Performance Measurement in the
Product Development Process

Doctor of Engineering in Automotive Engineering

Research Project 1

THE CHANGING STRUCTURE OF THE GLOBAL AUTOMOTIVE INDUSTRY

by

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ABSTRACT

This report describes the first of three projects that combined form a submission for an Engineering Doctorate (EngD) with the overall title of 'Performance Measurement in the Product Development Process'. The initial project provides a detailed critical analysis of the current issues within the automotive industry and thus sets the scene and defines the parameters for the subsequent product development (PD) focused projects. The project isolates the issue that leads to the core opportunity to contribute to the author's organisation and professional practice.

The research accesses some of the most senior PD staff in the global automotive industry in order to identify trends and drivers and how they impact on automotive PD. The project then also considers the resulting implications for the industry participants involved in automotive PD.

This project will show that consumer demand for new products coupled with product life-cycles becoming shorter has resulted in significant increases in new product launches that must be delivered by automotive PD departments.

Most of the industry's OEMs collaborate and outsource work as described in the literature, but this research identifies a significant perceived failure of OEM Full Service Supplier (FSS) relationships that is not reflected in the academic literature.

The use of computer based techniques continue to develop and respondents identified that key to their further implementation will be people who are able to operate in a culture that trusts the simulations.

The outcome of this project is clear evidence that new and substantially improved methods are needed for monitoring and managing the PD process in the global automotive industry. The efficiency of the automotive industry PD process must improve to enable a greater array of new products to be brought to market without a commensurate increase in PD resource levels.

THE CHANGING STRUCTURE OF THE GLOBAL AUTOMOTIVE INDUSTRY

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Glossary of Terms

CAD- Computer Aided Design

CAE- Computer Aided Engineering

DMU - Decision Making Unit

ESS - Engineering Service Supplier

FoE - Ford of Europe

FSS - Full Service Supplier

IAD - International Automotive Design

GM - General Motors

OEM - Original Equipment Manufacturer

PAG - Premier Automotive Group

Q1 - Ford Motor Company Quality Standard

SME - Small Medium Enterprise

SWOT - Strengths, Weaknesses, Opportunities, Threats

Tier 1 - Tier 1 Supplier

VW - Volkswagen

1 Introduction

1.1 Project Context

This project is the first of three projects that combined will form a submission for an Engineering Doctorate (EngD) with the overall title of 'Performance Measurement in the Product Development Process'. This initial project will provide an overview of the current issues within the automotive industry and thus set the scene and define the parameters for the subsequent Product Development (PD) focused projects.

1.2 Aims and Objectives

The emphasis of Project 1 is to explore the current issues within the automotive industry and how they impact on PD strategies.

The project also investigates the roles and responsibilities of the various types of organisations that participate in PD in the global automotive industry:

a. Original Equipment Manufacturers
b. System Suppliers
c. Engineering Service Suppliers

1.2.1 Aim

The aim of this project is to provide a critical insight into the current structure of the global automotive industry and by analysing the current issues and the changing environment, propose possible future states for the industry and identify the consequences for participants involved in PD.

In particular, the project will focus on aspects of the industry that impact or drive future PD strategies in terms of why new vehicles are needed, how they will be developed and who will develop them.

1.2.2 Objectives

Within this context the project objectives are to:

1. Investigate the current status of the global automotive industry and the roles of various organisations involved in automotive PD:

    i. Outline the recent history and current status of the global automotive industry.

    ii. Determine the current segmentation within the industry.

    iii. Identify the current roles and responsibilities of the participants within the industry.

2. Describe industry trends and drivers and how they will impact automotive PD:

    i. Identify the influences, both internal and external, that are being exerted on the industry.

    ii. Consider the resulting consequences for the automotive PD process.

    iii. Consider the resulting implications for the participants involved in automotive PD.

1.3 Statement of Scope of Work

This project will initially provide a brief overview of the development of the global automotive industry and discuss how this has affected PD strategies.

Primary research will identify and analyse the views of senior managers and leaders from within the automotive industry regarding its current state, future trends and their implications for PD strategies and processes.

This will then be followed by a literature review intended to compare and contrast the opinions of those involved in the initial research. The structure of the research will follow the objectives and research questions identified previously.

Analysis of the research undertaken will aim to provide an overview of the current issues within the automotive industry and thus set the scene and define the parameters for the subsequent PD focused projects.

To this end, this project will consider automotive PD in its broadest sense from initial planning of new products, through concept design, engineering development, testing and production implementation. However, manufacturing considerations such as location of factories and the processes involved in building vehicles will not be considered in detail other than where they impact on the PD process.

The aim of the literature review is to summarise and critically evaluate the available knowledge in the form of relevant published work and studies within the context of the thesis's primary research questions.

The framework below (Fig. 1.3.1) was developed for research:

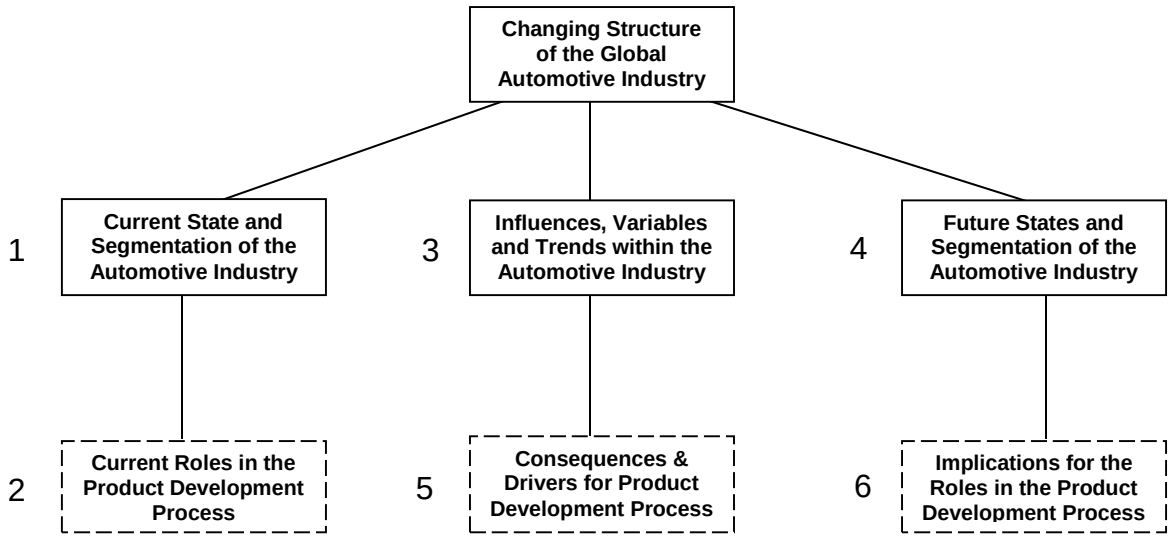


Figure 1.3.1 – Project 1 Research Framework

The literature review primarily considers the questions 1 to 2 and the primary research questions 3 to 6.

1.4 Structure of the Report

Chapter 2 includes a brief history of the automotive industry, describes the various organisations involved and introduces the concept of collaboration in PD.

Chapter 3 investigates the research questions, outlines the empirical research and tabulates and evaluates the results.

Chapter 4 discusses the implications for the automotive PD process and identifies the forthcoming focus of this Engineering Doctorate.

Conclusions are drawn in chapter 5 and recommendations for future work made in chapter 6.

2 The Automotive Industry

The global automotive industry is a little over 100 years old and has matured into an industry capable of producing 70 million passenger cars and light commercial vehicles per annum. However, demand in 2009 was significantly reduced by the financial crisis of late 2008 resulting in sales of 62 million (OICA, 2010). Many of the vehicle manufacturers (VMs), particularly in North America where sales have dropped from a pre-crisis norm of 16-17 million to 10.4 million units in 2009, are struggling to make a profit and are achieving sales by offering generous price and financing incentives. Margins are therefore very thin.

Sales in Western Europe also declined in 2009 and this combined with rising competition and excess capacity was expected to result in poor profit margins that would focus attention on cost cutting. Japan saw car registrations fall by 31.5% in 2009. Asia, excluding Japan, saw demand growth of 9% in 2009, down from over 20% in 2002 and 2003. This dramatic slowdown was mainly as a result of the Chinese market cooling down after growth of 70% in 2003 to 16% in 2004. India became the fastest growing major car market in 2004 with demand growth of 24% and car sales exceeding 1 million units for the first time. Elsewhere, the Russian market rose by 6%, the Middle East and Africa saw growth of 13% and Latin America saw growth after significant decline in the previous year.

In summary, whilst the emerging markets are experiencing growth, in general the global automotive industry is stagnant with poor profit margins.

2.1 A Brief History

The development of the world's automotive industry is well documented (Chanaron, 1998). The first phase from 1890 until 1910 took place mainly in Europe and involved craftsmen building low volume individually tailored vehicles to their customers' requests.

The second phase of mass production was initiated by Henry Ford in North America with his assembly line approach. Phase three instigated by Alfred Sloan at GM offered customisation via a range of vehicles with different brands, e.g. Pontiac, Buick and Cadillac.

US domination of the industry lasted almost 50 years from 1910 until the end of the 1960's. This period also included the introduction of monocoque stamped steel bodies. Meanwhile in Europe the automakers developed small popular peoples' cars, e.g. the Mini, Volkswagen Beetle and the Citroen 2CV.

Globalisation gained pace in the 1960s with the emergence of the Japanese industry and its export strategy into Europe. The term globalisation refers to the shift toward a more integrated and interdependent world economy (Hill, 1998). The Japanese product offering combined the technical virtues of European models with progressive improvement of US mass production methods. Thus, the fourth phase is defined by lean production (Womack, et al., 1990) introduced by Toyota in the form of it Toyota Production System (TPS) typified by just-in-time delivery of parts and the *Jidoka* system of stopping the production line and finding corrective actions to problems as they occur.

In the late 20th century the automotive industry was very competitive as it continued to develop on a global scale. As a result, the 1990s saw Merger and Acquisition (M&A) activity at both the Vehicle Manufacturer (VM) and supplier levels (Lung, 2003) as companies tried to achieve economies of scale. Figure 2.2.1 shows how the number of companies operating in the automotive industry has changed since 1900. Whilst this consolidation has led to an industry consisting of relatively few major OEMs and suppliers, it should be noted that M&A activity does not guarantee success as the failed BMW acquisition of Rover Group in the UK demonstrated. In 2000, GM agreed to purchase a stake in Fiat with an option to buy the whole company by 2007, but by 2004 GM had to pay Fiat $2Bn to exit this agreement.

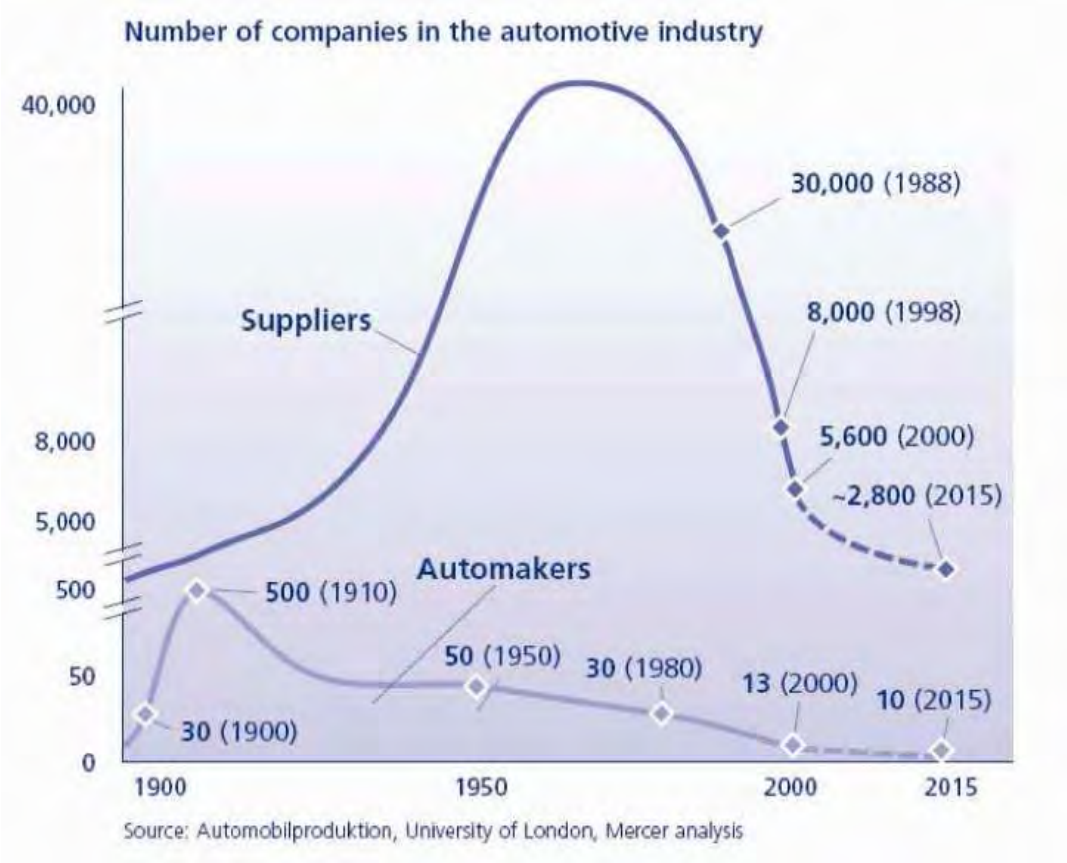


Fig. 2.2.1 – Number of companies in the automotive industry

(source: Becker, 2007)

2.2 Product Development in the Automotive Industry

Vehicle manufacturers (VMs), commonly referred to in the automotive industry as the Original Equipment Manufacturers (OEMs), must continually bring to market new innovative and exciting products if they are to survive current and future industry shake-outs. Goals such as zero emissions and zero fatalities have been set by legislators and the OEMs themselves. These all add to the pressure on the PD process.

PD is undertaken by most automotive OEMs with billions of dollars spent every year on designing and engineering new vehicles. This research programme aims to describe the global industry structure, identify the various roles undertaken within

automotive PD and ascertain the critical trends and drivers that will determine future PD success.

The competitive price situation in the automotive industry necessitates cost reductions in terms of component parts but also in capital expenditure on production tooling and PD. The latter two are typically amortised over the projected sales period for the vehicle.

Modularisation of the product facilitates collaboration in the form of OEM platform sharing and outsourcing of complete sub-systems to third party suppliers. These suppliers provide both products and services to the OEMs.

The trend of outsourcing and off-shoring of services also impact on the PD processes in the global automotive industry, e.g. hourly labour rates for engineers in India are considerably lower than those in the USA.

2.3 Collaboration in the Automotive Industry

Collaboration in the automotive industry exists on many levels. Four relationship strategies (Masella & Rangone, 2000) have been identified:

1. Partnership
2. Competitive Bidding
3. Securing Continuity of Supply
4. Systems Contracting

2.3.1 Partnership the Automotive Industry

As a means of sharing costs, joint ventures between OEMs in the automotive industry is commonplace, e.g. the almost identical Ford Galaxy and VW Sharan models that were built in a joint venture assembly plant in Portugal.

2.3.2 Outsourcing in the Automotive Industry

Over capacity and intense competition in the global automotive industry has led to outsourcing and supplier involvement in many areas as the OEMs have endeavoured to concentrate on their own core competences, e.g. product planning, concept design, final vehicle assembly and marketing.

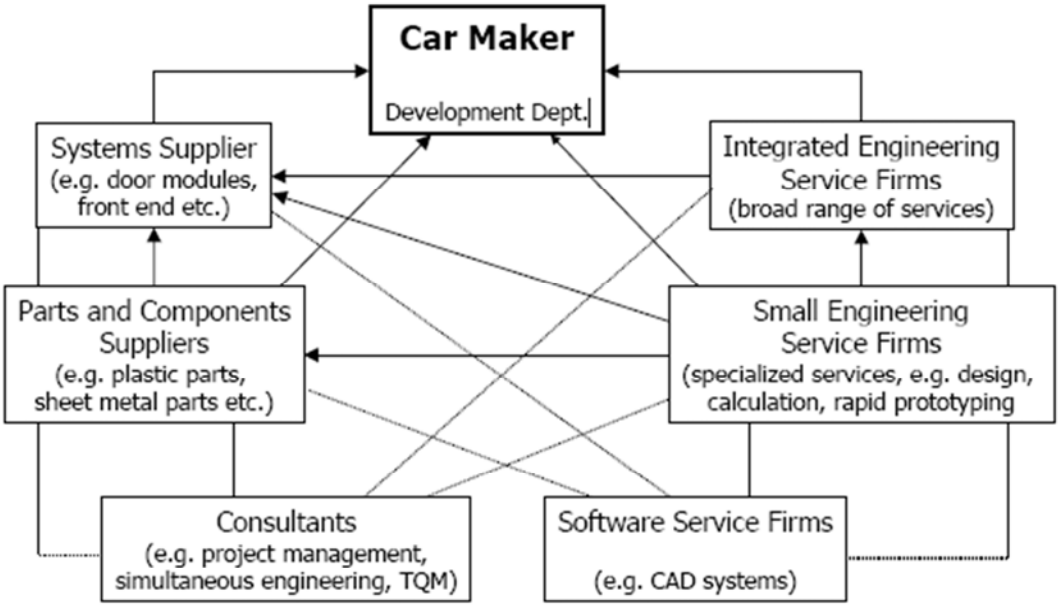
Moving assets (e.g. sub-assembly factories) off the OEMs' books to the balance sheets of suppliers increases OEM return on capital employed. This has led to less vertical integration within the OEMs. However, it should be noted that both Honda and Toyota regard high levels of internal assembly efficiency as a competitive advantage (Whitbread, 2003).

The OEMs have also attempted to reduce their supplier base, i.e. the number of suppliers, in an effort to reduce transaction costs. This has brought increased volumes for the chosen suppliers and the introduction of standardisation of quality control techniques.

Using technology and collaboration as dimensions (Kaufman, et al., 2000) identified four types of suppliers:

1. Commodity Suppliers
2. Collaboration Specialists
3. Technology Specialists
4. Problem-Solving Suppliers

Rentmeister (1999), figure 2.2.2, offered a model of collaboration identifying the two of the foremost types of suppliers to the car maker or OEM; the systems supplier and the Engineering Service Supplier (ESS).



Source: Rentmeister (1999: 13)

Figure 2.2.2 – Organisations involved in Automotive PD

(source: Rentmeister, 1999)

Not included in this analysis is the additional supplier segment of low volume contract assembly. For example, the BMW X3 variant was co-developed with Magna and is built by Magna-Steyr at its final assembly plant in Graz, Austria.

As previously stated, this project investigates PD in the automotive industry including the roles and responsibilities of its main actors:

a. Original Equipment Manufacturers (Car Makers)
b. System Suppliers
c. Engineering Service Suppliers (ESS)

A systems supplier that offers PD services to the OEMs, in addition to supplying modules or assemblies, is typically referred to as a Full Service Supplier (FSS).

3 Identifying Forces and Trends within the Automotive Industry

An initial literature search has shown that the macro level trends and drivers in the industry (MacNiell & Chanaron, 2005a) can be summarised as:

- Global Competition
- Legislation
- Consumer Demand

3.1 Research Objectives and Approach

The primary research sets out to verify the macro drivers previously identified in the initial literature search and then goes on to further explore the trends of collaboration and particularly outsourcing in PD in the automotive industry. This empirical research project is based on a survey of several global OEMs.

This is followed by a comprehensive literature search to further explore and expand on the initial findings. A further analysis comparing and contrasting the primary research findings, literature review and the author's own observations of the automotive industry and PD is then provided.

3.2 Research Questions

The following research questions are derived from the objectives:

1. What is the current state of the global automotive industry?

2. How is the industry segmented and who are the participants in the PD value chain of the automotive industry?

3. What are the trends and drivers within the global automotive industry?

4. What is the future state of the industry?

5. What are the consequences for the PD process in the global automotive industry?

6. What are the implications for the organisations involved in PD in the global automotive industry?

3.3 Methodology

Objectives 1 and 2 were researched by means of a literature review on the current status of the global automotive industry and the roles of various organisations involved in automotive PD. Primary research then sought to confirm the findings of the literature review and also identify further industry trends and drivers and how they impact automotive PD.

The overall methodology for project 1 involved the gathering of research data from three main sources:

1. Opinions and views of experienced industry leaders and experts.
2. Proven knowledge – peer reviewed journals.
3. The author's own observations based on historical case studies.

The criterion used in the initial literature search was global automotive industry trends with applicability to the PD process, but not manufacturing related trends.

3.3.1 Quantitative Methodology

Quantitative methods are associated with enumerative induction based on the quantification of data. These methods are used to find general patterns and relationships among variables. The strengths of quantitative methods are ease of control and accuracy. Control is achieved by scientific sampling and data collection whilst accuracy is derived from reliable analysis and measurement of the data.

3.3.2 Qualitative Methodology

Qualitative methods are those by which the researcher can create knowledge assertions based primarily on constructivist perspectives. Hypotheses can be constructed from engagement with participants and exploration of emerging themes (Maxwell, 1996).

Qualitative methods can be viewed as research methods that emphasise words, rather than quantification in the collection and analysis of data. They tend to investigate the importance of the subjective and experiential to capture how participants interpret complexity. Therefore, qualitative methods are employed when there is a need to discern patterns, trends and relationships. Clearly there are risks associated with subjective data and great care is required to identify truly authoritative voices.

Qualitative methods were employed predominantly in this research programme as the author wanted to establish inherent traits and characteristics of the PD process. The distinctive characteristic of hypotheses or propositions in qualitative research is that they are typically formulated after the researcher has begun the study.

Qualitative researchers rarely engage in statistical significance testing (Maxwell, 1996), but rather state their ideas about what is going on as part of the process of theorising and data analysis. However, data analysis does include quantitative

assessment by collating descriptors used, comparing for similarities and grouping into themes.

3.4 Research Methods and Techniques

The research methods or techniques considered appropriate to this project are:

1. Derived from the research questions and the finding of the initial literature search, a questionnaire sought to inquire as to the influences on the PD process as well as the types of collaboration and supplier relationships the companies had used in new PD.

2. Informal semi-structured interviews of key informants in the industry leaders and experts. It is considered that these will yield better results than formal questionnaires as the interviewees are likely to be conscious of the confidentiality aspects of new PD and its processes in the automotive industry and thus will be reluctant to put their views in writing.

3. Literature review of knowledge and best practice in the relevant subjects

    1. Books, journals, papers and industry trade magazines
    2. Desk research

4. Triangulation of results.

A semi-structured in-depth interview technique based on a pre-prepared questionnaire was used. Derived from the research questions, the questionnaire used as a basis to the interviews sought to inquire as to the influences on the PD process as well as the types of collaboration and supplier relationships the companies had used in PD.

3.4.1 Questionnaire Design

A questionnaire was developed for use in semi-structured interviews with senior PD executives of the major OEMs. The questionnaire was used to frame the discussion without leading to any specific answers.

The questionnaire was developed based on scientific principles (Munn & Drever, 2004) such that:

1. The subsequent data analysis was considered prior to design the structure of the questionnaire.
2. The questions sought to enquire further about the application of the performance measures of PD established in the literature survey.
3. The questions were predominantly structured rather than open.
4. Where open questions were used this was at the end of sections to offer the respondents the opportunity to offer additional information.
5. Suggestion was avoided.
6. A professional appearance and layout was developed.
7. The order of the questions was carefully considered with easier (e.g. general or biographical type) questions put first to ease the respondent into the task.
8. The number of questions was limited as excessive size can reduce response rates.
9. The questionnaire was piloted with a small representative sample initially.

The questionnaire was trialled with a pilot group of OEM PD managers that represented the sector. These were chosen based on their industry experience and interaction with senior managers and the corporate decision making process. The outcome was that minor changes were made in terms of the perceived size of the questionnaire as some managers felt that too long a questionnaire may dissuade some of the target group from participating.

The questionnaire included structured questions on the type of PD collaboration and outsourcing employed by the participants and also open-ended questions to illicit their opinions on PD performance and future industry directions. Each interview took between one and two hours to complete.

The final questionnaire was presented in 3 sections addressing:

- Influences and trends in the industry.
- Collaboration and outsourcing on PD projects.
- Implications for the future.

The final questions were deliberately left more open ended to allow the interviewees to provide other information they felt relevant to the discussion.

3.4.2 Interview Technique

The author sought advice on interview technique (Kvale, 1996) prior to organising the data collection events. Based on the findings of this advice, it was decided to conduct face to face interviews, rather than over the telephone, despite the fact that these would be time consuming and resource intensive. This was because it was important to get to the real feelings and opinions of the key informants. The interview process was rehearsed with senior members of the RLE management team and care was taken not to bias the results. However, the interviewer did have the opportunity to probe or ask follow up questions.

Rather than use closed, fixed-response interviews, where all interviewees are asked the same questions and asked to choose from among the same set of alternatives, a standardised interview with open-ended questions was chosen. The standardised questions allowed the time and structure to be controlled and responses analysed, whilst the open-ended approach allowed the interviewees to expand on certain key responses.

The in depth interviews with the identified key informants were conducted over two days at the Geneva motor show where the author had established that most of the major global OEMs would be represented by their senior management including their PD leadership teams. This also provided a setting with little distraction during the interviews as there are private meeting rooms behind stands at the Geneva show.

At the interview the background to the research was explained and confidentiality assured. The author explained the format and indicated that the interview would take a little over on hour to complete. The questionnaire was used to frame the discussion without leading the interviewees to any specific answers. Rather, it was used steer of the interviews whilst eliciting answers. The interviewer took written notes rather than using a tape recorder as this may have put the interviewees more on guard in terms of their responses. The notes were transcribed later for analysis.

The interviewer was able to follow up with two of the respondents, GM and Aston Martin, at a later date to clarify response and some key points. For example, the Aston Martin respondent stated that they had not used outside build companies but the author had established that Zagato of Italy had designed and built specific models.

3.5 Sources of Information

In project 1 it was important to seek the opinion of senior industry practitioners with solid industry oversight. The profile of the sample group identified comprised of individuals with significant overview of PD in the automotive industry rather than detailed engineering responsibility. This was more important than canvassing the views of hundreds of individuals by a large scale survey or by using focus groups or futures research. As the quality of data collected would be directly related to the interviewees' industry knowledge and experience it was decided to target only senior PD executives at global OEMs.

The sampling logic for identifying who to be included in the data collection of the primary research was:

- Experience of PD
- Position in the Industry
- Global Responsibility

To ensure an efficient use of time it was ascertained that the best results would be attained at the press day of an international motor show with several new vehicle launches thus attended by the leaders of the PD departments of most of the global OEMs. The Geneva motor show was selected as it attracts most of the global OEMS.

3.6 Research Findings

Interviews were conducted with senior PD executives from the following companies:

- Aston Martin
- BMW
- GM
- Hyundia
- Kia
- Volvo

This range of companies includes representation from Europe, America and Asia. A confidential list of interviewees and their roles in their organisations is included in the project 1 report appendices, as is a letter and questionnaire used in the research. The author's company position enabled unique access to this highly experienced cross section of people whose insights are authoritative across a balanced array and scale of PD processes.

With regard to statistical significance, interviews were conducted with six of nineteen major global OEMs represented at the show. Ford declined to participate, and Chrysler, TATA and Daihatsu (Toyota Group) failed to supply email responses as promised. Whilst this seems, at first sight, to be a small sample, this is compensated by the combined experience and provenance of the key informants interviewed. For example, the Volvo respondent had over 30 years of automotive experience and managed a PD department of over 4,000 staff.

3.6.1 Interview Response Analysis

The following steps were taken to organise, categorise and summarise the data prior to final analysis:

1. Transcription of the Interview Notes
2. Grouping of Descriptors
3. Searching for Common Themes

Examples of interview notes and transcriptions are given at appendix 2 of this report.

Tables 3.6.1, 3.6.2 & 3.6.3 contain a summary of the results of the semi-structured interviews performed at the Geneva motor show.

	Question	Aston Martin	BMW	GM
1	Influences on PD at current time?	Customer demand will force OEMs to do lower volumes on common platforms. Also requires flexible manufacturing.	Customers, attributes, cost, production, product catalogue (package, emmisions, trim levels).	Cost (Investment, Piece & Engineering). India & China. Customer Expectations. Re-use more from global brands.
2	Future Trends and Drivers?	Further fragmentation with the winning companies recognizing and responding to the markets early.	Re-evaluation ongoing - re-define what can be done. Supplier capability. Own people capability, Software capability.	Don't know where it stops. China and now India learning quickly.
3	Collaborated with another OEM?	No	Not significantly. PSA engines.	Across GM brands. Also SAAB with Fiat premium platform. Common values more important than commom culture.
4	Outsourced PD to a Full Service Supplier (Tier 1)?	In a limited way with systems and sub systems such as IP and seats. Not successful and in each case was insourced before Job 1.	Not so much as BMW wants to keep core competences in-house. Examples might be ZF transmissions, Continental, Bosch.	Complete Interior in the USA. Expected to benefit from other OEM knowledge but didn't happen. OEMs will integrate in future.
5	Outsourced PD to Contract Vehicle Assembler (Tier 0)?	No.	Magna Steyr - BMW X3. Ricardo - Mini. Karmann - folding roof systems.	Magna Steyr. Needs good initial concept study to guarantee good performance. Miss this in the beginning and it fails.
6	Outsourced PD to an Engineering Service Supplier ?	No and would not plan to do this - it is vital to have direct control of the product development and quality.	Yes, but not a great deal.	Yes, but differing experiences. EDAG were best with clear objectives and targets at outset. Miss this in the beginning and it fails.
7	Have you brought people from outside into your PD centre?	Yes, very successful, it allows you to select experts in their field but integrate them into the broader team ensuring common vision.	Yes, e.g. FEV on Powertrain. Will do more of this.	Yes, from Fiat, Alfa and Tier 1s. Good performance. Also 15 man team from Bertrandt integrated into team.
8	Outsourced PD to a low cost country (LCC)?	No.	Yes, but more interested in local knowledge for marketing purposes, e.g. California and Japan. Also CKD incl. in 24 production site - 6 main.	Yes, and now bringing people from India inside PD centre, e.g. SAAB. New approach but happening more & more.
9	Outsourced PD to another type of company?	Testing work is often outsourced but requires excellent correlation to known test standards.	BMW has core competences but some with software and Rolls Royce Plc.	Advanced government funded projects for supplier interest groups on new processes. Important in EU as Japan have done this for years.
10	How will roles change in the future?	These must be a clear and unique expertise and value add for this alternative to internal control to work. These must be a clear and unique	BMW will keep all core competence work in-house but some non-core will be outsourece, e.g. service functions, test.	OEMS will take back integration. Outsourcing a complete interior was not a good idea.
11	What type of PD will be outsourced in the future?	Testing.	All customer relevant stays in-house - engine and drivability. However, manifold could be with Mahle. Integration of electronics is also core.	Powertrain as investment costs are high. OEM will integrate. Virtual simulation. Opel outsourcing model not as competitive as SAAB.
12	What type of technologies will be most important in PD in the future?	Design simulation and particularly for electronic systems above quality is hard to guarantee within normal testing regimes.	Simulation will grow. Reduction in cycle times. Emissions & safety. Technical integration, comfort. Big Step - sustainable mobility.	Simulation to reduce lead time. Road, aero and stamping simulation - Subaru tools are down to 7.5 months long lead parts. Need right people.

Table 3.6.1 – Summary of AML, BMW & GM Responses

	Question	Hyundia	Kia	Volvo
1	Influences on PD at current time?	Brand strategy (Customer). Legislation - pedestrain protection.	Customer & Costs.	Customer variation. Taxes & indirect legislation, e.g. diesel in UK. Incentives on alternative fuels.
2	Future Trends and Drivers?	More indiviual people. Less universal cars.	Customer more important.	Flexibility in market will increase with growth of new countries. China - cylinder displacement legislation.
3	Collaborated with another OEM?	Yes, with Fiat for parts.	No.	Platforms across Ford & PAG brands. Electronics with PAG. Diesel engines with PSA. Generally, good but some issues with culture & time zone.
4	Outsourced PD to a Full Service Supplier (Tier 1)?	Yes. Wasn't always successful.	Yes, sometimes successful but not always.	Yes, but swinging back in-house after 10 years. Only partially successful. Customer facing systems must be kept in-house.
5	Outsourced PD to Contract Vehicle Assembler (Tier 0)?	Yes, all the time. Cabriolet with Karmann and also Pininfarina.	Yes, can be rewarding. Design/Styling remains in-house.	C70 with Pininfarina. Styling was in-house. Successful but some issues.
6	Outsourced PD to an Engineering Service Supplier ?	Yes, it depends on necessity.	EDAG (fantastic) on CNG project. Lotus Engineering good know how and rewarding.	Yes, Semcon & Caran.
7	Have you brought people from outside into your PD centre?	Yes, successful.	Yes, but must maintain contract secrecy.	Yes, 1000 heads at peak. 300 in-house, 300 close and 300 distant (Pininfarina). Successful.
8	Outsourced PD to a low cost country (LCC)?	Yes, to India.	Not India for low cost but to Korea.	Only, indirectly with Tier 1 (Delphi) to India for software programming. Successful and maybe do more.
9	Outsourced PD to another type of company?	No.	Benchmarking and pre-studies	No
10	How will roles change in the future?	Companies must adapt to clients needs.	More specialism, e.g. Fisker Coachbuild.	Closer management of Tier 1s. Must establish networks with low cost countries. Knowledge base plus low cost.
11	What type of PD will be outsourced in the future?	No idea at moment.	Body construction. Also, SWAT teams for quick projects.	No change - 80% should be done in-house. Facelifts can be outsourced to ESS with toolmaker - improve data flow in 3D design.
12	What type of technologies will be most important in PD in the future?	Virtual technology for efficiency and speed. Satelite studios to monitor market trends.	Computers, e.g. Alias for computer aided styling (CAS or CAID) However, needs human touch.	Virtual Engineering & Prototyping - but needs management focus. FEA & CAE - develop skills of people & culture. More NVH & verification.

Table 3.6.2 – Summary of Hyundai, Kia & Volvo Responses

	Question	Summary of Responses
1	Influences on PD at current time?	Customer Expectations (x6) , Cost (x3), Legislation (x3), Platforms/Re-use (X2)
2	Future Trends and Drivers?	More variety of product and customisation to meet market needs
3	Collaborated with another OEM?	Varies depending size of Group (e.g. GM / Ford) but generally successful.
4	Outsourced PD to a Full Service Supplier (Tier 1)?	Yes, but overall discontent. Reversal of outsourcing strategy in place in 50% of responses.
5	Outsourced PD to Contract Vehicle Assembler (Tier 0)?	Yes, and overall positive after design concept is complete.
6	Outsourced PD to an Engineering Service Supplier ?	Yes, but differing results. Clear agreement on specifications needed at start.
7	Have you brought people from outside into your PD centre?	Yes, and overall positive.
8	Outsourced PD to a low cost country (LCC)?	50/50 - but general satisfaction.
9	Outsourced PD to another type of company?	Testing, software, research and benchmarking.
10	How will roles change in the future?	OEMs will take reponsibility for integrating customer interfacing systems and not rely solely on suppliers to deliver end customer value.
11	What type of PD will be outsourced in the future?	Varied: Testing, Powertrain, Simulation, Body & Facelifts.
12	What type of technologies will be most important in PD in the future?	100% response for virtual simulation (CAx) tools. 50% respondents stressed human/people/cultural aspects of this future trend.

Table 3.6.3 – Summary of Responses

3.6.1.1 Current Influences

Increasing global competition based on cost and legislation was mentioned by 50% of interviewees and customer expectations were stressed by all respondents. Additionally, the interviewees didn't expect to see a significant change, i.e. reduction, in the challenges of balancing customer needs with the cost pressures resulting from global competition.

3.6.1.2 Future Trends and Drivers

Customisation of designs and further derivatives to meet increasing diversity in global consumer demands was a common theme as the respondents recognised the regionalisation of markets and their differing tastes.

3.6.1.3 OEM PD Collaboration

The larger groups such as Ford and GM have acquired several brands over the last decade and encouraged platform sharing across their family of vehicles. For instance, Volvo is using Ford platforms for several of its new vehicle. OEMs also collaborate outside of their immediate company groups. Collaboration between SAAB and Fiat was mentioned.

3.6.1.4 Use of Full Service System Suppliers

Most of the OEMs has utilised FSS support to develop and integrate modules and sub-systems. However, there was a general dissatisfaction with this model and the OEMs had come to learn through experience that the FSS integration capability was short of expectations.

3.6.1.5 Use of Contract Assembly

The use of outside companies to build production level vehicles was generally positively recognised with a high level of engineering capability provided.

3.6.1.6 Use of Engineering Service Suppliers

The majority of the respondents had used ESS support but there were differing responses in terms of satisfaction. Positive comments were made about German planning and organisation and the flexibility of UK based companies.

3.6.1.7 People Leasing for PD Support

Also referred to staff augmentation or labour leasing, all respondents has used external people and had positive experiences.

3.6.1.8 Use of Low Cost Country PD Resource

Half of the respondents had used low cost country labour and they were generally satisfied with the results.

3.6.1.9 Other PD Outsourcing

Vehicle and sub-system testing were often outsourced by the OEMS. A growing need for software development capability was identified.

3.6.1.10 Changing Roles in PD

OEMS will take back responsibility for integration from the FSS because of dissatisfaction with their delivery.

3.6.1.11 Future PD Outsourcing

Testing services and Powertrain development were mentioned. A significant need for

Simulation support and Body Engineering services, particularly face-lift or mid-cycle actions, was highlighted.

3.6.1.12 Future Technologies in PD

Computer Aided (CAx) tools for virtual simulation was listed by half of the respondents.

3.6.2 Summary of Primary Research Findings

In summary, the OEMS had tried various method of PD collaboration with differing levels of satisfaction. Of major note was the dissatisfaction with FFS integration services.

The need for virtual simulation services was heavily stressed by fifty per cent of interviewees.

3.7 Secondary Research

Secondary research in the form of literature review was employed to further the understanding of trend of globalisation of the industry and the roles and responsibilities of the various actors within automotive PD.

Becker (2007) provides an analysis of the mega trends that will affect the automotive industry until 2015:

1. Volume markets in saturation.
2. New orientation of global production locations.
3. Brand orientation of buyers' preferences.
4. Asian competitors on the advance.
5. Changing energy supply conditions.

Within the context of an industry suffering intense competition and on-going structural changes, eight trends were identified (von Corswant & Fredriksson, 2002):

1. Increasing importance of key performance criteria (e.g. delivery precision, quality and cost).
2. Product life-cycles become shorter.
3. Production and PD activities become more globalised.
4. Outsourcing is increasing (cost of purchased material).
5. Companies reducing their supply base.
6. PD time is decreasing.
7. Suppliers account for an increasing share of PD resources.
8. Use of Just-In-Time deliveries is increasing.

However, von Corswant and Fredriksson (2002) found that whilst all eight trends were recognised by suppliers, proposals 3 and 4 were not supported by the European OEMs. With regard to OEM and supplier relationships Lung (2003) identified the industry trends as:

1. Greater outsourcing and activities sold off or spun–off.
2. OEMs deal directly with and pass responsibilities to fewer larger suppliers.
3. Design responsibility given to Full Service Suppliers (FSS).
4. Development on platform strategies.
5. System integration and modularisation.

6. Supplier parks.

7. Global sourcing to larger suppliers built by acquisitions.

3.7.1 The Global Automotive Industry

The automotive industry is a truly global industry.

3.7.1.1 Globalisation

The term globalisation refers to the shift toward a more integrated and interdependent world economy (Hill, 1998). Whilst some commentators describe its development from roots in the 18th century industrial revolution in England, through the development of the internal combustion engine and finally with the widespread information access via computers (Warnecke, 1993) the more recent stages have been:

- Financial globalisation (1970s)
- Commercial globalisation (1980s)
- Productive globalisation (current)

The automotive industry's traditional markets of North America, Europe and Japan are mature. Known as the Triad nations, growth in these regions was only 8% in the 1990s. Significant growth beyond these traditional geographic markets will be found in the emerging markets of Asia and South America.

Thus, the major OEMs of the Triad nations seek to extend their global footprint with new production facilities to supply to these markets. Increased production volumes bring benefits of economies of scale via platform sharing strategies and increased purchasing power. This explains the increased merger and acquisition activity seen since the turn of the century. Examples in the last ten years have included:

- The merger of Daimler and Chrysler (Chrysler also had a 33.4% stake in

Mitsubishi and 10% of Hyundai)

- Ford acquisition of Volvo and Land Rover. Ford already owned Jaguar and Aston Martin.
- GM acquisition of SAAB
- Renault and Nissan Alliance (Renault owns 36.8% of Nissan and also 70% of Samsung)
- Toyota's increased control of Daihatsu

However, these alliances do not always bring the desired benefits. Ford, GM and Daimler have since, by 2009, sold all of their acquisitions listed above having been unable to manage the complexities and cultural issues they encountered. The VW Group has been more successful with the integration of acquisitions and has developed a complex platform strategy for its products across its subsidiaries:

- Audi
- SEAT
- Skoda
- Lamborghini
- Bugatti
- Bentley
- Porsche

Several of the multi-national organisations have also attempted to design the so-called "World Car", (Camuffo, 2001), to be sold in several global markets:

- Ford Mondeo, (Ford Contour & Mercury Mystique in the USA) – a $6bn project.
- Fiat Palio – world car family with production in 6 global plants.
- Renault/Dacia Logan - low cost car with production in 6 global plants.

These initial Ford and Fiat programmes were not a global sales success. However, Ford has since successfully developed the Ford Focus for global sales and the Logan is

selling well across very different global markets.

The main reason why these global programmes have suffered in the market place has been regionalisation, i.e. differing tastes in different markets. For example, in North America pick-up trucks account for a significant percentage of sales. This is also the case in Thailand but this is due to local taxation levels (5% tax for pick-up trucks against 43% for cars) rather than customer tastes. In Europe pick-up trucks only account for 5% of the market. However, cars with a diesel engine account for 43% of sales in Europe, significantly greater than anywhere else in the world. In Brazil the preference is for 1000cc cars, whilst in the ASEAN markets of Indonesia and Malaysia there is a preference for minivans over cars.

Continental Western Europe markets are traditionally dominated by their domestic OEMs, e.g. Fiat in Italy. The demise of larger vehicles produced by volume manufacturer e.g. the Ford Granada/Scorpio bears witness to the emergence of brand as a key differentiator and partly explains the Jaguar and Volvo acquisitions of Ford. However, the Mercedes brand successful move downstream into smaller cars, as it sought to increase sales volumes, demonstrates that premium brands are not only for larger cars.

Research by Kearney (2000) correctly predicted that the UK was developing as a premium automotive brand production and engineering centre. Whilst ownership of the brands has changed, in 2009, the vehicles of several premium brands are still produced in the UK:

- Rolls Royce - BMW
- Bentley – VW
- Jaguar Land Rover - TATA
- MG – SAIC, Nanjing
- Mini – BMW

The availability of low cost resources has generated a move to central Europe by the western European OEMs and Tier 1 suppliers, e.g. the Audi TT plant in Hungary.

In North America, Ford and Sloan at GM defined the first two revolutions of the global automotive industry (Maxton & Wormald, 2004). In the early 20th century the North American industry was categorised by high degrees of vertical integration, e.g. Ford in the 1920s had its own steel mill and forging operation. GM followed suit and integrated Fisher Body into its own organisation.

By the 1980s, the North American so-called "Big three" started breaking down these vertically integrated organisations with Chrysler forming strategic alliances with suppliers and concentrating on design, assembly and marketing.

At the start of 21st century the 'The End of Detroit' (Maynard, 2003) described the "Big Three" as focused on high profit light trucks and SUVs whilst the Japanese OEMs created a dominance in family and economy cars, introduced new brands (Lexus, Acura, Infiniti) for high margin luxury cars and then moved into minivans (Honda Odyssey) and cross-overs (on car platforms). Muller (2006) described some if the reasons 'Why Detroit Can't Compete':

- Sales Incentives – destroying profit margins.
- Labour Costs – union based labour.
- Legacy costs – pensions and medical.
- Interest – junk bond status leading to high borrowing costs.
- Excess capacity – too many factories.

Profits, where they did exist, quite often have come from finance operations such as General Motors Acceptance Corporation (GMAC). The concentration on products was lacking. Some cost reductions were achieved by moving production to Mexico which is part of NAFTA (North American Free Trade Agreement).

Likewise, in South America production plants have been established in the Mercosur nations of Argentina and Brazil. These relatively new plants have seen experiments in modular manufacturing driven by supply and PD strategies e.g. the late 1990s' Ford Amazon project in Brazil with 15 primary full service suppliers with own their factories adjacent to Ford's final assembly plant. Both GM and Chrysler have attempted similar strategies in South America with Chrysler going as far as receiving a rolling chassis, complete with wheels and tyres plus three hundred other parts, from its supplier Dana.

Asian markets differ significantly in structure and industrial capability (Veloso & Fuchs, 2004). However, in most countries the markets have been dominated by local firms as a result of protectionist policies.

Traditionally the leader of the automotive sector in Asia, Japan's industry developed in the post war period with a focus on quality and efficient production systems. It emerged as a significant industry force in the early 1970s as a result of the oil crisis as consumers demanded smaller more fuel-efficient cars.

At the end of the 1990s Japanese OEMs controlled approximately 75% of the South-East Asia market. European and Korean companies accounted for the majority of the remaining market share with US OEMs having a very small share. However, at the same time the Japanese market share in North American had grown to 40% of sales.

South Korea emerged as significant player in the automotive industry in the late 1980s and prior to the Asian financial crisis in 1997 had five domestically owned OEMs:

- Daewoo
- Hyundai
- Kia

- Samsung
- Ssangyong

It is worth noting that in 2008, as a result of the crisis and various corruption scandals none existed as they did;

- Daewoo absorbed Ssangyong and is now owned by GM
- Samsung is now owned by Renault
- Hyundai acquired Kia

3.7.1.2 Focus on the BRIC Nations

The BRIC nations, as categorised by Goldman Sachs, (O'Neill, 2001) of Brazil, Russia, India and China are experiencing year on year sales growth.

3.7.1.2.1 Brazil

Brazil has no domestic brands but has attracted significant interest from the global OEMs for production facilities. Consoni and Quadros (2006) describe the local PD capability of GM with the development of the Meriva in Brazil. This derivative on Corsa platform is now for sale in Europe as well as South America. This provides a good example of how local PD teams can be created to deliver complex projects. The project used Virtual Proving Ground software.

3.7.1.2.2 Russia

AutoVaz in Togliattti and Gaz are native Russian OEMs but export only a small percentage of their products. Several western OEMs have or are considering building plants in Russia.

3.7.1.2.3 India

The booming economy of India is experiencing annual growth rates in excess of 10% and in 2004 passenger car sales exceeded 1m units for the first time. Maruti Udyog is the market leader with 51% of passenger car sales followed by Hyundai and Tata Motors.

Of notable mention is the development by Tata of the Indica. Whilst it is sold as the City Rover in the UK it was developed by Tata at a cost of $400m without any financial or technical assistance from foreign OEMs. Tata, traditionally a truck manufacturer, leveraged the knowledge it had gained by improving the fit and finish of its pick-up trucks, sought technical support from suppliers and also employed the skills and experience of an outside independent design and engineering consultant in the form of IDEA of Italy (Venugopal, 2005).

3.7.1.2.4 China

Government controlled economic reforms are fuelling the transition to a full market economy in China. China is viewed by the OEMs as the largest growth market.

In 1997 GM entered into a 50-50 joint venture with Shanghai Automotive Industry Corporation (SAIC)

China has developed into the third largest automotive sales and manufacturing country in less than a decade with 30% annual growth in privately owned vehicles.

Many of the Triad nation OEMs are forging links with Chinese OEMs, figure 3.7.1.2.4.

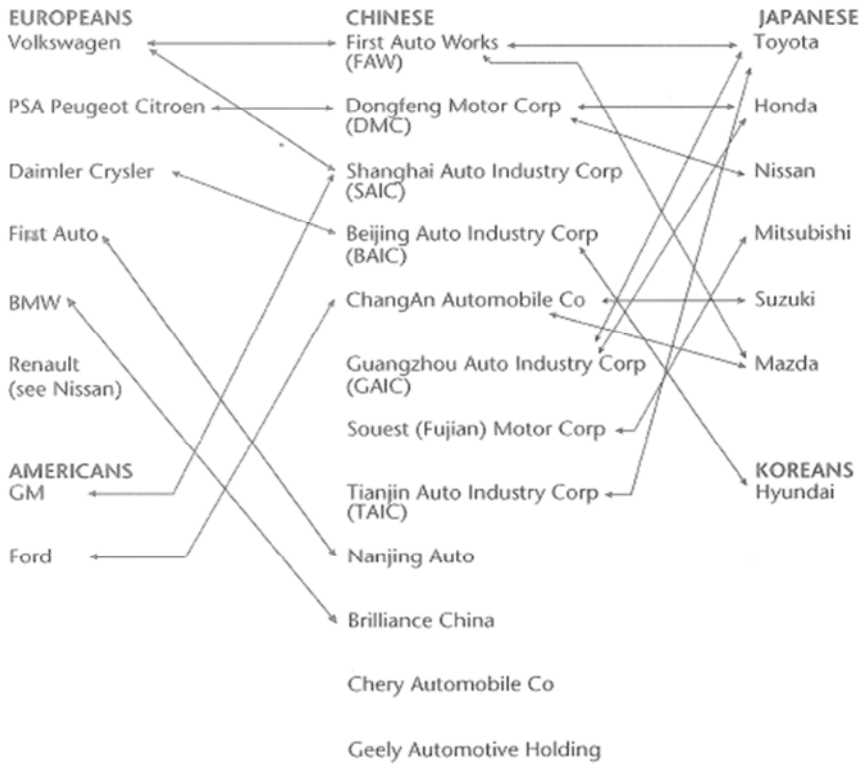


Figure 3.7.1.2.4 – Automotive OEM Partnerships in China (Norcliffe, 2006)

The ultimate sale of the assets of MG Rover to Shanghai Automotive Industry Corporation (SAIC), partly via Nanjing Automobile, will likely be one of the first of many mergers and acquisitions by Chinese OEMs in the global automotive industry.

3.7.2 Global Product Development Strategies

The emerging economies can also bring low cost development capabilities. Ford opened a technical centre in Chennai, India in 2001 and GM followed suit with a technical centre in Bangalore, India in 2003.

Renault relied on its Dacia PD centre in Romania to develop the Logan to be sold in several global low cost markets. The partnership with Avtovaz of Togliatti, Russia gives the Renault and Nissan alliance access to 4,000 low cost engineers.

OEMs are now looking further afield, evidenced by Nissan's more recent PD centre opening in Hanoi, Vietnam in 2008 (Figure 3.7.2).

Fig. 3.7.2 – Nissan Global PD Centres, February 2008 (source: Nissan)

In 2007 Honda announced plans to create a PD centre in Guangzhou, China with its partner Dongfeng Motor Corporation.

3.7.3 Roles & Responsibilities in Automotive Product Development

In the 1980s, Western companies saw Japanese supplier relationships as a source of competitive advantage (Lung, 2003). The *Keiretsu* structures of OEMs and suppliers were seen to enable the Japanese OEMs to remain lean and flexible. These long term purchasing relationships involve cross-shareholding, personnel exchanges, collaboration and technology transfer.

These collaborative structures resulted in reduction in new model development time, shared cost cutting exercises and rapid response to fluctuations in demand.

The so-called *Chaebols* of Korea developed in a similar manner. Western companies had traditionally maintained a distant or arms-length relationship with suppliers in order to obtain low cost parts.

The role of what became known as the Full Service Supplier (FSS) developed in the west in the 80's and 90's. Prior to this the OEMs designed the majority of the vehicle components themselves and delivered drawing to their chosen suppliers. These suppliers were selected on mainly commercial aspects. This was known as a 'make to print' relationship.

A FSS is typically defined as a supplier of components or sub-systems that also designs and develops the parts rather than making them to drawings provided by the OEMs. This supplier involvement allows the OEM to take advantage of the suppliers' first-hand knowledge of the specific PD and production processes relevant to their particular component.

A good example of this is automotive seating where Lear Corporation and Johnson Controls dominate the global market. Larger full service suppliers such as Magna have become known as mega-suppliers or Tier 0.5 suppliers.

The 80s and 90s also saw North American OEMs spin off their component parts divisions:

- GM created Delphi
- Ford created Visteon

The strategy for Ford and GM was to reduce their fixed asset base and rely more on suppliers and competitive bidding for their components. However, by 2010 both Delphi and Visteon had filed for Chapter 11 bankruptcy protection having been unable to generate sufficient revenues beyond their former parent companies. In contrast, it is worth noting that Denso was a spin-off of Toyota in 1949 and it continues to operate as one of the largest suppliers in the global automotive industry. In Europe, Fiat sold its Magneti-Marelli assets but PSA has opted to retain ownership of its interiors division Faurecia. This entity supplies several other global OEMs with interior components such as instrument panels.

A power shift in favour of suppliers has been identified (Fine, 2000) and Maloni & Benton (2000) discuss power in the buyer-supplier relationship. Indeed, supply sector consolidations in the late 1990s and early 2000s resulted in many suppliers expanding their market and products significantly. This resulted in a situation where the Tier 1 FSSs often have a greater module and system development capability than the OEMs, e.g. interior capability at Lear.

OEM/supplier relationships are covered by Whitbread (2003) with the following conclusions:

1. OEMs will increasingly focus on strategic sourcing strategies as a means of securing competitive advantage.

2. Platform rationalisation is well underway but speed varies among OEMs.

3. Convergence in OEM/Supplier relationships is apparent but key differences persist.

4. Suppliers are increasingly adopting screening techniques to select the customers and /or models that will yield best returns.

5. Some OEMs could be side-lined by suppliers because of price pressures.

6. OEMs are questioning the real abilities of system and module integrators.

7. Senior management changes at OEMs can drive evolving sourcing strategies.

8. Supplier associations are intervening in supplier agreement issues.

An example saw Tower Automotive deciding not to supply frames for the Ford Explorer and stating "expected returns at targeted pricing levels did not meet our requirements". However, Tower subsequently filed for Chapter 11 bankruptcy protection. This fate has also fallen to several large North American suppliers including Delphi, Dana and Collins & Aikman. This is partly due to an increase in raw materials prices fuelled by high demand in Asia and increasing energy costs.

3.7.4 The Role of the Engineering Service Supplier

An Engineering Service Supplier (ESS) provides PD services to the OEM that can range from the development of a simple component all the way up to the complete development, prototype build and testing of a new model ready for production. In some cases low volume niche production of vehicles is also offered e.g. Pininfarina in Italy, Magna Steyr in Austria and Valmet in Finland.

Engineering service suppliers also support full service suppliers and other tiers of suppliers where they have a need for design and development services. It is not uncommon for a systems supplier to market it-self as a full service supplier without actually having the capability in-house. It purchases the engineering services as required.

At the start of the 21st century the global market for outsourced automotive engineering services was estimated to be around 4bn Euros and growing (DKBR, 2000). The split of the global market by region is shown in figure 3.7.4.1.

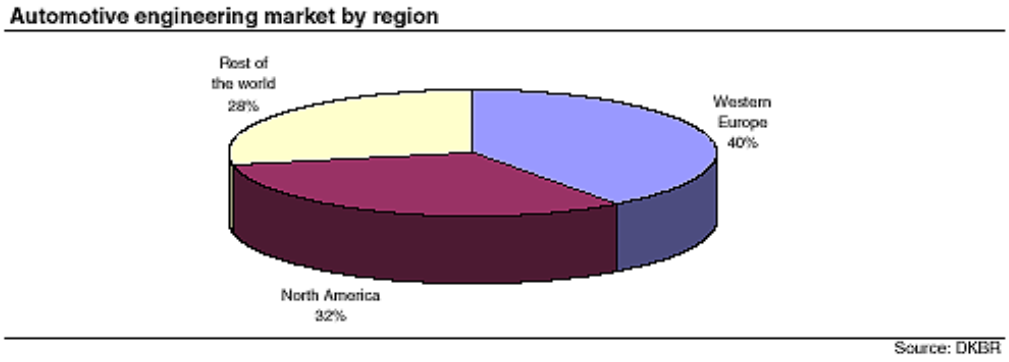


Figure 3.7.4.1 – Automotive Engineering Market by Region

(source: DKBR, 2000)

Ford Motor Company accounts for approximately 35% of the market in Europe. The Ford Motor Company outsources over £100m of its PD business in Europe per year of which 75% is performed in the UK. In 2005, in the UK, the Ford Motor Company

controlled the majority of the outsourced PD work available, as it owned Jaguar, Land Rover and Aston Martin via its Premier Automotive Group (PAG). The group also included Volvo Cars of Sweden at the time.

The major engineering service suppliers are tier 1, i.e. supply direct, to the OEMs and must be fully conversant with the various design and development techniques employed. Of significant importance are the preferred Computer Aided Design (CAD) systems utilised by the OEMs.

3.7.4.1 Engineering Service Suppliers – Segmentation

ESS development work is generally outsourced via one of two methods; as packages of work to be performed at the supplier's site or via leasing of personnel onto the customer OEM site.

The market is typical defined by industry analysts into three segments (figure 3.7.4.1.1):

- Styling and Design
- Vehicle Engineering (inc. Body Engineering)
- Powertrain Engineering

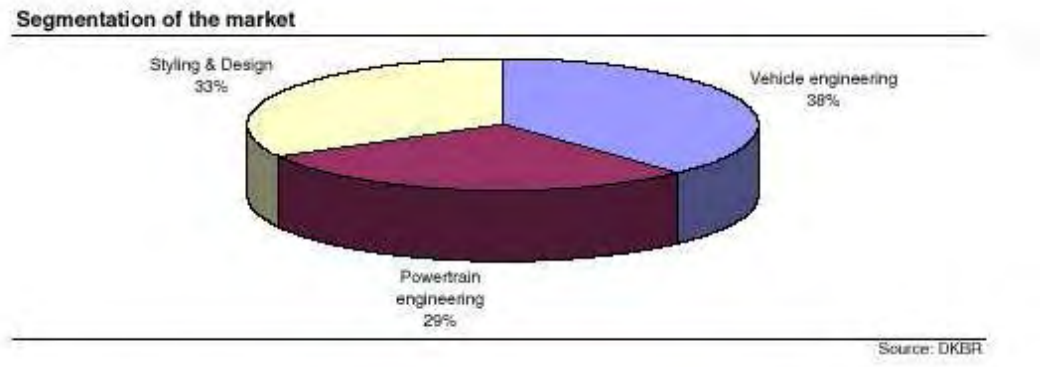


Figure 3.7.4.1.1 – Segmentation of the Automotive Engineering Market (source: DKBR, 2000)

3.8 Research Analysis Discussion

Maxton and Wormald (2004) describe an industry where:

- Technologies are increasingly mature and slow to evolve.
- Know-how has moved away from OEMs to suppliers.
- Distribution channels are not a protection.
- Large OEMs are in bad financial situations.

3.8.1 Customer Expectations

Consumer demand for a more varied product mix coupled with product life-cycles becoming shorter has resulted in significant increases in new product launches.

3.8.2 Product Trends

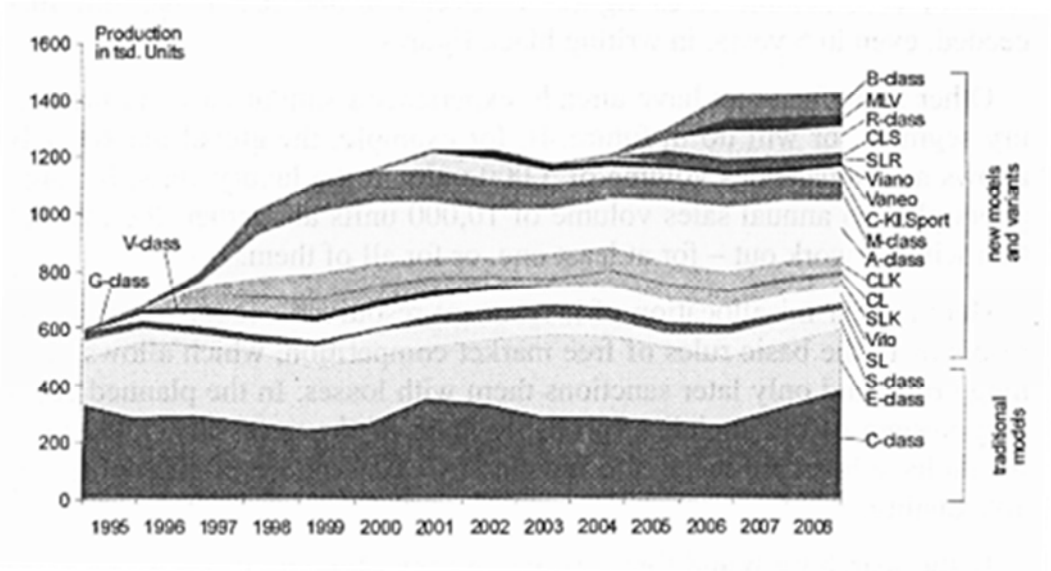


Fig. 3.8.2.1 – Mercedes Benz Models 1995 – 2008 (source: Becker, 2007)

Figure 3.8.2.1. shows the increase niche models in the Mercedes Benz product line-up from 1995 to 2008.

North American trend of buying light trucks in favour of cars may be reversing – cross-over vehicles on car platforms will be developed.

Platform strategies and re-usability of existing technology were mentioned by 33% of interviewees.

3.8.3 Legislation & Environmental Issues

Despite the Kyoto Protocol coming into effect in February 2005 few respondents specifically mentioned environmental issues. Only BMW mentioned sustainable mobility.

Environmental issues and response to global warming fears will also play a part in the future, but the OEMs will be led by legislation and incentive from governments (Sutherland, et al., 2004):

- Europe is leading and is focussed on reduction of solid waste and ISO 14000 certification
- Japan focussing on reducing solid waste and energy usage/CO_2 emissions
- US a distant third with emphasis on compliance to government regulations and worker safety

3.8.4 Cost - Raw Material Prices & Energy Supply

Steel prices have been driven up by demand in China.

The point of energy supply has been well documented with the price of a barrel of oil exceeding $140 for a brief period in 2008. Whilst this was a peak figure the price is expected to reside above $50 per barrel for the coming years.

3.8.5 Competition from Emerging Nations

Free trade in Asia between China and the ASEAN nations is leading to a regionally integrated market that will surpass Western Europe and possibly NAFTA. Whilst the project 1 research focussed on OEMs from the traditional triad nations of the USA, Europe and Japan, and includes input from the more recently developed South Korea, the role of China and the Chinese automotive industry remains unclear (Becker, 2007).

Alternative types of vehicles with composite/plastic bodies and electric power sources have already been developed in China (Veloso & Fuchs, 2004). In India Tata have launched their 1 Lakh Rupees (£1,300 in 2010) car that was expected to revolutionise thinking about mass produced low cost vehicles.

Cost does not just mean low cost parts but also services. Figure 3.8.5.1 provides a breakdown of hourly engineering rates in India versus the USA.

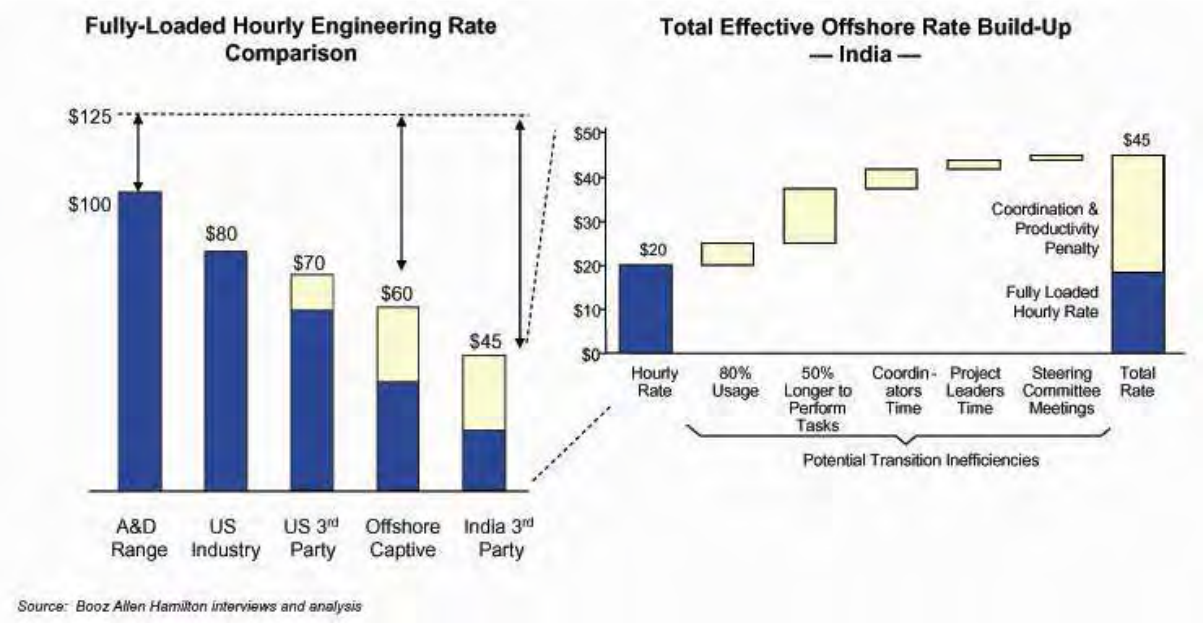


Fig. 3.8.5.1 – Hourly Engineering Rates, USA vs. India

(source: Roland Berger, 2004)

3.8.6 Supply Chain – Roles & Responsibilities

In general a comparison of results of the literature search with the research findings shows substantial similarities but highlights one noteworthy difference.

Increasing modularity in vehicle design and the broader use of standards and conformity (e.g. AUTOSAR in electronics) has allowed suppliers to account for an increasing share of PD resources.

Most of the OEMs had collaborated with another vehicle manufacturer, shared platforms, and outsourced work to suppliers as described in the literature but of significance was the perceived failure of the Full Service Supplier (FSS) relationships. This does not seem to be reflected in the academic literature. However, it is justified by the author's own experience and in some industry publications (Whitbread, 2003).

The research shows that the OEMs use of FSS resources for development and integration is reducing and OEMs will do more system integration in-house in the future. Engineering Service Suppliers (ESS) should expect to pick up more business from the OEMs as a result of this. All interviewees had experience with, and viewed as successful, bringing ESS headcount into their OEM PD centres. However, this increase in ESS revenue from the OEMs will be offset by a reduction of outsourced development work to the ESS from the FSS as their engineering content reduces.

3.8.7 Technology

All respondents in the research highlighted the greater adoption of computer aided (CAx) techniques enables PD times to decrease. The use of computer based simulation techniques continue to develop and respondents identified that key to this will be people who are able to operate in a culture that trusts the simulations. Figure 3.8.7.1 shows decreasing development times at four OEMs between 1994 and 2004.

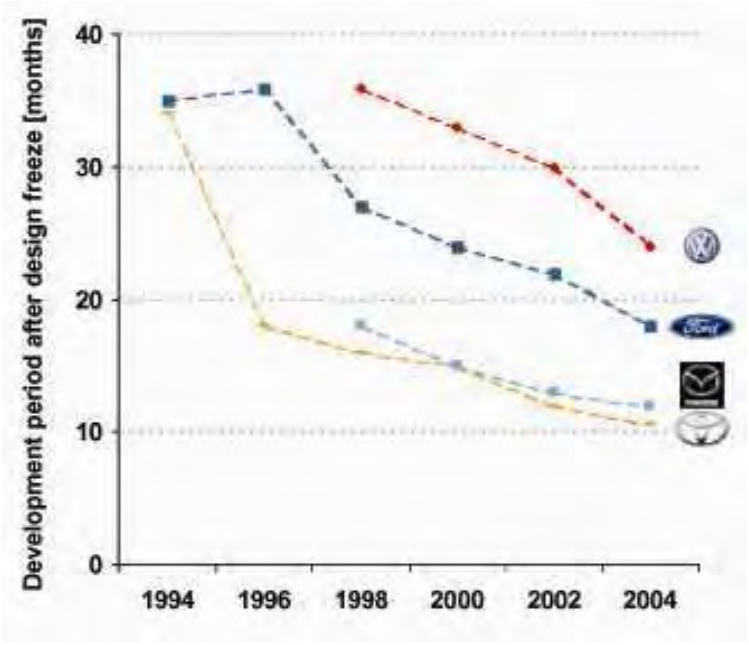


Fig 3.8.7.1 – Decreasing New PD Timing

(source: Roland Berger, 2004)

3.9 Future State of the Global Automotive Industry

Drawing conclusions across all the work so far on a definitive future state of the global automotive would be unwise. Increasing competition together with rising uncertainty make this an impossible task.

However, future vehicles will be:

- Lighter, smaller and safer.
- Power sources will operate on a wider range of fuels.
- Provided by OEMs offering a broader range of cradle to grave services.
- Higher degree of personalisation.
- Greater use of IT to monitor & control.
- More integration in transport systems.

The automotive industry continues to operate in a state of intense competition and seems to be waiting for something to happen to relieve this pressure.

Whether this will be the 'unbundled' revolution (Maxton & Wormald, 2004), Figure 3.9.1, resulting in greater sharing of modular assemblies or a major switch in material usage to meet ever tougher cost pressures remains unclear.

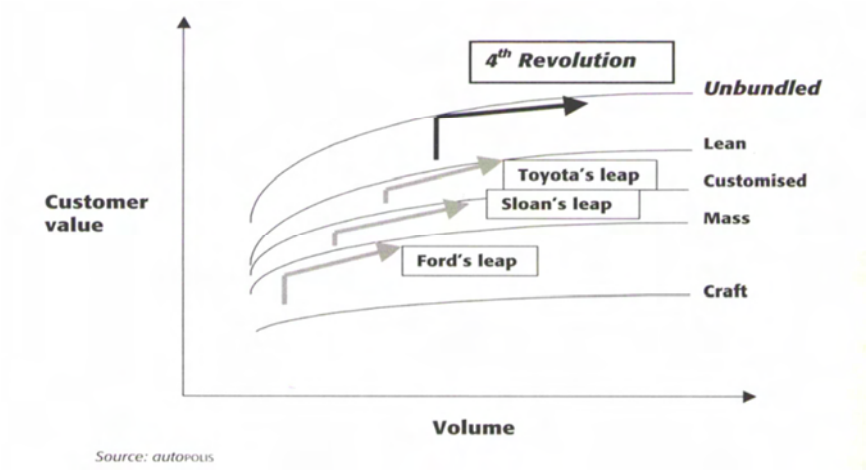


Fig 3.9.1 – Time for a Model Change – the 4th Revolution

(source: Maxton and Wormald, 2004)

Modularity in terms of design will continue to develop and will help reduce complexity and costs in the long term. However, modular assembly also enables emerging players or upstarts to gain ground quickly (Maxton & Wormald, 2004) by using the knowledge of existing suppliers.

This phenomenon has been termed 'Karaoke Capitalism' or institutionalised imitation (Ridderstraele & Nordstroem, 2004). For example, see the Chery QQ which is almost a direct copy of the Daewoo Matiz, sold for as little as the equivalent of £2,000 in China. This low price, can in part, be offered because Chery did not need to amortise expensive PD process costs into its selling price.

Energy supply concerns may also result in the "world car" becoming more widespread. The North American trend of buying light trucks or pick-ups in favour of cars may be reversing. Cross-over vehicles on car platforms are becoming more popular and most of the North American OEMs are looking to their European division's vehicle offerings to find potentially more fuel efficient vehicles to import in their home markets.

The automotive industry could also be destined to develop into two industries (Becker, 2007):

- Volume driven markets – emerging markets where cost is the main issue.
- Brand driven markets – mature markets where image and lifestyle are important.

The government led controlled bankruptcies of GM and Chrysler in the USA in 2009 may only be the start of a greater industry consolidation and right-sizing.

Free trade in Asia between China and the ASEAN nations is leading to a regionally integrated market that will surpass Western Europe and possibly NAFTA. Whilst the project 1 research focussed on OEMs from the traditional triad nations of the USA, Europe and Japan, and includes input from the more recently developed South Korea, the role of China and the Chinese automotive industry remains unclear (Becker, 2007).

4 Research Implications for Product Development in the Automotive Industry

The research has confirmed the macro drivers of increasing global competition, legislation and more diversity in consumer demand. These will not disappear and will likely continue to become more complex. The issue is; what does this mean for PD in the automotive industry?

4.1 Product Trends

Product differentiation will continue to be ultimately important in winning customers particularly in the brand driven markets described by Becker (2007). Thus, whichever way the automotive industry develops in the future customer demand for diversity of product on offer is likely to continue to increase. Figure 4.1.1 shows new vehicle launches in the USA between 2002 and 2007.

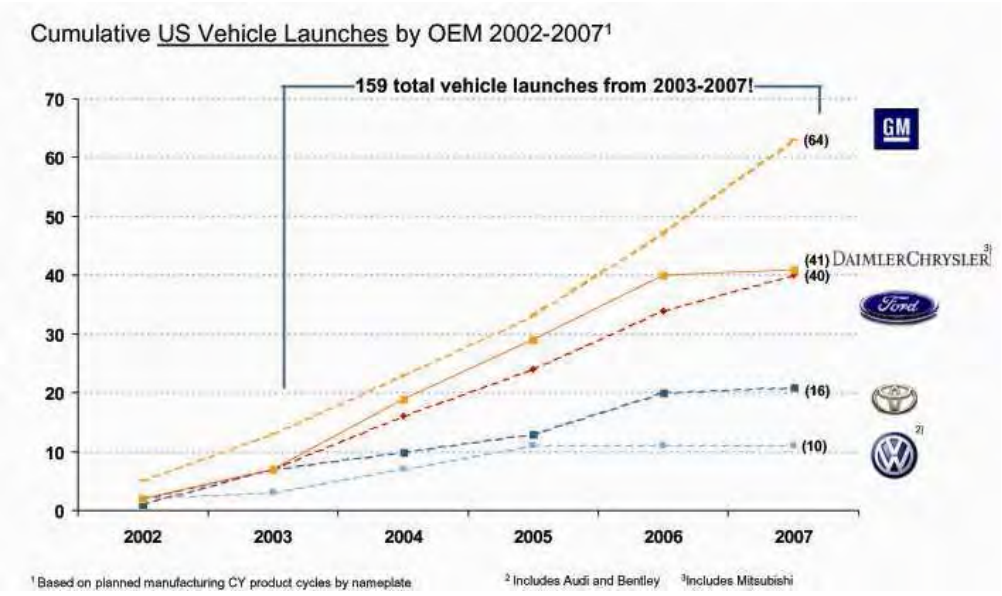


Fig 4.1.1 - Product launches in the USA 2002-2007

(source: Roland Berger, 2004)

Whilst a number of these launches may have been minor facelifts or simply badge engineering of existing products it is interesting to note that the two organisations

that brought the most new vehicles to market in these period both faced bankruptcy in 2009.

4.2 Cost & Competition

Despite the need to introduce a greater variety of products, PD budgets are not expected to increase as a percentage of revenues. Figure 4.2.1 shows R&D spend as a percentage of sales over the period 1998-2003. If overall volumes of sales are relatively constant it is clear that budgets for new PD are not increasing. Comparing this to Figure 4.1.1 showing new product launches highlights that the PD departments of the major OEMs are being asked to deliver more products with fewer resources.

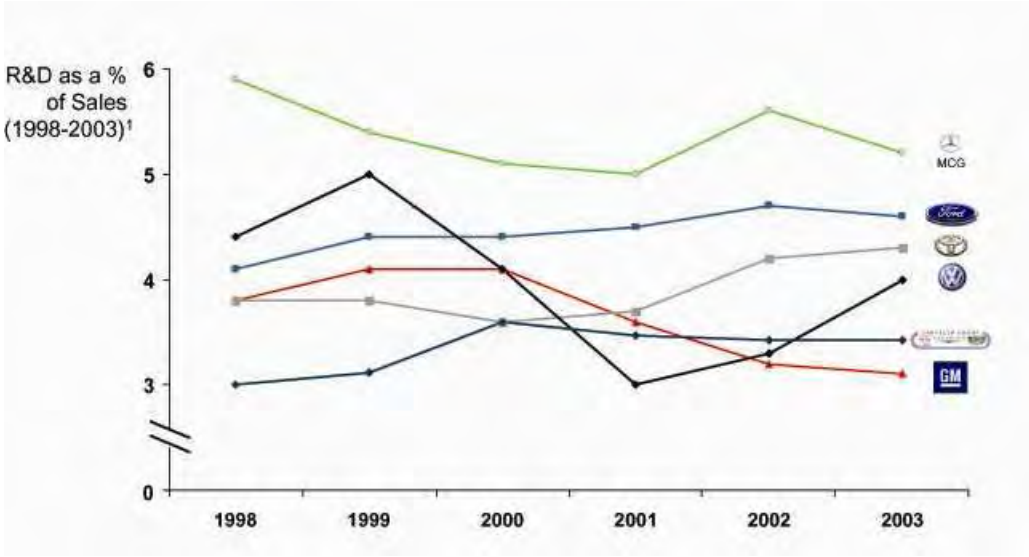


Fig 4.2.1 – PD Budgets as a Percentage of Revenues (source: Roland Berger, 2004)

Effective and efficient PD will be the key to success in this uncertain future. Efficiencies via the economies of scale delivered by modular construction techniques based on platform concepts will continue to be followed. This will be particularly so in

the volume driven markets (Becker, 2007) where cost is the main issue.

4.3 Roles & Responsibilities

Modular manufacturing and design approaches are already prevalent in the automotive industry. Decomposition of a system into modules requires three elements (Baldwin & Clark, 1997):

- An architecture that specifies what modules will be part of the system
- Interfaces that define how modules interact and communicate
- Standards and conformity

Some OEMs will continue to try to capture customers in both the brand and volume driven markets (Becker, 2007) and key to their success will be a successful combination of platform strategies and brand differentiation. The VW group has adopted the platform approach with its A04 (or PQ24) platform which provides the basis for its volume products the Volkswagen Polo Mk4, SEAT Ibiza Mk3, SEAT Córdoba Mk2, Volkswagen Fox, Škoda Fabia and the Volkswagen Gol produced in Brazil. However, in its next iteration, the A05 (PQ25) platform, it will also support the higher level brand Audi A1 product. It should be noted that platform sharing does bring with it a level of compromise as Jaguar discovered when they utilised the Ford Mondeo platform for their entry level product, the Jaguar X-type. The subsequent lack of sales volume was a result of the customer perception of a product lacking true Jaguar characteristics. More successful was Jaguar's use of the Ford and Lincoln DEW98 platform as a basis for the development of the S-type. This vehicle gained more market credibility as a result of its more traditional Jaguar proportions and styling.

Broader use of standards and conformity (e.g. AUTOSAR) allow suppliers to account for an increasing share of PD resources and enables PD times to decrease (Figure 4.3.1).

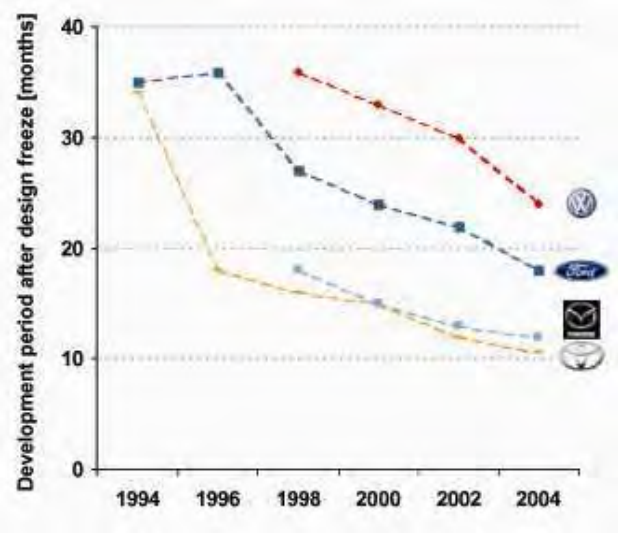


Figure 4.3.1 – Decreasing New PD Timing (source: Roland Berger, 2004)

4.4 Technology

The continued use of computer based simulation techniques will enable further reductions in PD time and prototype costs. The research identified that key to this success will be employing people who are able to operate in a culture that trusts these simulations. The increasing importance of the use of performance criteria in PD has also been identified in the research and literature (von Corswant & Fredriksson, 2002).

4.5 Summary of Findings

Consumer demand for new products coupled with product life-cycles becoming shorter has resulted in significant increases in new product launches.

The primary research interviews confirmed that most of the OEMs had collaborated and outsourced work as described in the literature. However, of significance is the perceived failure of the FSS integration role. This does not seem to be reflected in the academic literature. However, it is justified by the author's own experience and in some industry publications (Whitbread, 2003).

The use of computer based simulation techniques continue to develop and respondents identified that key to this will be people who are able to operate in a culture that trusts the simulations.

Project 1 has shown that the automotive industry is incredibly competitive and the pressure to develop more new products without the availability of more resources is unlikely to diminish. This efficiency is key to the sustainability of the OEMs. Additionally, simply putting out the most new products will not guarantee success. The products must meet customer needs whether this will be in the brand driven markets or volume driven markets (Becker, 2007). Effective use and re-use of modular construction techniques balanced with astute branding will be significant.

Impacts on the automotive PD process will be:

- Product life-cycles will become shorter.
- Production and PD activities will become more globalised.
- PD time will continue to decrease.
- Suppliers, particularly ESS, will account for an increased share of PD resource.

Whilst it has been shown that the OEMs outsource PD work via various means, and may succeed and fail with their tactics of system integration by FSSs and off-shoring to low cost countries, the really significant issue is that the automotive PD process itself must be improved to deliver more products in a shorter time period with fewer resources.

The actions identified in the literature (von Corswant and Fredriksson, 2002) will certainly lead to improvement in the process:

- Increased Partnering & Networking
- Better use of Collaboration Technology
- Better use of Global Resources and Knowledge

However, it is the performance of the PD process itself that must be the focussed on. How to measure performance of the automotive PD process and determine success are the significant issues.

4.5.1 Criticism of Methods

The primary research sample may be small but represents the views of several senior PD executives in the global automotive industry.

No primary research input from the developing nations of India and China. TATA were invited to participate and were to email a response but this did not happen.

5 Conclusion

Project 1 of this research programme set out evaluate the current commercial state of the automotive industry and identify the roles and responsibilities of companies involved in the PD process.

In particular the project focus was on aspects of the industry that impact or drive future PD strategies in terms of why new vehicles are needed, how they will be developed and who will develop them.

Through the research undertaken it is evident that there is considerable pressure on senior PD executives in the automotive industry to deliver a greater array of new products without increasing expenditure. This pressure is almost at bursting point with some executives not knowing where to turn next.

Throughout the research, meeting customer demands and expectations whilst staying on top of cost pressures was a universal response. Cost issues were described in terms of investment, piece price and engineering (PD).

Further fragmentation of markets and increased customer demand will require greater flexibility. Some interviewees stated they didn't know where pressures would stop and that China and India in particular are now learning quickly.

Most of the OEMs surveyed stated they will take back system integration from the Full Service Suppliers (FSS). One respondent in particular stated this was part of a redefinition of the core competence of the OEM. In general it was thought that specialist work needing a unique expertise would be outsourced in the future, i.e. the OEMs will be looking for specific capabilities in addition to just resource capacities. Additionally, there is a need to set up networks with low cost countries whilst balancing knowledge with cost levels.

All respondents identified virtual simulation as being of significant importance in the future. Within this, specific references were made to NVH, Aerodynamics, Craftsmanship and Stamping simulation. It was also pointed out that the people and culture of companies of the future must be conversant and comfortable with these virtual tools. The need for speed of reaction and flexibility was also highlighted.

The objectives of this project 1 of identifying trends and drivers have been achieved. Additionally, the roles and responsibilities of the key organisational players within the industry have been identified. However, to attempt to predict a definitive future state of the automotive industry would be unwise given the current pressures on organisations as a result of the competition in the global economy.

The industry itself continues to change and challenge the parameters defined in project 1. A particular example of this is the attempted acquisitions of Chrysler and Opel (both OEMs) by Magna International (a FSS). New OEMs, e.g. Fisker Automotive and Tesla, have been created as barriers to entry have been eroded by the introduction of new technologies aligned with huge government funding packages in the wake of the GM and Chrysler bankruptcies.

It is fair to predict that whatever happens next the survivors and future players in the automotive industry will have to have effective PD strategies that will be more efficient in their use of company resources than those of today. The question then becomes; how to measure success in PD and what is an efficient process? This question will form the basis of project 2.

6 Future Work – Research Project 2

The on-going competitive pressures identified in project 1 have also added to the overall analysis of the EngD and provided a focus on how to proceed. The originally proposed follow-up projects considered several enablers in the PD process; supply chain, human resources and technology. Without some sort of context as to what defines successful PD it is difficult to quantify the contribution each enabler can bring to the process. The use of performance criteria to measure and control PD processes has been identified in both the literature search and research interviewees in project 1. Project 2 will therefore evaluate the use of performance measurement techniques in the PD process.

It has become apparent through the process of delivering project 1 that in order to "determine the most effective ways" some sort of performance measuring system for the PD process needs to be established.

These measures need to include the parameters of:

- Time
- Cost
- Resource Usage
- Quality
- Return on Investment

The further research will be modified to investigate and critically assess current performance measurement techniques used in the automotive PD process and will suggest systems for the future that will contribute to the body of knowledge.

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Appendix 1 – Questionnaire used as Framework for Interviews and Preceding Letter

Section 1:

Q1. What are the biggest influences (internal and external) on the new PD process at the current time?

Q2. How do you see this changing in the future? What are the future trends and drivers?

Section 2:

Q3. Have you collaborated with another OEM on a new PD programme?

Q3a. If so, was it successful and would you consider this type of relationship again in the future?

Q4. Have you outsourced PD work to a Tier 1 Full Service Supplier?
(e.g. Lear Corporation)

Q4a. If so, was it successful and would you consider this type of relationship again in the future?

Q5. Have you outsourced PD work to a sub-contract vehicle assembler? (e.g. Karmann)

Q5a. If so, was it successful and would you consider this type of relationship again in the future?

Q6. Have you outsourced PD work to an engineering services supplier? (e.g. EDAG)

Q6a. If so, was it successful and would you consider this type of relationship again in the future?

Q7. Have you engaged people from an outside company to work in your development centre?

Q7a. If so, was it successful and would you consider this type of relationship again in the future?

Q8. Have you outsourced PD work to a low cost country? (e.g. India)

Q8a. If so, was it successful and would you consider this type of relationship again in the future?

Q9. Have you outsourced PD work to another type of company not described above? If so, please describe this relationship.

Q10. How do you see the roles of the types of companies described above changing in the future?

Section 3:

Q11. What types of PD work to you expect to be outsourced in the future? (e.g. Design Concept, Body Engineering, Powertrain Engineering, Testing)

Q12. What types of technologies will be most important to the PD process in the future?

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Attention: Head of Product Development

Future Product Development Strategies in the Global Economy

Dear Sir/Madam,

I am conducting a short survey as part of my Engineering Doctorate (EngD) programme at the University of Hertfordshire. The aim of the programme is to investigate the changing structure of the global automotive industry and how this will influence new product development strategies in the future.

I will be attending the Geneva Motor Show on the press days 28th February and 1st March and plan to conduct interviews on this subject with several industry leaders. I would be very grateful if you could spend some time with me discussing the current trends and drivers in the automotive industry and your views on their implications for the future.

A list of the type of questions I would like to address is attached. However, the discussion will be informal and all responses will be kept confidential.

Please let me know what time would be most suitable for you on either of the press days. I will return to your stand later but can also be reached via my mobile phone and email whilst at the show.

Thank you for your assistance in this matter.

Yours faithfully

Darren Gowland
EngD research - Future Product Development Strategies in the Global Economy

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Appendix 2 – Examples of Interview Notes and Transcription from the Semi-Structured Interviews

|

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Hans Folkesson
Senior Vice President

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/ 9 76 67-0 | PHONE ++1-313 / 5 34 70 99 E-MAIL INFO-US@RLE.DE | PHONE ++46-31 / 745 00 66

RLE INTERNATIONAL

NEXT MEETING: ______
LOCATION: ______
DATE/TIME: ______

4000 Eng
inc. 850 blue collar

1. Contradiction Customer Variation based on Hype
Demand or Society.
3 yr, 5 yr, 10 yr — now see pendulum effect.
30 yrs ago more predictable — after 1st oil crisis
Taxes & indirect legislation — e.g. diesel. rapid growth in UK
Incentives on alternative fuels — Sweden — now 10% not 25%

2. Flexibility in market will increase with growth of new countries.
China e.g. cylinder displacement legislation / taxes
3. Ford European Brands. — C1 Technologies
Long term foundation = globally
PAG — electronics.
+ diesel with PSA.
generally work well.
Synchronization — Communication — culture
not friction free timezones
4. Swinging back to in-house after 10 yrs
More balanced view
e.g. radio/audio — must keep knowledge in-house
Volvo packaging control quality ...
5 e.g. Pininfarina C70 — production outsourced
JV
sold Uddevalla — 40% kept 1 + unique parts
Styling — in-house + feasibility product dev.
6. Sensor / Camera
2 1/3 packages — 300 outside
new engine etc

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MEETING: ____________ NEXT MEETING: ____________

LOCATION: ____________ LOCATION: ____________

DATE/TIME: ____________ DATE/TIME: ____________

ATTENDEES: ____________

AUDIO/VIDEO: ____________

(2)

7. Total 1000 at peak in-house — 300 in house
Finnland ← — 300 close
— 300 more distant

Indi (8) ~~Als~~ indirectly — thru Tier 1 supplier e.g. Delphi
software programming
e.g. 580 — ~~General~~ central commution
9. No maybe Bosch / Siemens / Denso
Tampere directly

10. No major change — maybe closer to Tier 1 supplier.
must establish networks with low cost countries
Knowledge base + low cost level.

11. No big change — too high dependancy on consulted
e.g. packaging
80% should be designed in house
V4 → V5 — next 2 yrs
can go out, e.g. soft nose — details can be outsourced in combination with tool maker
improve data flow — and use people for 3D design engineer.

12. Virtual ~~Engineering~~ Tools. — Prototyping (needs management focus.)
Design for Six Sigma utilising failure mode avoidance systems.
e.g. Alias + software for craftsmanship from Chalmers University.
FEA + CAE — develop skills of people & culture
more NVH related tools + verification.

Name: Hans Folkeson Company: Volvo Car Company

Position: Vice President Product Development Email address:

Q1. What are the biggest influences (internal and external) on the new product development process at the current time? (e.g. customer wants, cost, legislation)
Combination of customer variation based on hype and demands on society.
3yr, 5yr, 10yr – now see pendulum effect
30 yrs ago more predictable – after first oil crisis
Taxes & indirect legislation,e.g. rapid diesel growth in UK
Incentives on alternative fuels – Sweden was 10% was 40%

Q2. How do you see this changing in the future? What are the future trends and drivers?
Flexibility in market will increase with growth of new countries.
China – e.g. cylinder displacement legislation/taxes

Q3. Have you collaborated with another OEM on a new product development programme?
Ford European Brands – C1 technologies
Long Term – Powertrain Globally
PAG – Electronics
PSA – diesel engines
If so, was it successful and would you consider this type of relationship again in the future?
Generally work well but not friction free – some problems with communication – culture & time zone

Q4. Have you outsourced product development work to a Tier 1 Full Service Supplier? (e.g Lear Corporation)
Yes, but swinging back to in-house after 10 yrs
More balanced view, e.g. radio/audio – must keep knowledge in-house. Partly commercial.
Volvo control packaging
If so, was it successful and would you consider this type of relationship again in the future?
Partially succesful

Q5. Have you outsourced product development work to a sub-contract vehicle assembler?
(e.g Karmann)
Yes, C70 with Pininfarina – outsourced feasibility, development of new parts & production.
Sold 60% of Udevella plant to Pininfarina.
Styling was in-house
If so, was it successful and would you consider this type of relationship again in the future?
Yes, but some issues

Q6. Have you outsourced product development work to an engineering services supplier?
(e.g EDAG)
Yes, Semcon & Caran – new engines etc. 1/3 packages

If so, was it successful and would you consider this type of relationship again in the future?

Q7. Have you engaged people from an outside company to work in your development centre?
Yes, total 1000 heads at peak. But 300 in-house, 300 close and 300 distant (Pininfarina)
If so, was it successful and would you consider this type of relationship again in the future?
Yes

Q8. Have you outsourced product development work to a low cost country? (e.g. India)
Yes, indirectly via Tier 1 to India – Delphi, software programming for S80 central communication – production in Tunisia
If so, was it successful and would you consider this type of relationship again in the future?
Yes, maybe with Bosch, Siemens or Denso

Q9. Have you outsourced product development work to another type of company not described above? If so, please describe this relationship.
No,

Q10. How do you see the roles of the types of companies described above changing in the future?
No major change – maybe closer to Tier 1 suppliers
Must establish networks with low cost countries
Knowledge base + low cost levels

Q11. What types of product development work to you expect to be outsourced in the future?
(e.g. Design Concept, Body Engineering, Powertrain Engineering, Testing)
No big change – too dependant on consultants e.g. in packaging
80% should be designed in-house
Catia V4 – V5 in next 2 yrs
Will put out e.g. soft nose – details can be outsourced in combination with toolmaker
Improve data flow – and use people for 3D design engineering

Q12. What types of technologies will be most important to the product development process in
the future?
Virtual Engineering tools – prototyping (needs management focus)
Design for Six Sigma utilizing failure mode avoidance systems e.g. Alias & software for craftsmanship from Chalmers University
FEA & CAE – need to develop skills of **people & culture**
More NVH related tools + verification

GM
GM Europe Engineering

Stig Nodin
Director

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Saab since 1981

1. cost pressure
investment + piece price — new engineering cost!
India & China
friend at Magna Steyr — VW pressure in China
must = re-use more from global brands
2. must deliver customer expectations.
(don't know where it stops — China and now India.
learn quickly.

3. GM — Brands
Fiat — premium platform
Yes, possible. Common values more important
than common culture.

4. Yes, in the USA. Complete Interior
benefit from other OEM knowledge — didn't happen.
they were learning! OEM should integrate.
Safety belts — Autoliv — they supply competence ✓
(specialist + advanced development
5. Magna Steyr — works well if good concept study +
layout
+ performance built in.
miss in the beginning + creates mess.
6. Different depending on company
EDAG best experience — clear objectives
deliverables based & targets. Same
more bad examples! Germany Very Good.
7. Fiat & Alfa Romeo + Tier 1s
always participate and sound outside oversight.
(good relations with T1 from advanced phase.
ownership by Fiat.

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MEETING: ______ NEXT MEETING: ______
LOCATION: ______ LOCATION: ______
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(2)

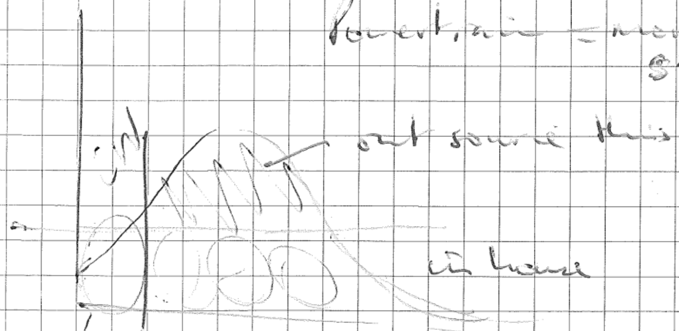
e.g. 15 people from Bertrandt – integrated in team

8. Yes.
Now taking people into Saab from GM India.
new – but coming more & more.

9. advanced – government funding or EU
Supplier interest group + Volvo + Saab
for new process – competence building model.
e.g. communication to cars – new standards
or fuel cells.
Very important in Europe – for competitiveness
Japan doing for many years

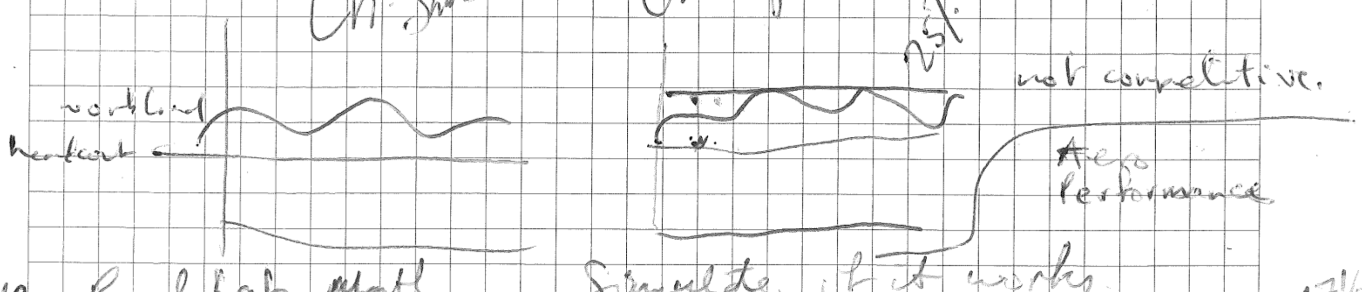
10. OEMs take back integration.
Complete interior not good idea.
Powertrain being integrate

11. Powertrain – more supplier in future
Structure costs. – old argument.



More Virtual
Simulation

Ch. Saab   Ch. Opel



12. Road → Lab → Math   Simulate if it works.
Reduce lead time!
Subaru – Saab 92X   Tool makers long lead 7/12 months
press simulation!

Name: Stig Nodin Company: GM Engineering

Position: Director of Engineering Email address:

Q1. What are the biggest influences (internal and external) on the new product development process at the current time? (e.g. customer wants, cost, legislation)
Cost pressure. Was investment & piece price but now engineering
India & China – VW has cost pressures in China
Must re-use more from global brands
Must deliver customer expectations

Q2. How do you see this changing in the future? What are the future trends and drivers?
Don't know where it stops – China and now India learning quickly

Q3. Have you collaborated with another OEM on a new product development programme?
GM brands
Fiat – premium platform
If so, was it successful and would you consider this type of relationship again in the future?
Yes, its possible. Common values more important than common culture (nationality)

Q4. Have you outsourced product development work to a Tier 1 Full Service Supplier? (e.g Lear Corporation)
Yes, in USA on a complete interior to benefit from other OEM knowledge
If so, was it successful and would you consider this type of relationship again in the future?
No, it didn't work. They were learning also. OEM should integrate.
Can work for specialists – Autoliv on safety belts – they supply competence & advanced development

Q5. Have you outsourced product development work to a sub-contract vehicle assembler?
(e.g Karmann)
Yes, Magna Steyr.
If so, was it successful and would you consider this type of relationship again in the future?
Yes, works well if good concept study & layout. Therefore, performance is built in (pre-defined). If you miss in the beginning it creates a mess.

Q6. Have you outsourced product development work to an engineering services supplier?
(e.g EDAG)
Yes, EDAG was best experience – clear objectives & targets. Deliverables based.
If so, was it successful and would you consider this type of relationship again in the future?
There have been bad experiences.
Germany very good on PM. UK good on experienced people.

Q7. Have you engaged people from an outside company to work in your development centre?

Yes, from Fiat, Alfa Romeo and Tier 1s. Also 15 man team from Bertrandt integrated into team.
If so, was it successful and would you consider this type of relationship again in the future?
Yes, Fiat had ownership and had good relationship with Tier 1s from advanced stage.

Q8. Have you outsourced product development work to a low cost country? (e.g. India)
Yes, now taking people into SAAB from GM India
If so, was it successful and would you consider this type of relationship again in the future?
Yes, its new but happening more & more

Q9. Have you outsourced product development work to another type of company not described above? If so, please describe this relationship.
Yes, advanced government funding or EU for supplier interest groups @ Volvo & SAAB for new processes - competence building model, e.g. communication to cars, new standards or fuel cells. Very important in Europe for competitiveness. Japan has been doing for many years.

Q10. How do you see the roles of the types of companies described above changing in the future?
OEMs take back integration. Complete interior was not a good idea.

Q11. What types of product development work to you expect to be outsourced in the future?
(e.g. Design Concept, Body Engineering, Powertrain Engineering, Testing)
Powertrain integration will be outsourced more in future.
SAAB headcount is competitive – Opel not. See graphs.

Q12. What types of technologies will be most important to the product development process in the future?
Road – Lab – Math
Virtual Simulation if it works. Aero Performance.
Reduce lead times – e.g. toolmaker down to 7.5 months using press simulation.

Name: Jeremy Main Company: Aston Martin Lagonda Ltd.

Position: Director PD and Motorsport Email address:

Q1. What are the biggest influences (internal and external) on the new product development process at the current time? (e.g. customer wants, cost, legislation)
Customer demands - the markets are fragmenting and the customers are in the driving seat with manufacturers willing and able to provide lower volume derivatives of common platforms. This has also required flexible manufacturing.

Q2. How do you see this changing in the future? What are the future trends and drivers?
Further fragmentation with the winning companies recognizing and responding to the markets early.

Q3. Have you collaborated with another OEM on a new product development programme?
No
If so, was it successful and would you consider this type of relationship again in the future?

Q4. Have you outsourced product development work to a Tier 1 Full Service Supplier? (e.g Lear Corporation)
In a limited way with systems and sub systems such as IP and seats.
If so, was it successful and would you consider this type of relationship again in the future?
Not successful and in each case was insourced before Job 1.

Q5. Have you outsourced product development work to a sub-contract vehicle assembler?
(e.g Karmann)
No Zagato?? DG
If so, was it successful and would you consider this type of relationship again in the future?

Q6. Have you outsourced product development work to an engineering services supplier?
(e.g EDAG)
No and would not plan to do this - it is vital to have direct control of the product development and quality.
If so, was it successful and would you consider this type of relationship again in the future?

Q7. Have you engaged people from an outside company to work in your development centre?
Yes
If so, was it successful and would you consider this type of relationship again in the future?
Very successful, it allows you to select experts in their field but integrate them into the broader team ensuring common vision.

Q8. Have you outsourced product development work to a low cost country? (e.g. India)
No
If so, was it successful and would you consider this type of relationship again in the future?

Q9. Have you outsourced product development work to another type of company not described above? If so, please describe this relationship.
Testing work is often outsourced but requires excellent correlation to known test standards.

Q10. How do you see the roles of the types of companies described above changing in the future?
These must be a clear and unique expertise and value add for this alternative to internal control to work.

Q11. What types of product development work to you expect to be outsourced in the future?
(e.g. Design Concept, Body Engineering, Powertrain Engineering, Testing)
Testing

Q12. What types of technologies will be most important to the product development process in the future?
Design simulation and particularly for electronic systems above quality is hard to guarantee within normal testing regimes.

Appendix 3 – Details of Interviewees

- Aston Martin — Jeremy Main

  (Director – Product Development)

- BMW — Daniel Kammerer on behalf of Dr. Burkhard Goeschel

  (Corporate Affairs Technology Communication - Director of Product Development)

- GM — Stig Nodin

  (Director – Product Development)

- Hyundia — Thomas Saelzle

  (Manager – Product Development)

- Kia — Pontus Fontaeus

  (Director - Design)

- Volvo — Hans Folkesson

  (Senior Vice President - Product Development)