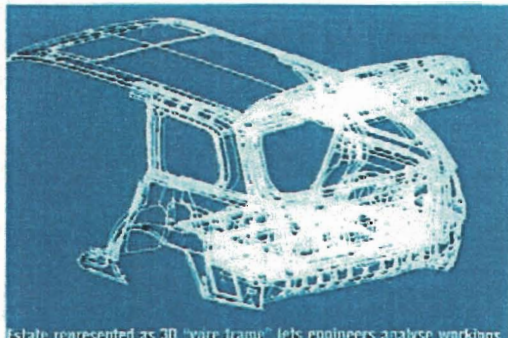
Development times will speed up

areas turn red if parts interfere with one another or fail to fit.

Nissan buys in software products including IDEAS Master Series from SDRG Ltd, the CAPE tool set from Technomatrix and the Dynamo virtual modelling suite.

Virtual testing of this sort matters because it produces tangible results. The Primera took 40 months to develop and the Primera estate 30 months. Those times are expected to fall by 30 per cent, so future models will have development times of just 20 months.

Jesse Crosse



Estate represented as 3D "wire frame" lets engineers analyse workings

APPENDIX

Evening Standard West End Final

23 June 1998

Page 19

It's virtually a whole new way of motoring

BRITISH scientists have "driven" the world's first virtual car in a breakthrough that has far-reaching repercussions for the global motor industry.

Nissan announced today that it had "built" a complete family hatchback at its virtual reality laboratory near Luton.

Engineers wearing 3D eye-sets can see and "touch" models destined for UK roads years before they have been built at

by **DAVID WILLIAMS**
Motoring Correspondent

land. They can switch on headlights to see if they illuminate the road ahead, turn on air-conditioning to ensure cold air reaches the driver and check doors are a close fit.

Using techniques undreamt of a decade ago, Nissan can check windcreens for reflections

the vehicle's designs — held in a computer memory — become the real thing. Virtual reality even allows engineers to "drive" the car of the future over rough roads to see how the suspension performs and turn on the wipers to see if they clear "virtual" rain.

By using their unique window on the future, they can iron out problems that routinely cost the motor industry

SUNDERLAND ECHO

9 July 1998

Future Nissans designed by virtual reality

NISSAN designers can now build a new car without setting foot in a factory. Once built they can then switch on the car's air conditioning, without any air, and try out its headlamps without any bulbs.

This is the world of virtual reality which is set to transform the development of new cars, and Nissan is leading the way.

Virtual reality technologies are being used in the development of the Almera-replacement to be produced at Nissan's Sunderland factory in the year 2000, and were also used in the development of the Primera Estate which entered production early this year.

By drastically cutting development time virtual reality will lead to the faster appearance of new models designed to even higher reliability standards.

At Nissan's technology centre in Cranfield, computer-generated virtual cars are assembled from virtual components using virtual robots and virtual manufacturing staff. Engineers wear 3-D eye-glasses to see a virtual production line and experiment with different ways of arranging the machinery. This ensures that when the production line is really built it will be set up in the simplest and most efficient way. Before virtual reality, engineers had to build full-size pilot production lines. Now, a working design can be produced in a fraction of the time, and at a fraction of the cost.

"The aim of the virtual factory," explains Andy Palmer, NETA's chief engineer of vehicle test and design, overseeing the project, "is to find ways to

By LES OLIVER
Motoring editor

make assembly as easy as possible. The easier a car is to assemble, the higher quality and more reliable it will be, and the less time it will take to produce."

As well as discovering the most efficient way of manufacturing, Nissan's virtual technology uses virtual people to simulate the actions of manufacturing staff. Engineers can take measures to avoid health and safety concerns such as excessive bending and other health and safety hazards.

The use of virtual reality also extends to testing the reliability and durability of vehicles and components before they are actually built. This means that vehicles can be tested faster without compromising higher quality standards. Actual components are still used, but increasingly these tests will simply confirm computer predictions. For example, virtual headlamps can be tested in a number of computer-generated weather conditions, and the interior of a car can be simulated to make sure that there is no distracting windscreen glare from rain and fog during night-time driving. Virtual reality can also find the most effective flow of air from a car ventilation system, and even be used to fine-tune suspension by driving virtual cars over a selection of grueling virtual road surfaces.

The time to develop new models is falling all the time and this rate will increase as the effects of virtual reality are felt. The Primera Estate, launched in January, took 30 months, the Almera-replacement is expected to take 30 per cent less, with future development time expected to be 20 to 30 months.

APPENDIX

Appendix Eight

Nissan Definition of HS Platform

APPENDIX

Appendix Nine

HS Supplier Explanation – Including First Concepts of RFT Design

APPENDIX

Appendix Ten

Extracts (Censored) from a Typical Planning Drawing Analysis

APPENDIX

Appendix Eleven

Output from Recent Intranet Based “Engineers Handbook”

APPENDIX

Appendix Twelve IQPC Presentation Material Extract

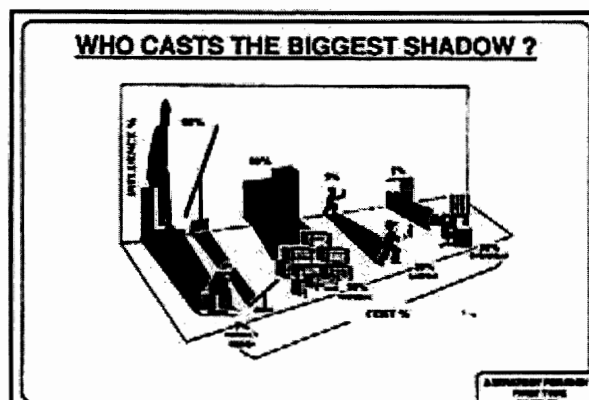
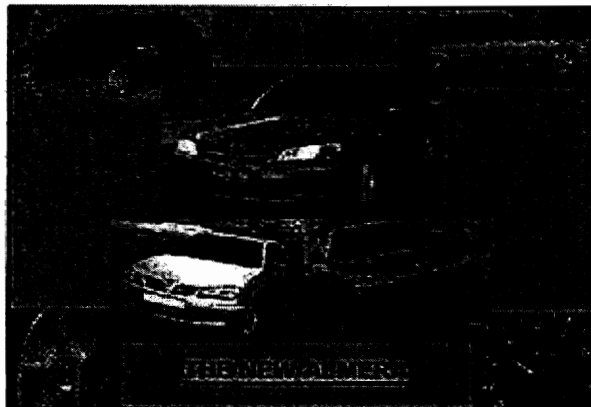
APPENDIX

A STRATEGY
FOR
RIGHT FIRST TIME

**IMPROVING DEVELOPMENT EFFICIENCY THROUGH
OBJECTIVE MEASUREMENTS AND LOGICAL STRATEGY**

Presented by
Mr. Kevin Puddephatt - Nissan Technology Centre Europe

A STRATEGY FOR RIGHT FIRST TIME
PAPER TYPE
10/00/00



APPENDIX

DEFINITION OF RFT






**RIGHT FIRST TIME TARGETS ZERO DESIGN CHANGE
AFTER MAKING THE INITIAL PRODUCTION RELEASE.**

A PRODUCT DEVELOPMENT
PANEL ITEM
10-02-02

NISSAN DEVELOPMENT PROCESS

A PRODUCT DEVELOPMENT
PANEL ITEM
10-02-02

NISSAN TQM TENETS

1. SET CLEAR TARGETS 
2. MANAGE USING FACTS 
3. IMPROVE COMMUNICATIONS 
4. USE THE P.D.C.A CYCLE 
5. STANDARDISE BEST PRACTICE 

A PRODUCT DEVELOPMENT
PANEL ITEM
10-02-02

APPENDIX

DEFINITION OF RET

THE FINAL TARGET WAS AN 80% REDUCTION IN THE NUMBER OF POST PRODUCTION DESIGN NOTES. (COMPARED TO A PREVIOUS PROGRAMME)

ARMSTRONG CONSULTANTS
PART 2006
10/01/06

"REDUCE DEVELOPMENT COST BY 40%"

- Graph depicts 'M Primary company budget

- BUT, how can 40% reduction be achieved?

ARMSTRONG CONSULTANTS
PART 2006
10/01/06

"LESS DESIGN CHANGE EQUATES TO LESS DEVELOPMENT COST"

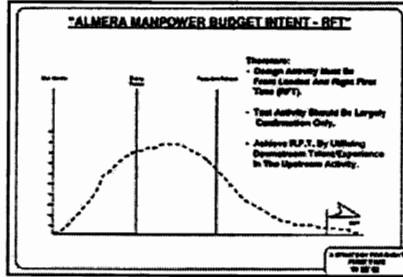
Development Resource Usage Strongly Correlated With Design Note Issues

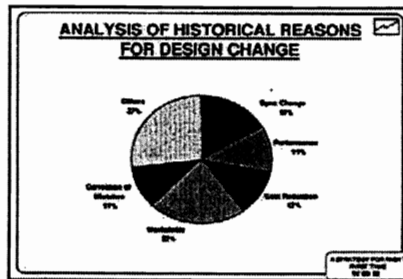
60% Reduction in Design Change Red 6 Month Post-Project Expense To 20% reduction in resources

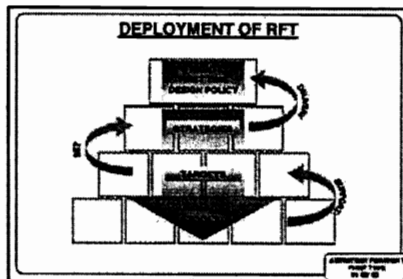
- Of Course Resource Profile is Important

ARMSTRONG CONSULTANTS
PART 2006
10/01/06

APPENDIX







APPENDIX

THE CURRENCY OF RFI

$$\frac{\text{TOTAL COST OF DESIGN CHANGE}}{\text{TOTAL NUMBER OF DESIGN CHANGES PER PROGRAMME}} = \text{AVERAGE COST PER DESIGN CHANGE}$$

A REPORT FROM THE
W D C

TACTICS AND TOOLS DEPLOYED

- SIMULTANEOUS ENGINEERING
- COMPONENT PLANNING DRAWINGS
- DESIGN REVIEWS
- COMPUTER AIDED PRODUCTION ENGINEERING
- OTHER TOOLS (TOTAL 34)

A REPORT FROM THE
W D C

TACTICS AND TOOLS DEPLOYED

W.D.C.	W.D.C.	W.D.C.	W.D.C.
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36

A REPORT FROM THE
W D C

APPENDIX

THE RESULTS AT "START OF PRODUCTION"

Primary Measure -
DESIGN CHANGE REDUCTION

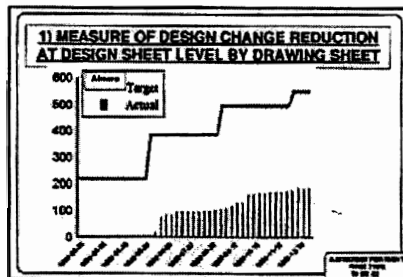
APPROVED FOR RELEASE
DATE 10-10-82

PRIMARY MEASURE:

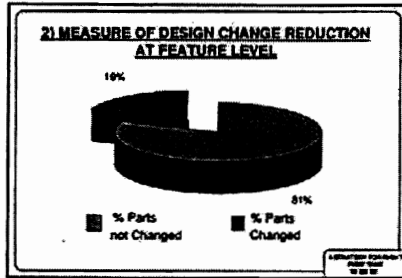
A "DESIGN CHANGE" CAN BE CONSIDERED AT 3 LEVELS:

- 1) BY DRAWING SHEET : A DESIGN NOTE CAN BE SUB-DIVIDED BY DRAWING SHEET WITH ALL CHANGES ON THAT SHEET BEING COMBINED AS ONE BATCH
- 2) BY FEATURE : INDIVIDUAL DIMENSIONAL OR FEATURE IS DETAILED BY DRAWING ISSUE LEVEL ON THE DRAWING
- 3) BY DESIGN NOTE : ONE DESIGN NOTE CAN RELEASE A "PACKAGE" OF CHANGES FOR ANY GIVEN SYSTEM

APPROVED FOR RELEASE
DATE 10-10-82

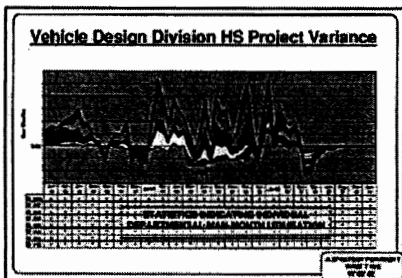


APPENDIX

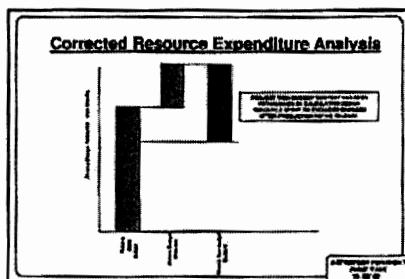


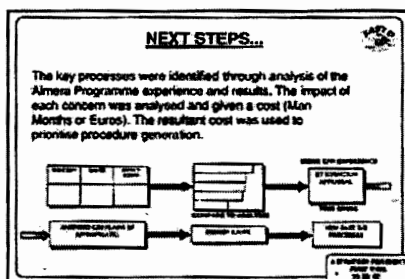
RESOURCE ANALYSIS

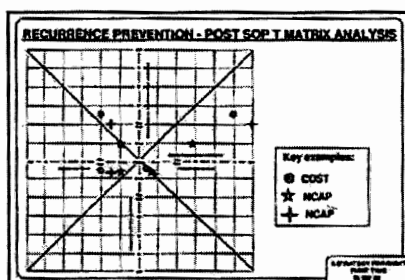
Small text in bottom right corner: © 2000 GM Corp. All Rights Reserved. 10/00



APPENDIX







APPENDIX

ALMERA CONCLUSIONS

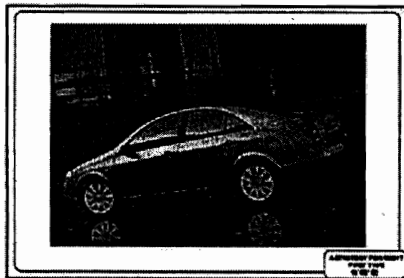
- ACHIEVED 80% REDUCTION IN NUMBER OF DESIGN NOTES WITH AN "AGREED" LEVEL OF RESOURCE
- NEED TO ENSURE FUTURE RESOURCE NEGOTIATIONS REVOLVE AROUND "REALISTIC" MEASURES

ALMERA PROJECT
PAGE 100
10/00

NEXT PROJECT – 'New Primera'

KNOWING WHY DESIGN CHANGE OCCURRED ON THE ALMERA GAVE US THE CONFIDENCE TO IMPLEMENT STRATEGIES THROUGH THE HOSHIN KANRI TO IMPROVE DEVELOPMENT EFFICIENCY ON THE NEXT PROJECT BY AN ESTIMATED FURTHER 30%.

ALMERA PROJECT
PAGE 101
10/00



ALMERA PROJECT
PAGE 102
10/00

APPENDIX

DEVELOPMENT IMPROVEMENTS

- Eliminate prototype builds to reduce development time.
- Communication improvements – information speed and reach.
- Reinforce best practice from Almera project.

A simulated environment
PAGE 7/10
10/01/02

Elimination of Prototype Builds

- Use IT to enable virtual builds.
- Make digital mock-up an integral part of the development process.
- Increased use of simulation tools (CAE).

A simulated environment
PAGE 7/10
10/01/02

Communication

- Cross functional teams.
- Development team in Japan during early stages of development.

A simulated environment
PAGE 7/10
10/01/02

APPENDIX

Best Practice

- Establish Engineer's portal – access to information.
- Engineer's handbook.

APPENDIX F
PAGE 108
10/10/10

CONCLUSIONS

- RFT is an important strategy to improve development efficiency.
- RFT should be planned using TQM principles.
- Several iterations to the process may be required.

APPENDIX F
PAGE 108
10/10/10

APPENDIX

Appendix Thirteen

FASTD Explanation Table & Relationship Diagram

APPENDIX

Appendix Fourteen

Financial Times – World Automotive Manufacturing Article

FINANCIAL TIMES

WORLD

AUTOMOTIVE

MANUFACTURING

Essential Monthly Analysis of Key Trends in Vehicle Manufacturing

Issue No.15 July 1999

In this issue

Interview: Nissan European Technical Centre
 FT WAM finds out about Nissan's Right-First Time design philosophy

Fuel cells
 If fuel cells are taken up as quickly as some manufacturers are forecasting, what will be the impact on the powertrain manufacturing industry? Jeff Daniels develops the scenario

Flexibility
 New robots are key to more flexible body shops, Anna Kochan reports

Redesigning cars for Japan
 Steve Sady reports on re-working of European vehicles for the Japanese market

e-Commerce
 QAD's vision of the impact of e-Commerce on vehicle manufacturing

Rover Oxford
 Susan Brown visits the all-new Rover Oxford plant

Data
 The Harbour Report North America 1998 - full details inside

Financials
 Latest vehicle manufacturer financial results



FINANCIAL TIMES
 Automotive

Renault/Nissan alliance starts work

CARLOS GHOSN, THE NEW CHIEF operating officer of Nissan (as of 1st July), has announced that he is committed to outlining a turnaround plan for Nissan by the time of the Tokyo Motor Show in October this year. Speaking to an audience in Berlin, he explained that there has been two months of emotion, but he has been listening to people and that he is sure that the solutions are inside the company. "People are lucid about what has to be done" he said.

Ghosn confirmed that common platforms are under consideration and, while it has not yet been officially decided to base the next Micra (or March as it is called in Japan), and the next Clio and Twingo on the same platform, he would be very surprised if it did not happen.

For the two companies Ghosn cited four basic actions as essential for future success:

- Making the customer a core concern
- Reducing costs, while at the same time improving innovation, quality and delivery time
- Introducing new management styles
- Growing internationally - true to a long-term vision.

These four basic actions are already visible at Renault and Ghosn will see them introduced at Nissan. Ghosn is credited with the success of Renault's recovery programme launched in 1997, and this is why he has been chosen to turn Nissan around.

To support the long-term vision of the alliance new structures have been set up to promote communication and synergies between the two groups.

Renault and Nissan held their first joint Global Alliance Committee (GAC) meeting in Paris at the beginning of June. The com-

mittee is the senior management body of the Renault/Nissan partnership and will meet once a month alternating between Paris and Tokyo or by video-conference. The meetings will be chaired by Nissan president Yoshikazu Hanawa and Renault chairman Louis Schweitzer. Five other Renault and five other Nissan senior executives sit on the

While it has not yet been officially decided to base the next Micra and the next Clio and Twingo on the same platform, Ghosn would be very surprised if it did not happen

committee. The next meeting takes place in Tokyo on July 28th.

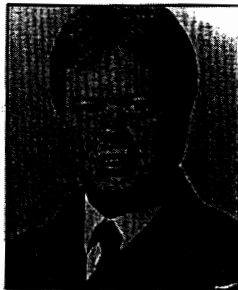
In addition to the Global Alliance Committee several other bodies have been set up. Eleven Cross-Company Teams (CCT) are being created to promote all possible synergies between the two partner companies. The teams report to the GAC and cover the following areas:

- Product planning and related strategies
- Powertrain
- Vehicle engineering
- Purchasing and supply
- Japan
- Asia/Oceania
- Mexico/Central America
- South America
- Europe
- CIS/Turkey/Romania/North Africa
- Middle East/sub-Saharan Africa block

The work of the GAC and the CCTs will be

Key to Nissan's productivity: Right-First-Time design

The new Almera due to emerge from Nissan's UK Sunderland factory next year could easily have been produced in Japan had it not been for the efforts of Andy Palmer to make major time and cost savings at Nissan's European Technology Centre in the UK. **Anna Kochan** interviewed Andy Palmer about the techniques he employed



ANDY PALMER IS GENERAL MANAGER of vehicle design & test at Nissan's European Technology Centre (NETC) in the UK. In order to 'win' production of the new Almera from Japan, Palmer's team had to make a commitment to achieve stringent cost and time targets. Specifically, this meant reducing the cost of bought-in piece parts by 34 percent, shortening the development cycle time by 30 percent, and cutting the cost of development by 40 percent, compared to the Primera, the previous model developed in the UK. To achieve these goals, the NETC initiated a five-year project to develop a Right First Time (RFT) design methodology which is due to conclude next year - at about the time that the new Almera arrives, hopefully on time, in the showrooms.

According to Andy Palmer, the theory of Right First Time is that, once the design of the car is finalised and released for production, no design changes should be made. With each design change costing Nissan an estimated £13,000, and the number of changes running into the thousands, the potential benefits are enormous.

Though the theory of eliminating design changes is good, he accepts that it is somewhat unrealistic and inflexible, in practice. "Late specification changes may be necessary to satisfy the customer," he explains. So, instead of setting a target of 100 percent reduction in post-production design changes, the target was set at 80 percent. This,

in any case, would provide the required 40 percent reduction in development cost, he estimates.

The RFT methodology is largely based on analysing masses of data collected during the Micra and Primera development programs to pinpoint exactly when design changes were made, as well as the source of the change and the reason for it. According to Palmer, this data is one of Nissan's great strengths. "It is easy for the data to be lost. What you need are rigorous systems for recording and maintaining the design change data and then for accessing the information and bringing it back into the development process," he emphasises.

The RFT methodology also involves specifying tactics and tools, and setting objectives to tackle the causes of the design changes. One tool which Palmer brought in during the course of the Almera programme and which has shown great potential for reducing design changes is computer-aided production engineering (CAPE).

The theory of Right First Time is that, once the design of the car is finalised and released for production, no design changes should be made

CAPE, says Palmer, played a large part in reducing workability concerns on the Almera. "When we analysed the data for past models, we found that workability concerns were the single most frequently-cited reason for a design change, accounting for 22 percent of changes," he explains. They often relate to assembly problems when parts are difficult or impossible to fit. They can also occur because a part gives rise to a repetitive strain injury.

The CAPE tool Nissan selected for its European operations, and since adopted in Japan, is the Tecnomatix suite of software. The choice was based partly on the software's connectivity with CATIA, a design software widely used among the supplier community, and with IDEAS, the design software being comprehensively adopted throughout Nissan.

But also important, says Palmer, was the ability of the Tecnomatix tool for projecting design data in virtual reality. "It is very important to use this facility during design reviews. Usually, we only project in two dimensions though when suppliers come in who are not familiar

"Usually, we only project in two dimensions, though when suppliers come in who are not familiar with the way the whole vehicle goes together, it is very helpful to do a 3D projection, just for ten or 15 minutes"

with the way the whole vehicle goes together, it is very helpful to do a 3D projection, just for ten or 15 minutes" he adds. "It just helps them understand the perspective of the drawings."

The CAPE tool helped remove design changes from three main areas that had historically been problematic: the front end, the forward cockpit area and the rear trunk area. It was used, for example, to model the assembly process involved in mounting parts such as seats, instruments panels and steering wheels. Palmer reports that the results have been highly satisfactory. He says that studies show that if the software had been brought in at the start of the Almera programme, it would have removed 75 percent of workability concerns. As it was, it succeeded in eliminating 67 percent of them.

As NETC continues to develop the application of the CAPE tool further in vehicle development, Andy Palmer is hoping to reduce the number of prototype vehicles that need to be physically built. "If you take out a build stage, you reduce your master schedule by three to six months," he estimates. The plan, he adds, is to specify as part of the master schedule, that, at certain times during the development, the CAD models will be available and the trial engineer will do a virtual build, in the same way that real builds are done at the moment. "We have already done virtual builds but they will now become a formal part of the development process," he says. The current thinking is to incorporate three virtual build phases in the schedule, though this has not been formally agreed as yet.

A reduction in prototype tooling is also part of the time-saving effort being made for future vehicle development programmes. "We are looking at our design change history to identify components where we feel that we have sufficient knowledge to go directly to a

production tool," Palmer says. This will not be possible in all cases because the cost of a change, if needed, can be extremely high. In those particular instances, rapid prototyping technologies might be a means of providing a more cost-effective approach, he believes. "The best decision might be to make a tool using rapid prototyping technologies. This would be a cheaper approach and would allow quicker design iteration," he suggests. Stereolithography could also help for body fitting parts, such as around the headlamp, where there is interaction between several body panels and where an accurate fit is imperative, he adds.

Palmer's challenge for the future is to reduce cost still further, but also to reduce weight. "Cost and quality have always been important for us. Now, because of environmental factors, weight is also becoming a focus of attention," he says.

The concern about weight opens a great window of opportunity for Nissan's European subsidiary and its partners because, although steel technology is very advanced, lightweight automotive materials such as plastics and aluminium are very expensive in Japan compared to Europe. Palmer is hoping to create a centre of expertise around lightweight materials at the NETC and to work on new solutions with European suppliers which can be passed on to the

Palmer is hoping to create a centre of expertise around lightweight materials at the NETC and to work on new solutions with European suppliers which can be passed on to the Japanese parent company

Japanese parent company. This is, in fact, already starting to happen. Plastics technology developed in Europe for a European-built Nissan vehicle is to be adopted for a Japanese-built one. No decision has yet been finalised about whether the supplier will set up production facilities in Japan or ship the parts from his European plant.

One Nissan supplier currently shipping product from Europe to Japan is Valeo for headlamps. "Even with the cost of shipping, we have developed a headlamp in Europe whose cost and performance makes it appropriate to be used in Japan," Andy Palmer reports. ■

APPENDIX

Appendix Fifteen

Collaborative Automotive Design and Product Development Presentation

APPENDIX

Appendix Sixteen

July 2002 – Automotive News Europe – Latest Leadtimes

Car development is faster, but delays are common

Automakers appear more willing to slow the pace to ensure excellence for critical new models

EMANUELE CARO
AUTOMOTIVE NEWS EUROPE

Carmakers are accelerating product development to save time and money and get hot products to market as fast as possible. Shorter schedules are critical. Customer preferences change rapidly and new segments are emerging. But for a variety of reasons several new-model programs have recently been delayed.

The trend is clearly toward faster development. Electronic tools, for example, have enabled carmakers to bring projects to a much higher level of maturity before cutting metal. That reduces the number of prototypes that are needed and shortens development time.

Volkswagen saved five months on the new Polo through greater use of digital mockups.

Volvo's speedy development of the XC90 sport-utility owed much to new technology.

"We worked totally with competitors," said Hans Wilman, vehicle line manager for the XC90 project, with "more or less no last-car series."

Die cutting lead times have long been a bottleneck. But Oxford, England-based technology company Novare, for example, is working on sprayforming techniques that promise to radically cut tooling production time.

Currently, tools of up to \$600 x 800m can be produced by sprayforming. Novare, backed by Ford and Oxford University's technology transfer company Isis Innovation, expects that sprayforming will eventually lead to big savings in time and cost for tooling.

Recently some new-car launches have even been pulled forward. The

Mercedes-Benz E class was scheduled for launch in May or June 2002, but was then pulled forward to February.

Ford brought forward the launch of the Fiesta as part of Ford's European restructuring.

But at the same time program delays are becoming more common. For one thing, the new tools have not always met expectations.

Yves Dubreil, program manager for Renault's large-car range — the Laguna, Vel Satis and Espace — said the performance of Renault's computer development tools was a disappointment and a factor behind the delayed launch of the Laguna.

Laguna went on sale in 2000 but "the process with the prototypes was not as efficient as we supposed," said Dubreil.

The Laguna finally arrived five months behind schedule.

Though time to market is important, it continues to take second place to other objectives.

The Vel Satis launch was delayed by the decision to build Nissan's V-6 engine into the program, said Dubreil. But he said the engine was critical to the Vel Satis project.

Several European carmakers have had to delay launches to allow them to modify new models.

In two extreme cases, Ford and Volkswagen scrapped their first programs aimed at the booming small SUV market. Midway through the projects it became clear that they would not match competitive benchmarks.

Audi recently killed its A6 replacement and began over a fast.

The benefits from a late introduc-

Some major program delays

Caraker	Model	Delay
Audi	A6	More than a year
Lancia	Theta	2 years
Mitsubishi	Spyder	1 year
Porsche	Cayenne	9 months
Renault	Laguna	5 months
Renault	Vel Satis	5 months
Renault/Espace	Espace	6 months
Volkswagen	Polo	5 months

tion are much smaller than the potential losses from getting a mainstream model wrong.

Auto companies aim for rapid development, but at the same time try to introduce more innovations. More complex high-end cars tend to take more time to develop.

Carmakers appear to be more willing to slow the pace to ensure excellence on small volume, up-market niche models.

Development times can also be stretched when carmakers enter a new segment or are engineering a particularly critical model.

The new Phaeton, Volkswagen's first car in the luxury class, took almost five years to bring to market.

"It was a 100 percent new product with new technical systems everywhere," said Wilhelm Werneck, the Phaeton's project manager.

Volkswagen also placed special emphasis on production training to make sure that quality levels were achieved, since the new car is being assembled in a new plant in Dresden, Germany.

Quality concerns have been a major factor slowing the ramp-up of mass-market models. Another has been the volume of products coming down the pipeline. Companies look for suitable launch windows and try not to overwhelm their distribution networks with too many products.

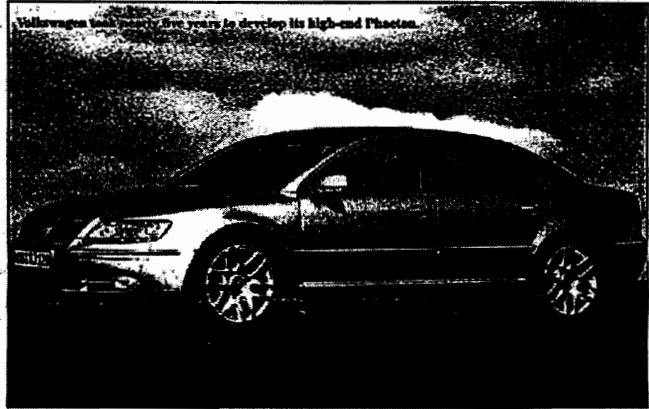
Launches across several brands have to be staggered. The new Seat Ibiza reached the market two years after the Fabia, the first car to use the Volkswagen group's PQ34 small-car platform.

Audi has had to delay the launch of its A8 replacement by more than a year so that it doesn't clash with the launch of the Volkswagen Phaeton.

Product modification is another cause of holdups. The Renault Avantage, codeveloped with Matra, was changed when clients suggested that the car should be positioned higher than initially planned.

Rapid-fire launches can also be difficult for assembly plants to manage. Dubreil says Renault's experience is that a plant must leave a six-month gap between new product launches.

Dubreil says it is difficult to do one car right after another because a launch requires a lot of commitment and extra time sacrifice at the plant.



Volkswagen took nearly five years to develop its high-end Phaeton.

Time from design freeze to Job One varies greatly

Carmakers still vary significantly in the amount of time that they take to get new cars ready for the market. But the trend is to shorter development times.

BMW

The 7 series went from design freeze to start of production in just 34 months. Given the car's high level of technology, the program team considers it a remarkable achievement.

The Mini's development was slower. The project began in September 1997, basic styling was fixed in 1997 and the start of production was in April 2001. But the program took place in turbulent conditions. BMW said the bulk of Rover's assembly operations and changed the assembly plant for the model midway through the program.

DaimlerChrysler

DaimlerChrysler took 44 months for the new Mercedes-Benz E class, compared with 71 months for its predecessor. Though a key model with major innovations — such as electro-hydraulic braking developed with Bosch — DaimlerChrysler was able to pull forward development by four months.

Niche Mercedes models have been developed in a similar time frame. The CLK was done in 47 months. The Vaneo, which uses the A-class platform, took just 44 months from concept to start of production.

The Maybach is also expected to have taken just 44 months to develop when it is launched this autumn.

Fiat Auto

Fiat took 36 months to develop the Stilo from

Development time of some recent models

Model	Design freeze to start of production
Audi A8	44 months
BMW 7 series	34 months
BMW CLK	47 months
BMW Vaneo	44 months
BMW Maybach	44 months
DaimlerChrysler E class	44 months
DaimlerChrysler CLK	47 months
DaimlerChrysler Vaneo	44 months
Ford Focus	36 months
Ford Fiesta	36 months
Ford Mondeo	36 months
Ford Puma	36 months
Ford Galaxy	36 months
Ford Focus	36 months
Ford Fiesta	36 months
Ford Mondeo	36 months
Ford Puma	36 months
Ford Galaxy	36 months
Ford Focus	36 months
Ford Fiesta	36 months
Ford Mondeo	36 months
Ford Puma	36 months
Ford Galaxy	36 months
Ford Focus	36 months
Ford Fiesta	36 months
Ford Mondeo	36 months
Ford Puma	36 months
Ford Galaxy	36 months

"Felder Zero," the preliminary investment evaluation, to production start. Time from design freeze to start of production was just 24 months.

Fiat has been less successful in meeting its



Citroen C3

timetable on lower-volume models. The Lancia Thesis has had one of the most troubled developments in recent history. The luxury sedan was originally planned for the end of 2000, but was not shown for the first time until March 2001. Customer deliveries are now planned to begin in September 2002. The main problems was communication between the car's electronic systems.

Ford

The new Fiesta was done in three years. Development was accelerated by six months to help with Ford's European comeback. Production was then ramped up cautiously to make sure the plant met quality standards at volume rates.

PSA/Peugeot-Citroen

Robert Peugeot, PSA's director of innovation, says it is more important to create processes that guarantee meeting schedules than to shorten the actual development time. The relatively short lead time for the

Citroen C3 has been followed by a slow production ramp-up to address initial build quality concerns.

Renault

Development of the company's new large-car platform offshoots, the Laguna, Vel Satis and Espace, has been plagued by delays. All the models arrived late. Initial development problems had a knock-on effect on later launches since all three are produced in Renault's Douai, France, plant.

Volkswagen

Under Ferdinand Piech VW had a strong preference for getting the product right, no matter how long it took. The Phaeton took almost five years to develop, arriving one year late. The Touareg was delayed by nine months because of problems with the development of the large-structure control.

But the new Polo was developed off the PQ34 platform in a respectable 36 months, and new VW boss Bernd Pischke is expected to focus on delivering cars on schedule.

Volvo

Volvo S60 had one of the longest development periods of any recent new model — six years — due largely to corporate and strategic changes.

But on its new large cars Volvo has made a lot of progress toward speeding development. Volvo needed just 44 months for the S60 launched in 1998. On the XC90, developed just after Volvo was acquired by Ford, the time was reduced to 27 months.

APPENDIX

Appendix Seventeen

NMUK TQ Story

APPENDIX

The Nissan TQ Story

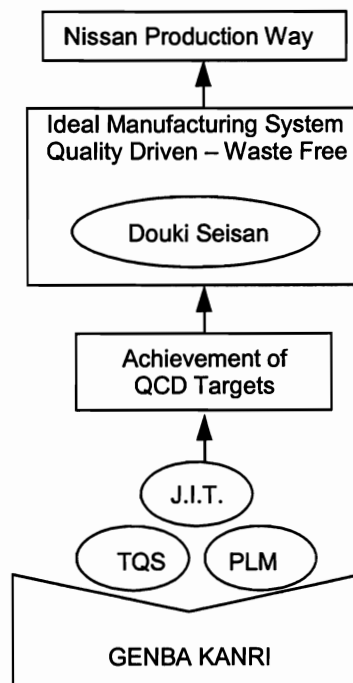
1. Setting the subject
2. Explain reasons for choice
3. Setting targets
4. Planning the activity
5. Establish current condition
6. Analysis
7. Planning countermeasures
8. Implementing countermeasures
9. Confirm the effect
10. Standardising
11. Review and future action plan

Mr Itoh and Mr Ikeda both of Nissan's Murayama plant first introduced TQ Story method to NMUK in 1992. They were internal specialists, principally in Manufacturing Engineering which, at that time was at the heart of Nissan. Using the principals of TQM as understood in Nissan, with the tools of Dr Deming and the principals of Kaizen, they developed and deployed the Nissan TQ Story. Today, this is called the Nissan Production Way and can be seen copied by many competitors due to its ability to create Flexible Mass Production Lines which challenge the historical dogma of "Job", "Batch" and "Flow" [Ref 5.3 Terry Hill, 1999]. Since that time, all production departments have practised and drawn benefits from TQ story method. Maintenance and indirect departments have had similar experience and benefits from variants of TQ Story method.

The practice of TQ Story method to resolve a problem can take anything from 2 – 26 weeks. Though in the case of a 26 week TQ Story, group members are only involved full time at the beginning of the activity (first few weeks). After that involvement is "as and when" data is available and conclusions or actions can be taken. The length of a particular activity is decided by management, who will consider the problem's complexity, size and the time cycles involved together with the resources that will be needed.

APPENDIX

TQ Story method is part of NMUK's commitment to Total Quality Management (TQM), as can be seen in the diagram below. TQ Story, JIT (Just In Time – a Production Control System that procures parts to the assembly line at the time they are required and eliminates Work In Progress to a greater extent) and PLM (Planned Maintenance – which sees production machinery being maintained ahead of breakdown through a variety of tools, from a regular maintenance schedule to “Machine Health Sensing”) are the three main elements (activities) of Genba Kanri (workshop management) that support TQM [Ref 5.4].



APPENDIX

Apart from using a structured approach, successful TQ Story method activity depends on the following key principles: -

- only consider facts, avoid hearsay and speculation
- look for variances in process, performance and results
- involve zone members in the activity
- the process of TQ Story is more important than the result
- produce a schedule based on the PDCA cycle and stick to it
- use all 11 steps, but only choose the most suitable of the 7 tools
- improvements are only worthwhile if they are maintained
- don't be afraid of change or failure
- be enthusiastic, things are more likely to get done
- best results are produced when group members are committed to and enjoy the activity

Each element of TQ Story is explained in more detail [Ref: 5.6 Nissan Motor Manufacturing (UK) Limited – Copyright 1998].

Plan Stage

< Step 1. Setting The Subject >

The first step in problem solving is to find a suitable subject by deciding on which problem to address. Since everybody will work together on what could be a long project, it is important to select a challenging and motivating subject.

One might think that problems are easy to find as long as people are problem-conscious, but this is not enough. Not only must one be problem-conscious, one also needs to be selective in the choice of subject if there is to be a meaningful benefit in the use of TQ Story.

APPENDIX

Selecting the most suitable subject is easier if the following key actions are carried out.

- i. Consider work situation
- ii. Describe the subject
- iii. Decide on which subject to tackle

Let's now look at each of these key actions in more detail.

Consider Work situation

a) Check Section/Dept role

- What is your function within the company?
- How should you carry out that function?
- How should your workplace be set up?

b) Check Policies/Objectives

- How do company policies affect you?
- What company/dept/section objectives have been agreed/set?
- What plans have been made to aid the achievement of these objectives?

Each of these key aspects is what could be called a high level consideration. Once these have been taken into account, problems and subjects that could be the focus of a TQ Story method activity can be generated.

c) Check Problems

Subjects could also be generated by asking:

- What kinds of problems are giving us trouble?
- What things would we like to improve further?
- What long-term problems have we been experiencing?
- What items have no apparent cause for failure / poor end results?

Describe the Subject

Being clear about the subject can help ensure that there is a common understanding of what it is. It can also make the topic easier to focus on and set targets against. There are three main elements in a specific clearly stated topic.

APPENDIX

a) Elements

- object (Noun), What i.e. the control characteristics
 - grinding checks
 - secondary damage
- action (Verb), How i.e. the direction or level of the improvement
 - reduce
 - remove
- location, Where, i.e. in the process, component, material region
 - corner of the neck
 - before the final stage

b) How to Express

Express the topic in terms of attacking something bad rather than improving something good (this is because the latter style of expression tends to lead people to chase after the ideal and rely too much on the help of others):

E.g.

- reduce defect ratio ✓
- improve OK ratio x
- reduce number of days late ✓
- improve delivery x

Express in terms of results rather than methods:-

E.g.

- reduce number of missed fixtures and fittings in hotel guest rooms ✓
- standardise fixtures and fittings for hotel guest rooms x
- reduce time callers are kept waiting when reserving rooms by telephone ✓
- prepare instruction manual for hotel reservation calls x

APPENDIX

Do not confuse countermeasures with topics:

E.g.

- improve sales staff's product knowledge ✓
- improve product education for sales staff x
- decrease torque-fastening defect rate ✓
- improve torque-fastening method x

Express in clear, commanding terms:

E.g.

- reduce defect rate ✓
- try to reduce the defect rate x

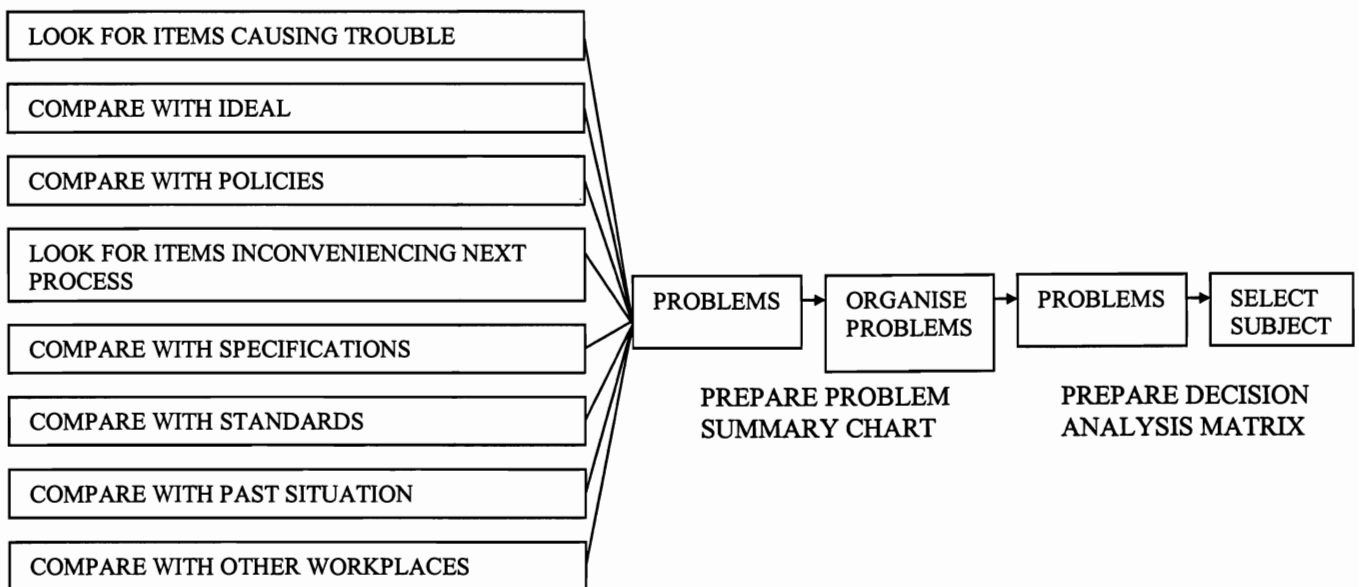
c) Grouping

Once problems have been listed they can be organised into like groups. This is sometimes called a topic chart or problem summary sheet as shown overleaf.

APPENDIX

- Chip
 - Scratch
 - Dent
 - Protrusion
- } Secondary damage
-
- Runs
 - O/peel
 - Finish
- } Paint concerns
-
- Dirt in paint
-
- Fits
 - Flushes
- } Body concerns

The next stage in the model is to evaluate the subjects that have been listed. The model below shows a process for generating and dealing with possible subjects.



Approaches to Identifying Subjects.

Deciding which subject is to be tackled could be done simply by the group discussing the options. In other cases a decision analysis chart may need to be drawn up. In both cases

APPENDIX

the topic that is finally decided upon needs to be discussed and bought off as a suitable topic for the investment of time and effort of a TQ Story method activity.

Decide Which Subject to Tackle

a) Decision Analysis

Carrying out a full decision analysis to evaluate the worth of each subject can take some time, but it does have the advantage of:

- clarifying the thoughts and opinions of group members
- providing evidence to justify your choice
- Identifying problems worthy of TQ Story activity in the future

An example decision analysis and guide notes are shown on the next 2 pages.

APPENDIX

Table 1 Example Decision Analysis Chart

DECISION ANALYSIS (1)

Item	Suitability for Circle/Group				Need for Improvement				Data Availability ③	Score	Priority	Decision	
	Is the problem common to all circle members?	How easy is it for the members to tackle the problem as a circle?	Will the members be able to co-operate together?	How long will the project take?	Will it help to raise the circle's abilities?	How great is the need for improvement	Does it meet workplace need?	How much will the activities cost?					What sorts of results can be expected?
②	- Common to all members - Common to most members - Only relevant to a few members	- Highly relevant problem of great interest - Topic too ambitious - Topic affected by outside influence	- No worries on this score - Yes, with a little effort - Not satisfactorily	- 2-4 months - 2 months or less - 5 months or more	- Difficult problem but will rise abilities - Will raise abilities if effort is made - Just a casual idea	- Requires urgent attention - Important but not very urgent - Not urgent	- Must be dealt with now - Is inconveniencing others - Not very relevant	- Will incur no extra costs - Minor costs only - Expensive	- Reward in proportion to effort - Fairly good results - Minor results only	6 3 1	⑦	⑧	
Maximum Scores	3	5	3	5	3	7	5	5	8	6	50		
①	Eliminate grinding cracks	5	2	5	3	7	3	5	8	6	48	1 st	✓
	Improve efficiency of hold pitch process	3	3	2	5	7	3	5	8	1	42	2 nd	
	Improve safety and hygiene scores	2	3	3	3	2	5	1	2	1	37	4 th	
	Introduce computer processing	3	1	2	1	3	2	1	5	1	18	5 th	
	Produce assembly labour hours	1	5	3	1	3	5	3	8	3	39	3 rd	

APPENDIX

Decision Analysis (1) Guide notes

- ①. Clearly expressed subjects, capable of being developed as a measurable target
- ②. Evaluation criteria in two main areas – suitability for the circle/group and the need for improvement, each is sub divided into more detailed criteria. The list show at ② can be added to if the occasion calls for it, e.g. an addition to need for improvement could be "countermeasure already in existence"
- ③. How much data is available on the subject can have an impact on the success of the QC Story method activity
- ④. The maximum score that each criterion can achieve is a weighting method that needs to be decided on by the group. The score should reflect the relative weight/importance of the criteria when compared to other criteria. In the example the criteria "what sorts of results can be expected" is seen as the most important with a score of 8. Whereas "is the problem common to all group member" only scores 3
- ⑤. Once the maximum score is determined the medium and low scores need to be assigned to each criteria
- ⑥. Each of the subject is then scored on the 1st criteria, then the 2nd and so on
- ⑦. Scores for each subject are totalled
- ⑧. The highest scoring subject will be in 1st place, others are ranked accordingly, logically the choice of subject for QC Story method activity would be the one that was 1st

Step 2. Explain Reasons For Choice

Consider the Background

Explaining the background, by stating the importance and urgency of the problem can be useful. If the group asks itself the following questions, it is likely to be easier to justify the final choice of subject:

What is the problem?

- is it related to the policy or objectives of the department/section?
- is it an important problem?
- does it occur suddenly or is it continuous?
- what are the effects of the problem?

APPENDIX

Show the condition of the problem.

It is important to know exactly what the fault is, so collect as much data as possible. The problem should be shown by graph, or any other appropriate TQ Tool, though Pareto diagrams are often used at this point. Sketches or photographs could also be used to help you to explain and clarify your choice.

Step 3. Setting Targets

A target indicates the level of improvement that should be achieved. It is determined by balancing the ideal against restrictions such as time, and the amount of manpower and money available for investment in the project.

This step involves 2 key actions

- Target characteristics
- Considerations for setting the level

Let's now look at each of these actions in more detail

Target characteristics

Since targets are the goals of our problem-solving activities, they must be expressed in concrete, easily understood terms.

A model that is a useful guide in the Setting of objectives and targets is S.M.A.R.T.

Specific = What are we going to do to what i.e. "reduce scrap levels @#2"

Measurable = By how much i.e. "reduce scrap by 20%"

Agreed = By those involved

Realistic = Be capable of being achieved

Time = By when will it be achieved

The target values are set will depend on the degree of difficulty of the topic and the problem-solving abilities of the group in addition to departmental objectives or needs and of course the time constraints.

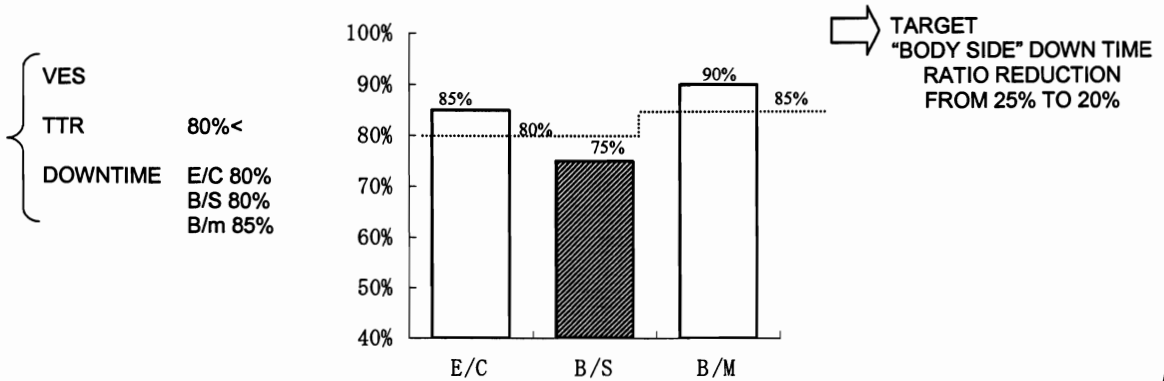
APPENDIX

Considerations for setting the level

There are no fixed rules for deciding on target values, but they are usually chosen from considerations such as the following:

Objectives the amount by which we want to reduce the number of defects or nonconforming products, as set by dept/section objectives.

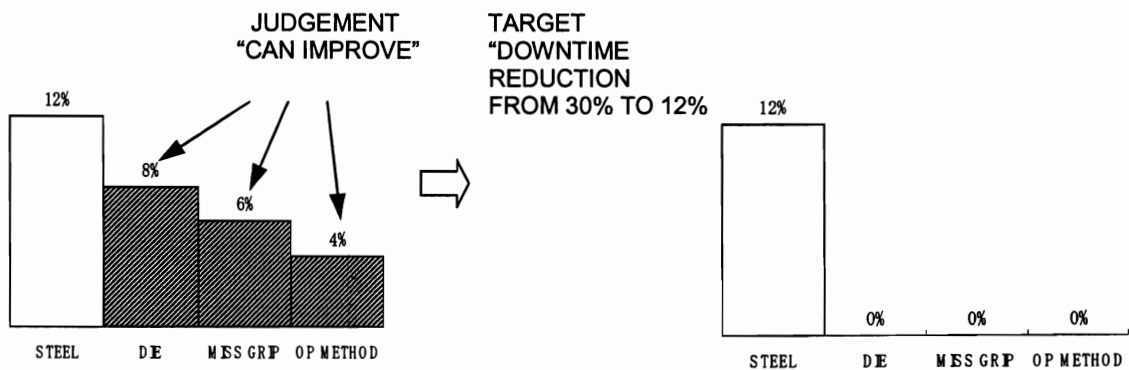
BODY SHOP TARGET



* **Comparison** with values set by other departments.

Logic (as the base for values)

OPERATION 70%	DOWNTIME 30%
------------------	-----------------



APPENDIX

Essential values that must be achieved regardless of other considerations (e.g. those relating to safety).

Questions can be asked to confirm the value of the target i.e. will it.....

- Produce **benefits** that outweigh the cost and effort of producing them.
- Be high enough to provide **motivation** (be meaningful - not trivial)
- **Stimulate desire and action** on the part of the group members over the full term of the activity

Step 4. Planning The Activity

Produce a schedule

When drawing up a schedule, two of the major questions to be asked are concerned with the What and the When of the activity. These can be clearly shown on a schedule, which is an example of a Gantt chart or schedule chart.

Other questions to ask are:

- Who will do what and was their ability/character considered when their role was assigned?
- Who will be involved and/or kept informed?
- Where will data be gathered?
- Where will people meet?
- Why are we carrying out each step?
- Why will each of the steps take the time that it does?
- How will we carry out and display each step?
- How much data will we collect?
- How much resource will we need?

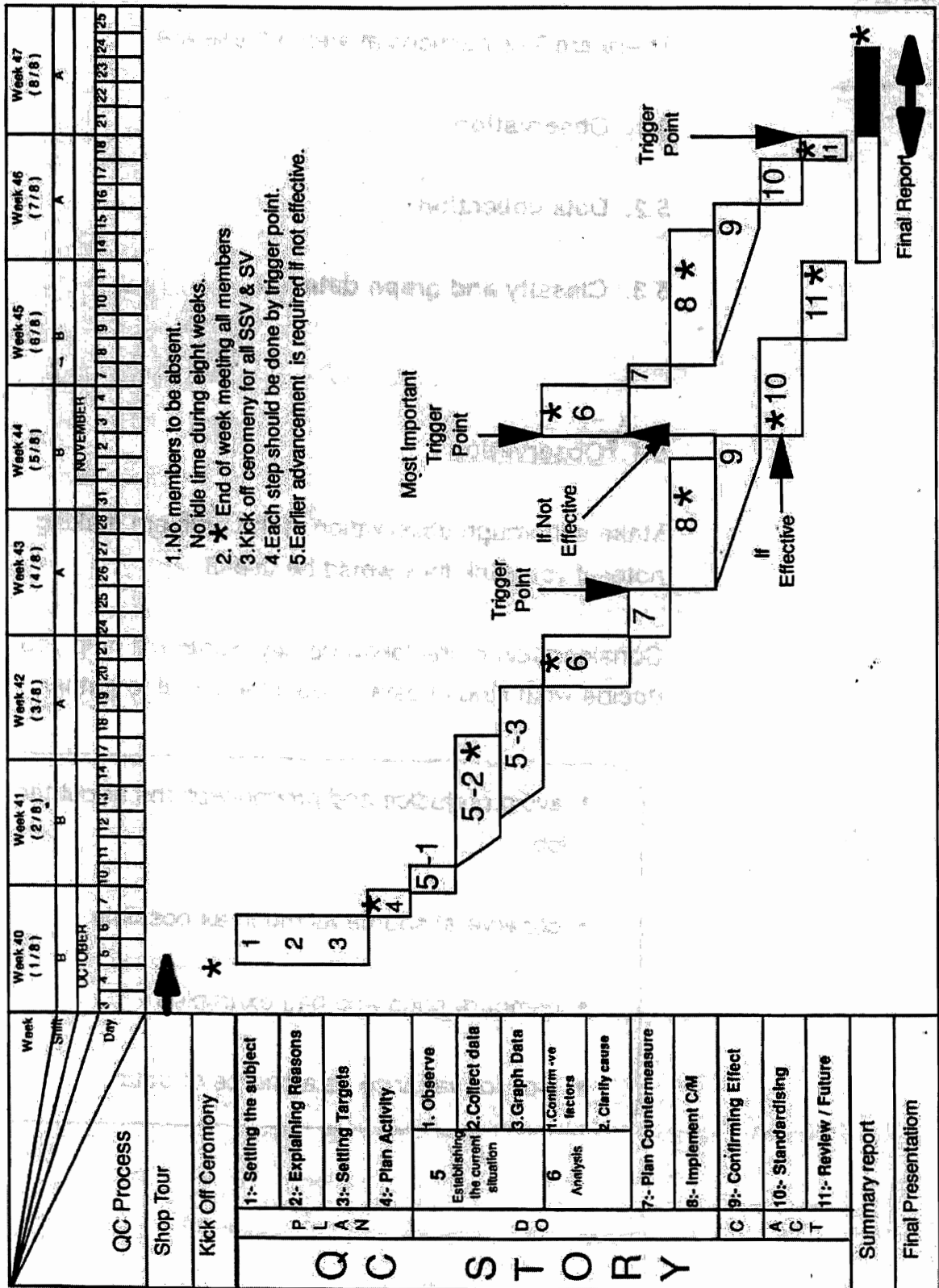
Buy Off

Because the plan will show the type and level of resource needed it will need buying off by your Senior/Manager.

APPENDIX

Table 2 Example QC Story Activity Scheduled Chart

Example



APPENDIX

Do Stage

Step 5. Establishing The Current Condition

There are 3 key actions at step 5 these are

Observation

Data collection

Classify and graph data

Observation

Make a thorough observation of the problem, making notes if you think they would be useful.

Consideration of the following key points will help you to decide what kind of data it could be useful to gather:

- avoid prejudice and preconceptions about the job
- observe at source as much as possible
- compare good and bad examples
- look for variance as a source of data

Data Collection

Before collecting data, it is important to discuss and decide what kind of data is required and would be useful. Most failures and delays of TQ Story come from not having clarified the following three issues:

WHY am I collecting the data?

What will the data be used for?

WHAT data should I collect?

Is the accuracy of the measurement equipment ok?

Is the measurement method correct?

Is the sample of sufficient size?

Are the calculations correct?

Is the data valid?

Are trials that try to reproduce the fault/effect needed?

How far back in time do we need to go to gather data (cycles)?

APPENDIX

HOW should the data be collected?

Who collects, when to collect and how to collect. This could call for data gathering sheets to be devised to suit the particular problem being tackled. The detail on this form could include the list on page 25 i.e. shifts, models, times, operators etc.

The benefit of collecting data is that it can help you to:

- understand the current condition
- set realistic/challenging targets
- measure progress
- justify the time/money spent on the activity
- base your decisions on fact not feelings

The example schedule in Table 6.2 shows this step as lasting 7 days on the 8-week activity, circumstances may dictate that data is gathered over a longer period.

Classify and Graph Data

Once the data has been collected on the data gathering sheets (devised to suit the subject) it can be reviewed with the aim of classification

a) Classification

This is the grouping of data under common points and/or features with the aim of highlighting differences. It is the foundation for the preparation of diagrams and graphs when applying the 7 tools.

The following points are recommended as viewpoints for consideration when classifying/grouping data.

- | | |
|---|-------------------|
| - By Material | By types of fault |
| - By Machine and equipment | By method |
| - By Operator | By facility |
| - By Operation method, operating conditions | |
| - By time | By shift |
| - By Environment and weather | By part of car |
| - By Measurement/Inspection | By model |
| - By New project/existing product/initial product | |

APPENDIX

b) How to classify

The data from the original data gathering sheets can be increased in value by classifying further, using one or more of the 7 TQ tools.

The classification and display in one of the tools can:

- Show variation in data
- Identify need for further analysis
- Divide problem
- See problem from multi point of view
- Breakdown the problem

The choice of tool for a particular set of data depends on what it is that you are trying to show/display. The table below shows which tool can be used to satisfy a particular requirement.

Requirements	TQ Tool
1. To show variance, trends or peculiarities against time	Line graph
2. To gather, sort and categorise data	Check Sheet (tally chart)
3. To show how much variation is present in a range of data and the distribution shape produced	Histogram
4. To rank and prioritise data or causes according to pre-determined criteria (i.e. volume, cost, time, fault type)	Pareto Diagram
5. To show the strength of any relationship between two variables	Scatter Diagram
6. To monitor the normal output of a process and show values that can help predict failure rather than react to it	Control Chart
7. To display all possible causes and their relationship	Cause and Effect Diagram

Step 6. Analysis

So far we have set targets, drawn up the activity plan, and gathered data on the current condition, which has been displayed in one or more of the 7 TQ tools. The next step is to analyse the cause. This is the most important step of TQ Story.

APPENDIX

Accurately identifying the true cause is critical because it can tell us what to do in the next step, i.e., (considering and implementing countermeasures). If one does not clearly identify the causes, one is likely to waste time and money trying out various ineffective countermeasures.

Analysing the causes means using TQ tools to investigate the relationship between caused and quality characteristics and pinpointing the particular factors that are adversely affecting the characteristics. Here, “causes” mean the main factors that are creating problems and appear likely to be influencing the results of the process.

The purpose of analysing the caused is to find out what measures should be taken against what factors. If the cause and effect relationships are not accurately identified at this stage, one will end up taking action but improving nothing. Therefore gaining no benefit from the activity.

The causes should be generated and analysed following the procedure below:

Brainstorm possible causes

Analysed the relationships between characteristics and possible causes

Summarise the results of the analysis

Decide what are root causes

Brainstorm possible causes

Start by listing the various categories of possible causes. Hold a brainstorming session attended by all those directly and indirectly involved in the work. Gather a large number of opinions from those present as to what they feel/think could cause the problem/effect you are investigating. Draw up a cause and effect diagram, that is big enough to take 400-500 ideas, (this is a typical number of suggested causes in a TQ Story brainstorm activity). Effects should be expressed in terms of what is wrong with the present situation, “scrap levels are high”.

APPENDIX

Analyse the relationships between Characteristics and possible causes

In this step, we examine what we consider to be the most important causes on the cause and effect diagram. We try to discover which are the true ones and what relationship they bear to be characteristics of the problem. The important thing here is not to guess but to identify the facts correctly. To do this, one should use TQ Tools to analyse data such as the following:

- Past data
- Categorized (classified) daily data
- New data obtained from experiments/trials in the workplace (trials can be useful in helping to confirm the degree of influence that one characteristic has over another).

When analysing data, one should remember to do the following:

a) Examine differences between categories/groups of data. Categorise the data according to the 4 Ms (Machines, Manpower, Materials, and Methods) and Environment. Prepare categorised graphs, histograms, scatter diagrams, and control charts, and look to see whether or not there are any differences between each category – see Tables 4,5 & 6.

b) Examine time changes. Use graphs, check-sheets, and control charts to see whether or not the characteristics and causes are changing with time – see Table 7.

c) Investigate correlation. Prepare scatter diagrams and check for correlation between paired sets of data that is between causes and characteristics, causes and causes, and characteristics and characteristics – Table 5.

d) Investigate the workplace and the hardware.

Carefully observe the workplace and the people and things in it. If complains have been made about nonconforming items or products, investigate further.

APPENDIX

RIMS BEING WARPED

Table 4

BAR CHART

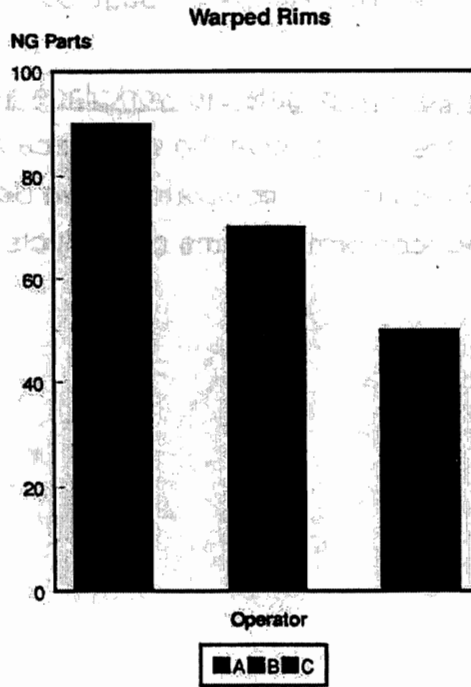
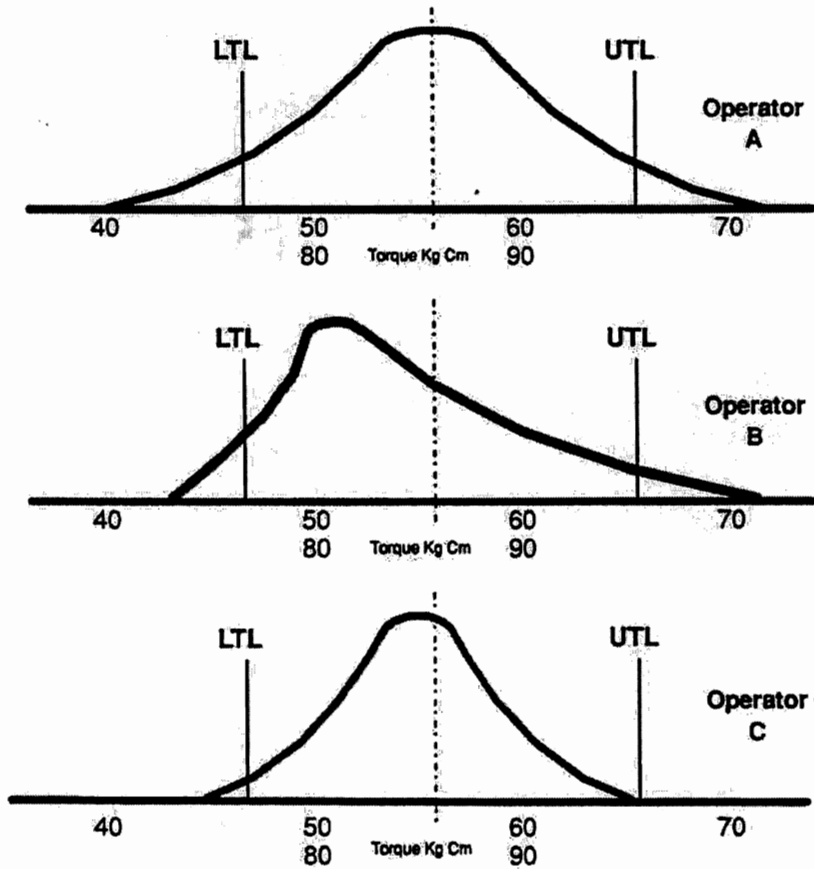


Table 5

HISTOGRAMS



APPENDIX

Table 6. Tool Breakage Scatter Chart

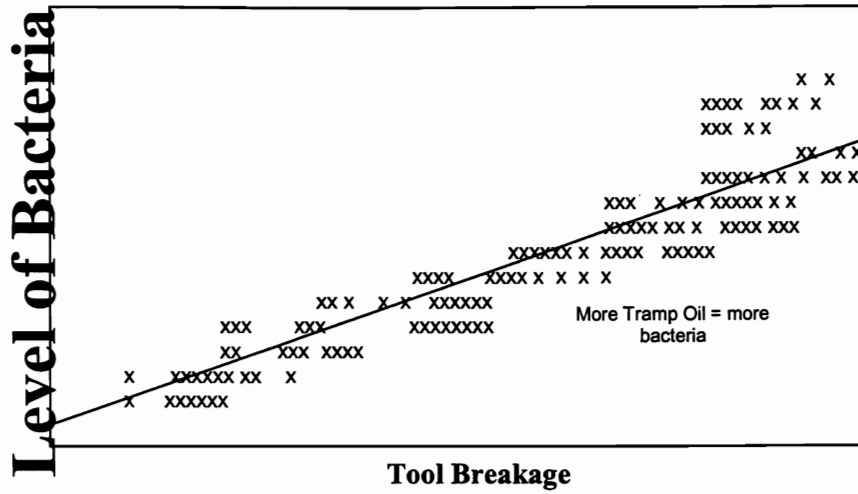
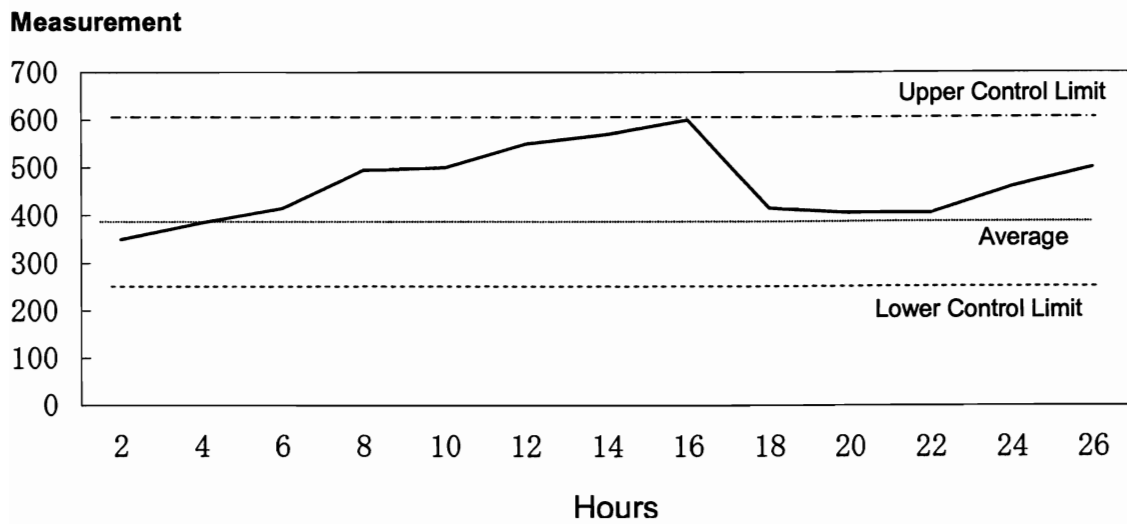


Table 7 Die Temperature Control Chart



APPENDIX

Summarise The Results of The Analysis

It is important to check whether the causes highlighted on the cause and effect diagram are in fact the true causes, before any premature countermeasures are introduced.

In many case studies one often see causes taken from the cause and effect diagram and immediately subjected to countermeasures without being investigated to see whether they are in fact the true causes.

This approach is risky, as the causes listed often consist of random guesses or preconceived ideas on the part of the group members, and may not represent the true facts.

A useful tool at this point is the Matrix diagram (cause - fact), which can increase the objectivity with which the causes are viewed. This objectivity is due to the fact that each cause is systematically cross-referenced with each available fact. An example can be seen on the next page – Table 8

APPENDIX

Table 8 Example of Cause and Effect Diagram

SENDER NECK DAMAGE CAUSE + FACT DIAGRAM

○ EXPLAIN
 ✕ CANNOT EXPLAIN
 △ NEED MORE DATA

POSSIBLE CAUSES	PROBLEM CHARACTERISTICS									
	60% OF N.G. OFF MA2	MA2 WATER SHUTOFF DURING MOULD OPENING	80% OF N.G. OFF 'B' SHIFT	MA2 MANIFOLD PRES. 0.3 BAR-MA1-MA3	MOST OF N.G. ON MONDAY EARLIES	MA2 HAS WORST SENDER DISTORTION - 8mm	80% OF SENDER N.G. @ 11:30AM	MA2 HAS SMALLEST SENDER OUTER DIA.	N.G. PARTS HAVE LOW SENDER NECK HEIGHT	
STACKING TANKS ON FLOOR	✕	✕	✕	✕	✕	△	✕	✕	✕	○
TANK LOCATION ON PALLET	○	✕	✕	✕	✕	✕	✕	✕	✕	✕
SENDER DIA. CUTTING OP. ANGLE	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
TANK SHAPE VARIANCE	○	○	✕	○	✕	✕	✕	○	○	○
TANK COOLING EFFECTS	△	○	✕	○	✕	○	✕	○	○	○
BRACKET HEATER NOT IN LINE	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
BLOW MOULDER - MOULD OPENING SEQUENCE	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕



○ EXPLAIN
 ✕ CANNOT EXPLAIN
 △ NEED MORE DATA

POSSIBLE CAUSES	PROBLEM CHARACTERISTICS											
	60% OF N.G. OFF MA2	MA2 WATER SHUTOFF DURING MOULD OPENING	80% OF N.G. OFF 'B' SHIFT	MA2 MANIFOLD PRES. 0.3 BAR-MA1-MA3	MOST OF N.G. ON MONDAY EARLIES	MA2 HAS WORST SENDER DISTORTION - 8mm	80% OF SENDER N.G. @ 11:30AM	MA2 HAS SMALLEST SENDER OUTER DIA.	N.G. PARTS HAVE LOW SENDER NECK HEIGHT	SENDER NECK DIST. IS 20% OF WK 88-90 N.G. PARTS	WALL THICK. GREATEST ON MA2 (USONIC)	MA2 ROT. CORE TEMP IS 5 DEG. HIGHER THAN MA1,3
STACKING TANKS ON FLOOR	✕	✕	✕	✕	✕	△	✕	✕	○	△	✕	✕
TANK LOCATION ON PALLET	○	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
SENDER DIA. CUTTING OP. ANGLE	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
TANK SHAPE VARIANCE	○	○	✕	○	✕	✕	✕	○	○	○	✕	✕
TANK COOLING EFFECTS	△	○	✕	○	✕	○	✕	○	○	○	○	○
BRACKET HEATER NOT IN LINE	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
BLOW MOULDER - MOULD OPENING SEQUENCE	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
ROTATING CORE OPERATION	△	✕	✕	✕	✕	△	✕	✕	✕	✕	✕	✕
SET UP OF PALLET	○	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
OPERATOR SKILL LEVEL AND START AFTER BREAK	✕	✕	△	✕	○	✕	✕	✕	✕	✕	✕	✕
BLOW MOULDER STARTUP METHOD	✕	✕	✕	✕	△	△	✕	✕	△	△	✕	✕
PARISON PROFILE CONTROL	○	✕	✕	✕	✕	○	✕	○	○	✕	○	✕

Additional characteristics identified during analysis.

* Additional possible causes identified during analysis

APPENDIX

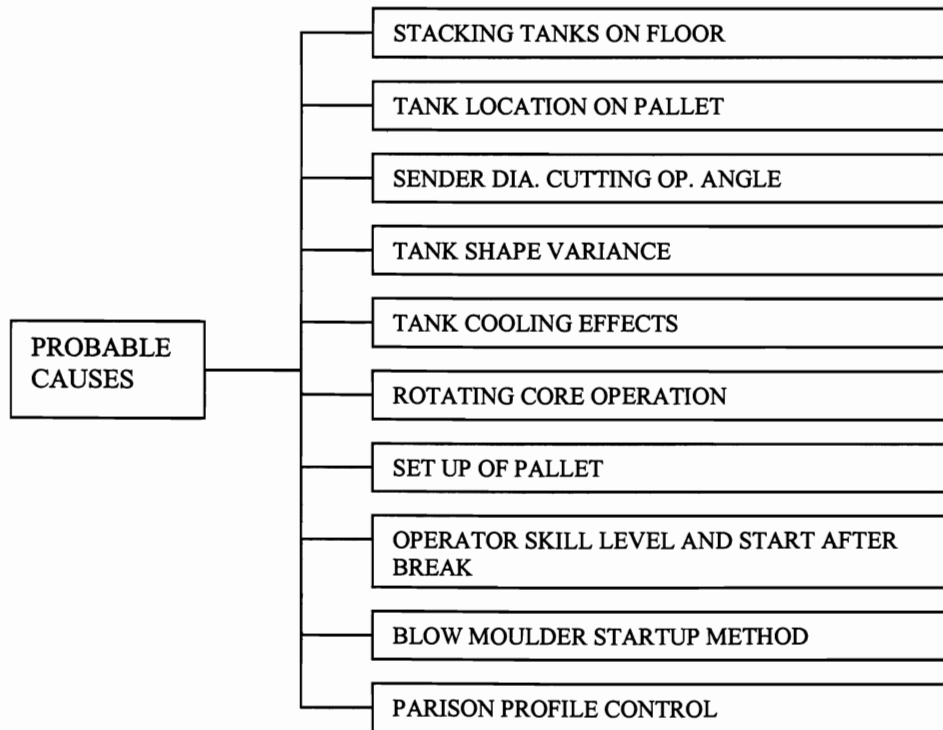
Decide What Are Root Causes

The Matrix cause effect diagram can help to indicate which is/are the most probable cause(s) of the problem.

Repeating the question “Why?” up to five times during discussion, can help in arriving at the real root cause rather than the effect.

The “sender neck” problem shown below generated 10 probable causes, each of these could be further interrogated by the question “why?” to identify root causes.

Once root causes are found, the next step “Planning Countermeasures” can be started.



APPENDIX

Step 7. Planning Countermeasures

Generate Countermeasures

Once a cause is identified, consideration needs to be given to its removal. Brainstorming can be used to generate options/countermeasures. Decision analysis can help ensure an objective evaluation of the options available. A variation of the decision analysis used at Step 1 can be used, and is shown on the next pages with guide notes.

Evaluate Countermeasures

When countermeasures have been generated they will need to be evaluated to identify which ones ought to be implemented.

An example of a decision analysis matrix (2) tool that can be used to evaluate countermeasures is shown on the next page. – Table 9.

APPENDIX

Table 9 - Example Decision Analysis Matrix (2)

COUNTERMEASURE		1.	2.	3.	4.	5.		
OBJECTIVE		CHANGE STEEL	ADD GUIDE PIN	ADD CHECKING	INSTALL HEATER	PRESS DIE MAINTENANCE		
(1) MUST	RELIABILITY							
	DIFFICULTY							
	INFLUENCE							
	SAFETY							
	ETC.							
	ETC...							
(2) WANT		(4)	(5)					
		(3)WEIGHT	SCORE	WEIGHTED SCORE	SCORE	WEIGHTED SCORE	SCORE	WEIGHTED SCORE
	INVESTMENT COST	8	9	72	8	64	9	72
	OPERATOR COST	10	10	100	1	10	10	100
	RUNNING COST	6	10	60	3	18	4	24
	TIMING	5	7	35	6	30	8	40
	EFFECT	8	7	56	2	16	9	72
	ETC							
	”							
	”							
TOTAL (6)			323		138		308	
DECISION (7)								
PRIORITY (8)			1			2		

Guide Notes for Decision Analysis (2)

1. Decide which objectives or criteria are important to you when deciding which countermeasure(s) to use, i.e.

- Reliability
- Difficulty
- Influence on others/process
- Safety
- Cost
- Timing

2. Classify objectives into MUSTS (1) and WANTS (2)

3. Identify and Develop Countermeasures and enter on the analysis sheet

4. Screen through Musts (Rule out any countermeasure that does not meet objective)

5. Weigh Wants (3) “1-10” to reflect importance of each objective (10 = most important)

APPENDIX

6. Score (4) alternatives “0-10” against how well they meet objectives
7. Work out weighted score (5) by multiplying “Weight” x “Score”
8. Add totals (6)
9. Decide most suitable countermeasures (7)

Another tool that can be used at this stage is the “Systematic” or “Tree” diagram (one of the 7 new tools) this helps in the objective consideration of the value of each countermeasure.

The possible causes lead onto a series of countermeasures, each one is then rated against the following criteria: -

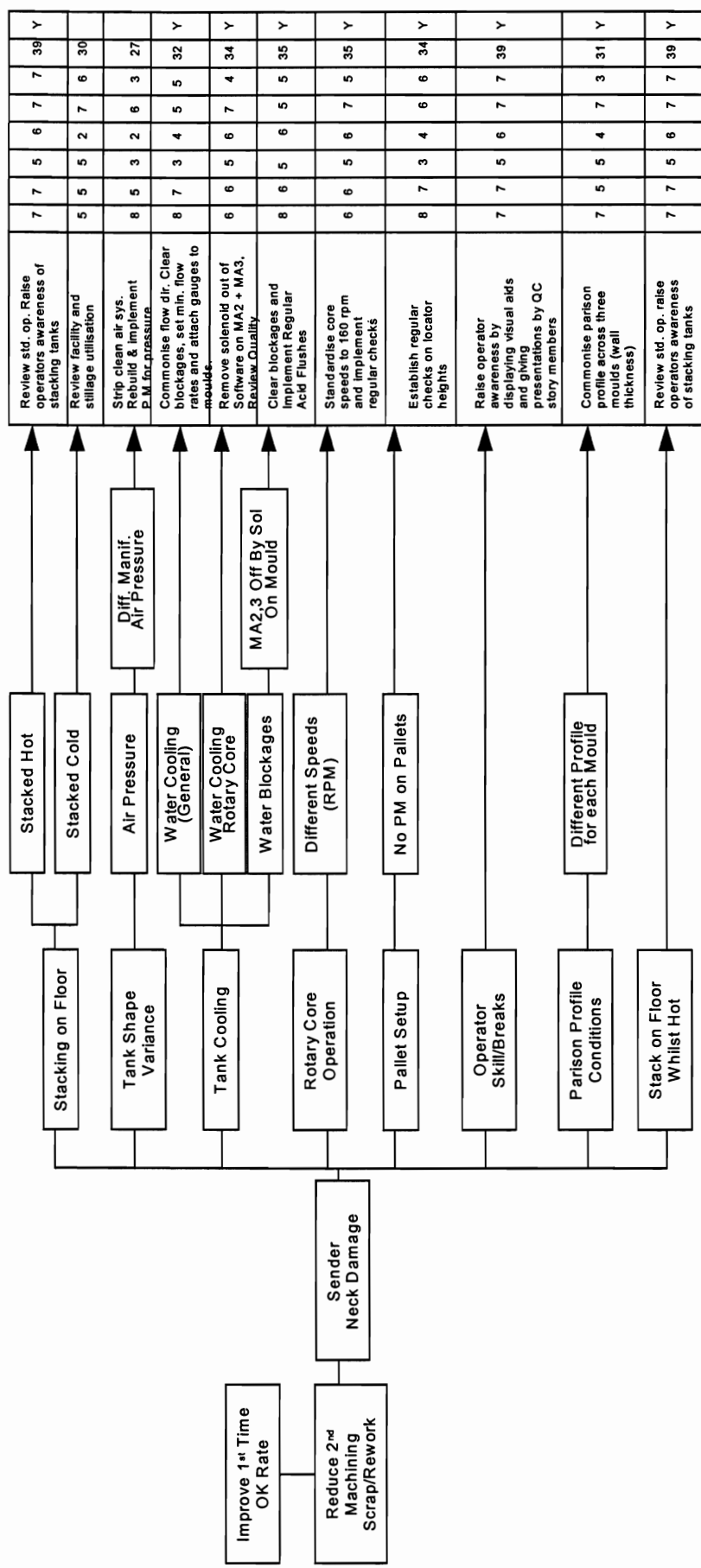
- Benefit
- Feasibility
- Cost
- Time
- Safety
- Process effect downstream

The criteria and the value given to each countermeasure needs to be discussed and agreed by the group before the scoring can begin. This system can be more useful when you are dealing with a larger number of countermeasures. An example is shown on the next page. – Table 10.

APPENDIX

APPENDIX

Table 6.10 Example of Tree Diagram with Decision Matrix
 SENDER NECK CONCERN
 COMBINED SYSTEMATIC DIAGRAM
 OR
 TREE DIAGRAM WITH
 DECISION MATRIX



APPENDIX

Step 8. Implementing Countermeasures

Application Care Points

- Prioritise countermeasure and stick to them
- Consider changes to layout, station etc as well as operation method
- It is likely that many countermeasures will require modification (trial and check)
- Confirm countermeasure effect using same observer as Step no.5 (establish current condition)
- Decide which monitoring procedures and tools to use to display the effect of the countermeasure. Also consider what time frame is needed to confirm the effect.

People Care Points

- Before implementing decide each members responsibility and schedule
- Minimise disruption i.e. part way through the shift/job (fudge factor)
- Involve operators where possible
- Gain agreement of Zone Members, Engineering, Maintenance and Safety for countermeasures
- Share results with all Zone Members

APPENDIX

Check Stage

Confirm the Effect

Monitor Results

The first task here is to decide which tools would be most suitable to show the gain that has been made by the TQ Story activity. Another thing to decide is the time frame over which data needs to be gathered. Pareto diagrams (e.g. Table 11) are a favourite tool at this step, though graphs (e.g. Table 12) and histograms (e.g. Table 13) are also often used

Table 11 - Pareto

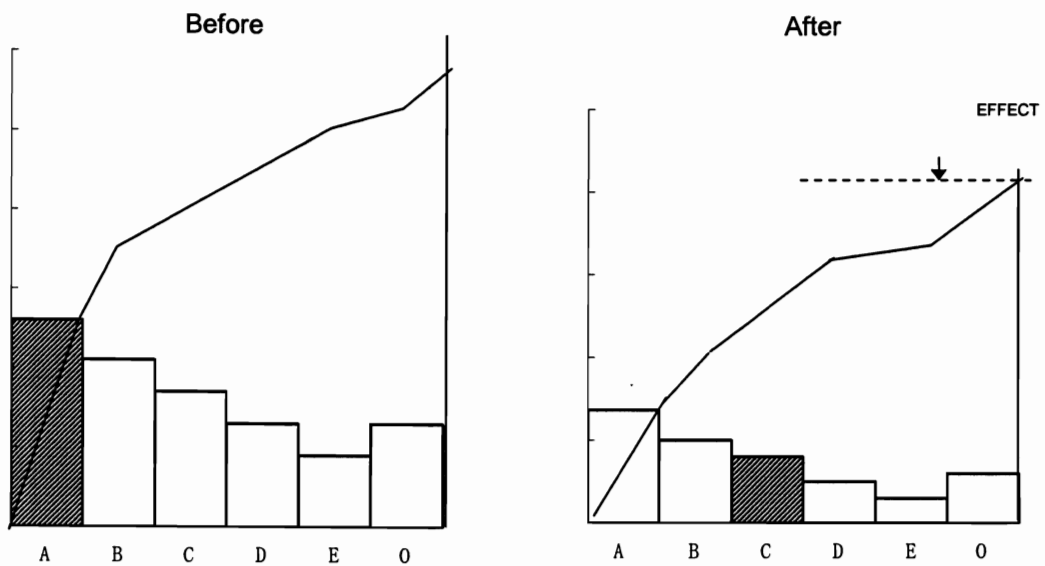
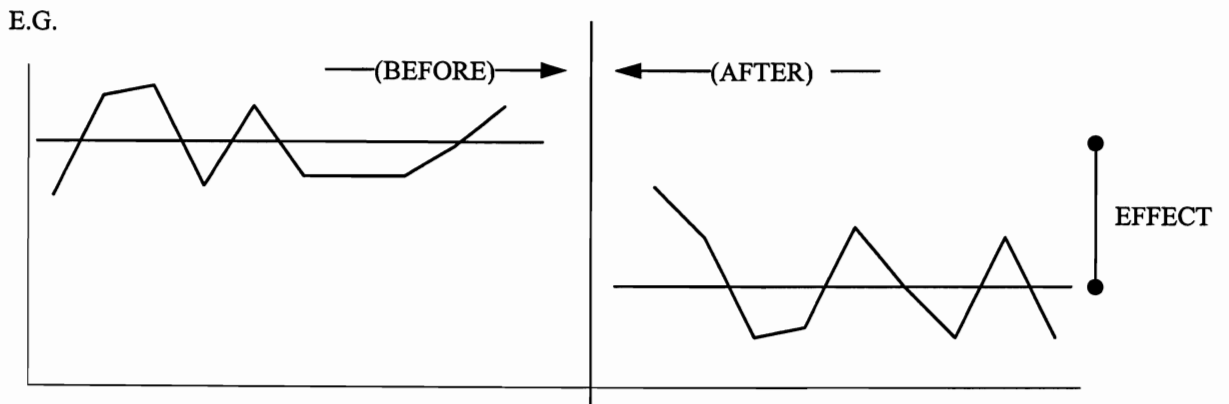
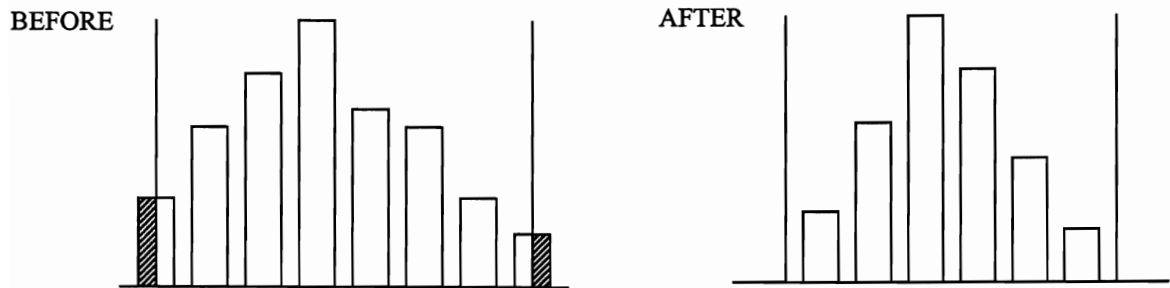


Table 12 - Graph



APPENDIX

Table 13 Histogram



Compare Before and After

The feature/characteristic that is being compared is dependant on what you want to show i.e.

- Production/volume increase
- Decrease in cost
- Decrease in defect

Action Stage

Step 10. Standardising

Fixing the Operation

If the fault is to be prevented from recurring the following items need to be considered:

- Standard operation sheet revised
- Cycle time revised
- Standard machine condition revised
- Operator trained to new operation
- Checks on the operation and quality carried out daily for 2 weeks (returning to previous method often happens within two weeks after change).
- Visual management used to monitor effect i.e. control charts, checklists

Extend Countermeasure

Extra benefit from the activity can be gained if the countermeasure is applied elsewhere; such as to other

APPENDIX

- Operations
- Machines
- Sections
- People

Step 11. Review And Future Action Plans

This is the final step in the process and there are 3 aspects to consider:

- 11.1. Review activity
- 11.2. Report findings
- 11.3. Consider future activities

Let's look at these aspects in more detail

Review Activity

The activity as a whole needs to be reviewed from three angles:

a) Process

- how well has the countermeasure worked and
- how worthwhile was the gain that was achieved
- how long and what methods will be used to monitor the process

b) People

- how well did the TQ Story method team perform in each of the 11 steps – i.e. what went well or not so well

c) Outcomes

Report Findings

The findings are reported in 2 ways:

- Written report, which is based on the 11 steps of TQ Story and the visual tools and documentation used during the entire activity
- Presentations to supervisors and zone members which are based on the 11 steps of TQ Story and the visual tools and other documentation that was used.

APPENDIX

Consider Future Activities

Points to consider here are:

- Is any follow up action/monitoring needed on the concluded activity
- What topic(s) could be considered for future TQ Story method activities.
Possibly review the topic analysis at Step 1 for the topic(s) that came 2nd, in terms of the need to resolve (although faces/data could have changed in the meantime).
- A schedule (Gantt chart) could be the most likely tool to use at this point, to lay out the intended plan for the future.
- What was achieved as a result of the application of TQ Story Method

TQ Story Conclusions

The use of standardised TQM tools such as TQ story, via Policy Deployment to enable process change is not reported elsewhere. These sections have described these per-existing tools. The following sections will describe their specific implementation in the case company; reflecting on the impact for RFT Design (as an objective) and on TQ Story-Policy Deployment-Process Change (as a tool set).