Capturing Ergonomics Requirements in the Global Automotive Industry

by

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Abstract

This thesis examines the issues surrounding the collection and dissemination of customer ergonomics requirements in the automotive industry. The aim of the research is to develop a Toolset of methods, known as the Lifestyle Scenario Toolset, for gathering customer requirements in overseas markets, and for presenting the information collected to design teams, taking a user-centred design approach. The Toolset was developed and evaluated with the co-operation of employees from a major UK automotive company.

Four studies were conducted, the first comprised a series of interviews to establish the needs of both the data gatherers and data users for a Toolset of methods to collect and communicate overseas customer information. The data gatherers were drawn from the company's Market Researchers, Ergonomists and people responsible for the company's overseas operations. The data users were the design team responsible for the development of the company's next generation 4X4 vehicle. Results showed that the data collection tools which formed part 1 of the Toolset should be quick to use, require no ergonomics expertise to implement and be cost effective to use. The interviews with data users identified the need for tools which could communicate customer ergonomics requirements to them in a way which fitted in with their current working practices. In addition the tools needed to communicate information in language which was familiar to the design team, and be visually based where possible.

The second study explored the development of suitable data collection tools for inclusion in the Lifestyle Scenario Toolset. Building on the needs identified in the first study together with information from the current literature a number of data collection tools were developed for inclusion in part 1 of the Lifestyle Scenario Toolset. These tools were a questionnaire, driving diary and photographs, focus group, ergonomics audit and background information tool. The tools were designed to collect a range of different data types, e.g. qualitative, quantitative,

pictorial and customer verbatims, to provide a rich picture of users and their activities. The tools were used in a field trial to collect data from overseas customers about their ergonomics requirements and the tasks they carried out using their vehicle, in the context of their lifestyle.

The third study focused on the development of a set of tools to communicate the data collected in part 1 of the Toolset, to the design team who would use it in their work. The data communication tools were developed to provide information to design teams at a number of levels, enabling them to use the data at an appropriate level for their needs. High level summaries of each of the tools were developed and scenarios presented on storyboards were used to integrate information from all of the data collection tools to provide detailed information about customers' ergonomics requirements and lifestyle. The data communication tools also used a variety of data types and presentation mediums, such as pictures, graphs and customer quotes to increase the richness of the data presented.

The fourth study involved the evaluation of the suitability of the Toolset for collecting and communicating overseas customer ergonomics requirements. The data gatherers, and data users (design team) carried out a field trial using the Toolset to establish its usefulness to them in their work. The results of the evaluation showed that the data gatherers found the Toolset easy to implement and were able to use it to pick up overseas customers ergonomics requirements. The communication tools were able to provide the design team with new and useful customer ergonomics information, in a range of formats which they felt comfortable using in their work. The implementation of a user-centred design approach to the development of methods for collecting and communicating overseas customer ergonomics requirements enabled the creation of a Toolset which met the needs of the people who will use it. This increased its acceptance by people in the company and thus the likelihood of the Lifestyle Scenario Toolset's continued use within the company.

Acknowledgements

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Contents

List of figures

List of tables

List of appendices

Chapter 1

Introduction to the research

1.1 Chapter Summary

This chapter provides an introduction to the research issues investigated in this thesis. It begins by describing the background and rationale behind the research. This is followed by an overview of the company which was involved in the research (Rover Group) and its organisational structure. Next the aims and objectives of the research are specified, and finally the structure of the thesis is presented.

1.2 General Introduction

Many new products introduced into the marketplace today are still difficult and frustrating to use. They are clearly not designed to meet the needs of users as effectively as they could be. One of the main reasons for this mismatch between technology and the user is a continued lack of understanding by companies of their product users' requirements. To improve this situation Ergonomists have long advocated the need to include users as fully as possible in the design process. Users have first hand knowledge about their needs and desires for a product and as Stanton (1998) emphasises "given that user activity is central to design, this information needs to be captured and incorporated into the design process". As companies become more aware of the need to consult with their customers their design process should become more user-focused in its approach. User-focused design places users at the very heart of the development process and draws attention to the needs of the users (Bannon 1991).

The utilisation of user-centred design techniques are well established in the field of human-computer interaction (HCI) to aid the development of new software, however more recently user-centred design and user requirements

capture methods have been introduced into the design and development of consumer products. Many of the techniques and lessons learned from HCI applications can be transferred to consumer product design.

In user-centred design it is considered essential to bring the Ergonomist in at the earliest stages of the development process, because this is when changes can be made to the product, with the least cost to the design process (Stanton 1998). However, too often Ergonomists are brought into the design process at the later stages when a design has been decided upon and the main features of the product have been fixed. At this stage there may be little the Ergonomist can do to influence the design within time and cost limits which constrain most projects. In addition to the cost reduction afforded by the early introduction of ergonomics, incorporating user requirements at this stage of development enables design modifications to be made easily because the design has not yet become 'frozen' through interlocking dependencies (Grudin et al 1987), and the requirements can be used to define constraints on the development of the design at the outset (Lim et al. 1992).

Although it is important to involve users in the design process, and to consider their needs for a new product, it is equally vital that once these requirements have been collected they are effectively communicated to developers of new products, i.e. the Designers. Without proper communication between Ergonomists and Designers user requirements may still be misrepresented or overlooked in the design cycle. However, this communication process raises issues which hinder the co-operation between the two disciplines. Ergonomics and design are based on fundamentally different backgrounds; design emanates from the arts whereas ergonomics is based more on scientific disciplines, and this has been a major source of miscommunication between the two. Nevertheless, it is important that Ergonomists and Designers continue to try and develop appropriate methods to communicate ideas and information with each other. In this way the requirements of product users are considered and effectively incorporated into product design.

Ergonomics is rapidly becoming recognised in industry as an important factor in providing a powerful market edge for new products. This is especially true of the automotive industry. Over the last few decades the automotive industry enjoyed the benefits of being a 'seller's market'. Companies were able to produce ever more complex and technologically advanced vehicles in the knowledge that they could sell as many as they could make. There was no need to consider the customer in this equation (Ludvigsen 1996). However, during the late 1980s and early 1990s a fundamental change took place in the industry, as described by David Power of J.D. Power & Associates, the industry "shifted from a producer-controlled automobile market to a customer-driven marketplace, and we shall never return to the former" (cited in Ludvigsen, 1996). It is also important, due to the complexity of many consumer products that Product Designers have access to ergonomics information to ensure that products are acceptable and usable by the user (Bonner 1998). Again this is particularly the case for automobiles which are very complex, and with which users interact closely. The design of a vehicle can have serious implications for the health and safety of users, for example poorly designed controls and displays can distract a driver's attention from the driving task and may result in an accident (Jordan 1992), and badly designed seats can cause discomfort, in particular low back pain, on long journeys (e.g. Porter et al. 1992).

The need to determine user-requirements becomes even more important as companies become increasingly global. Although companies may have a relatively good idea of how their products are used, and the people who use them, in the home market, this is often not the case for overseas markets. The diverse nature of overseas markets, in terms of users, their environment and the activities they carry out, make it very difficult for Designers to have first hand knowledge of all markets. It is important to ensure that products which are designed to be used in a range of different markets meet the needs of their entire user population as closely as possible, i.e. that in addition to home market customers, overseas customer requirements are taken into consideration when designing the product.

These problems were recognised within the automotive company, Rover, and this research project aims to address some of the issues raised. The following points were identified as the main motivation for this research.

1. Design teams are rapidly becoming more aware of the need to meet actual customer (user) requirements in their new product designs.

2. Techniques to identify and capture user requirements have been developed more fully in some application areas than others. For example methods in developing computer software are well developed and used, whereas in the area of automotive design, techniques have not been explored in depth and are not yet well established.

3. The general move towards selling in global markets means that different and possibly unknown requirements must be met. Finding the best ways for capturing these requirements is high on the agenda of automotive manufacturers.

4. At present we know little about how to capture and understand user requirements when lifestyle[1], as well as the physical and psychological characteristics of users are considered. This may create a new set of user requirements which must be incorporated into product design.

5. Problems arise when trying to communicate ergonomics information to other design team members, partly because of the fundamental differences in the way the disciplines work.

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[1] The term 'lifestyle' is used in the context of this thesis to mean the wider issues, such as family structure, activities and expectations which impact on a person's requirements for a particular product.

1.3 The Rover Group

This section describes the Rover Group, the company structure and its business organisation in overseas markets, as it pertains to this project.

1.3.1 The Rover Group Company

The Rover Group is Britain's largest automotive manufacturer, producing over half a million vehicles per year, and employing approximately 40 000 people in the UK and internationally. In 1994 Rover Group and BMW combined to become the seventh largest motor company in Europe. However, Rover have been keen to maintain their own identity and retain their products' distinct 'Britishness', although there has been collaboration of technology between Rover and BMW where this does not alter the appearance of a vehicle.

1.3.2 The Company Structure

The Rover Group's products are divided into four distinct ranges, or marques; Land Rover, Rover, Mini and MG. Each marque has a set of marque values, that is a set of attributes such as ruggedness or luxury, which describe the type of vehicle being produced. These marque values are more or less consistent across each range, but within the marque some products may emphasise particular values more than others.

New teams are brought together for each new product, and may be different on each design. Designers and Engineers may work on vehicles in any or all of the marques.

1.3.3 Rover's Overseas Markets

Rover exports products to more than 100 countries and in 1997 sold over 275 000 vehicles to overseas customers. This makes them the third biggest exporter in the UK, and the figures show that over half the vehicles produced by Rover are now sent overseas. Most of these vehicles went to the European market, but nearly 100 000 went to other world markets. The growth in the export

side of the business is becoming more and more important as Rover are looking to expand their sales even further in the world-wide market place.

Rover's overseas operations are split into two groups. In the larger markets Rover has set up National Sales Companies (NSCs) which are wholly owned subsidiaries run by Rover. National Sales Companies have been established in most countries in the EU, as well as North America, Japan, Australia and South Africa. The NSCs are accountable to the Rover Sales and Marketing Manager. Where the market is too small to justify setting up an NSC sales are directed through independent importers and co-ordinated under the umbrella of Rover International. Rover International is a section of the Rover Group which deals exclusively with overseas sales. Its operations are split into geographical locations, e.g. Far East, Middle East, Africa, South America. Each section is headed by a Sales Manager in the UK, who oversees the importers within his geographical area. This overseas company structure is shown in Figure 1.1.

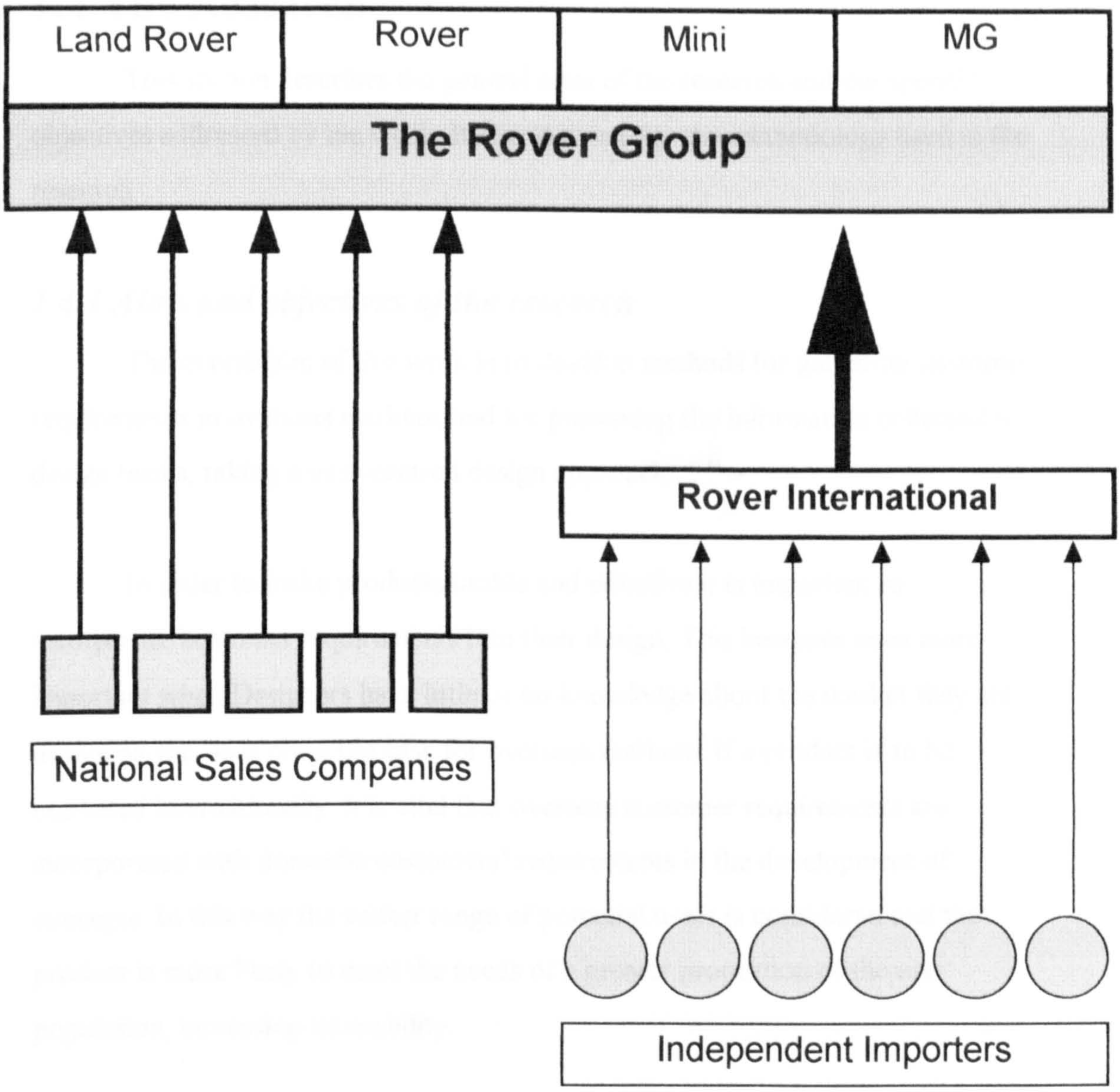

Figure 1.1. Rover Group's Overseas Structure

1.4 The Research

This section describes the general aims of the research and the specific objectives addressed by the work. It also summarises the methodology used in the research.

1.4.1 Aims and objectives of the research

The overall aim of this work is to develop methods for gathering customer requirements in overseas markets, and for presenting the information collected to design teams, taking a user-centred design approach.

In order to make products usable and effective it is important to incorporate customer requirements into their design. This becomes even more important when Designers have little or no knowledge about the market they are designing for, as is often the case for overseas markets. If a product is to be marketed internationally it is vital that overseas customer requirements are incorporated with domestic customers' requirements in the development of concepts. In this way the widest range of potential users is considered and the product is more likely to meet the needs of a greater proportion of the user population, increasing its usability.

One of the most suitable ways of gaining a deeper understanding of customers' requirements is to use several different types of information from a number of sources, to provide a rich picture of users and their activities. In addition to the collection of as broad a range of data about customers and their requirements as possible, it is also important to ensure that data collected is presented to the users of this information in a way which they find acceptable in the context of their current working practices.

To achieve the above aim of the research the following objectives and sub-objectives were specified:

1. To develop a set of methods which can be used by non-ergonomics experts, for collecting customer ergonomics requirements in global markets. This will form part 1 of a Toolset.

    - To establish the needs of people who will collect the data in overseas markets for a Toolset of data collection methods.
    - To develop a set of data collection methods which meet the needs of the data gatherers.
    - To evaluate the suitability of the Toolset for collecting overseas customer ergonomics requirements.

2. To provide an appropriate set of methods for communicating the information collected to members of design teams, e.g. Designers, Concept Engineers. This will form part 2 of a Toolset.

    - To establish the needs of the people who will use the data collected in their everyday work, for a Toolset of communication methods.
    - To develop a set of data communication methods which will meet the needs of the data users, i.e. the design teams.
    - To evaluate the suitability of the Toolset for communicating overseas customer ergonomics requirements to design teams.

1.4.2 Overview of the project methodology

This work took the general approach of systems design as its starting point. This approach considers a system, such as a driver driving a vehicle, as part of the much larger system in which it exists. Thus the interaction of the driver and vehicle is affected by the environment in which the driving takes place.

The work reported here also took a user-centred approach to the design process. Thus the user, whether they be the user of the Toolset or the user of the vehicle being investigated through the Toolset, was considered central to the research. At all times the user was considered together with the equipment they

were using, the environment they were in, and the tasks they were conducting. Further the interaction between these elements was addressed, such as the effect of the equipment on the task undertaken.

User-centred design was employed both whilst developing the Toolset and also to provide a framework for the development of suitable customer data collection tools. During the development of the Toolset the needs of those people who would use the Toolset to gather data, and those who would use the results produced were considered. By placing the user at the centre of the development process, their needs and requirements could be used to shape the Toolset so it was acceptable to them and fitted in with their current working practices.

Data collection tools for use in the Toolset, e.g. the questionnaire and driving diary, were also developed using user-centred design to collect data about customers, the tasks they carried out, the equipment used, the environment which they were in, and the interaction between all these factors.

1.4.3 Overview of the research programme

The research presented in this thesis was conducted in close conjunction with the Rover Group, and personnel from the company were involved in providing input into the project, Ergonomists, Designers, Marketing Researchers. This helped to ensure that the Toolset developed fitted with the needs of the company, was useful and usable in the context of their work. In the first instance the tools and methods developed were intended for use by the company's employees, both in the UK and overseas, in the design of new vehicles for overseas markets. The work was conducted within the constraints of the company taking account of, for example, the company's organisational structure and the levels of resource available to the research programme.

1.5 Outline of the thesis

This section outlines the remaining chapters of the thesis. Figure 1.2 shows the structure of the thesis. A review of the published literature relating to the utilisation of user-centred design to ensure that customers' ergonomics requirements are incorporated into new products is presented. The review covers aspects of the product design process, the integration of user requirements in the development of new products and the communication of ergonomics information to design teams. The use of multiple methods in user requirements capture and communication to increase confidence in and depth of the information collected are discussed. The final part of the literature review covers issues which must be considered when collecting and using customer information from overseas markets.

Next the thesis presents work related to the development and evaluation of the Lifestyle Scenario Toolset, in four separate studies. Chapters 3 and 4, which comprise studies 1 and 2 consider the needs of people who will use the Toolset in their work. In Chapter 3, study 1 reviews the existing methods used within Rover to capture user requirements, both in the UK and overseas markets. Discussions were conducted with Marketing Researchers, Rover International personnel and Ergonomists within the company to investigate their current practice with regard to data collection, and to ensure that their requirements for the Toolset were considered in its development.

In Chapter 4, study 2 reports on the process of specifying the requirements of the users of the Toolset data. This involved a series of discussions with expected users of the Toolset data, principally Designers, Concept Engineers and Ergonomists. The discussions focused on current design practice within the company, and specifically how customer and ergonomics information is presented and incorporated into the design cycle.

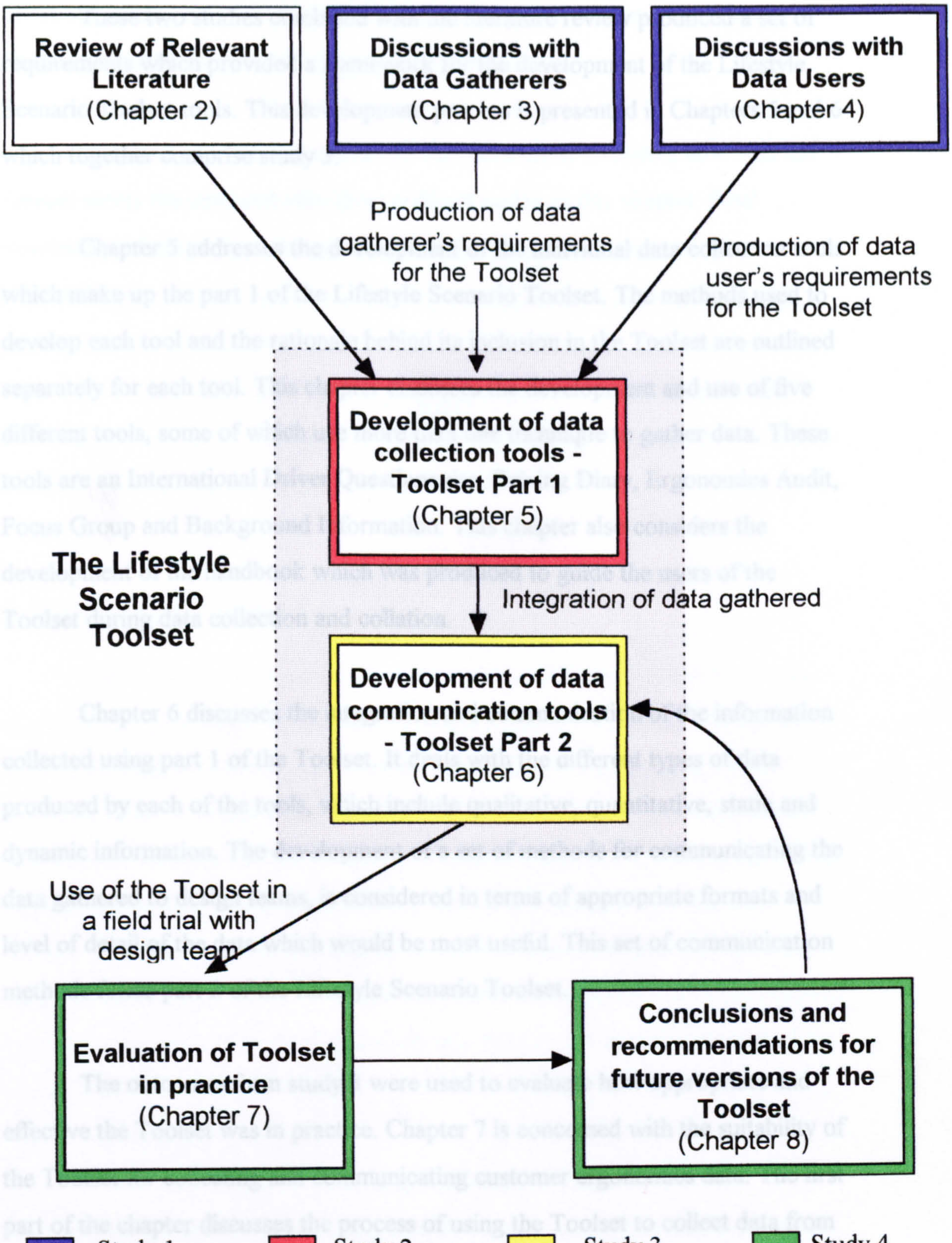

Figure 1.2. Overview of Toolset Development Process

These two studies combined with the literature review produced a set of requirements which provided a framework for the development of the Lifestyle Scenario Toolset tools. This development process is presented in Chapters 5 and 6 which together comprise study 3.

Chapter 5 addresses the development of the individual data collection tools which make up the part 1 of the Lifestyle Scenario Toolset. The methods used to develop each tool and the rationale behind its inclusion in the Toolset are outlined separately for each tool. This chapter discusses the development and use of five different tools, some of which use more than one technique to gather data. These tools are an International Driver Questionnaire, Driving Diary, Ergonomics Audit, Focus Group and Background Information. This chapter also considers the development of the handbook which was produced to guide the users of the Toolset during data collection and collation.

Chapter 6 discusses the integration and communication of the information collected using part 1 of the Toolset. It deals with the different types of data produced by each of the tools, which include qualitative, quantitative, static and dynamic information. The development of a set of methods for communicating the data gathered to design teams, is considered in terms of appropriate formats and level of detail of the data which would be most useful. This set of communication methods forms part 2 of the Lifestyle Scenario Toolset.

The outcomes from study 3 were used to evaluate how appropriate and effective the Toolset was in practice. Chapter 7 is concerned with the suitability of the Toolset for collecting and communicating customer ergonomics data. The first part of the chapter discusses the process of using the Toolset to collect data from overseas markets, including problems encountered and suggested changes to be made during future use of the Toolset. The need to involve different departments to gather information with some of the tools and the difficulties of collecting data remotely from overseas markets are also considered. The second part of the chapter addresses the effectiveness of the communication methods and the

usefulness of the data collected using the Toolset to the design team. Additional issues concerning the ownership and storage of the information within the company are also considered.

Chapter 8 provides a summary of the research. It considers how well the Toolset meets the aims and objectives outlined earlier in this chapter. Final conclusions of the work and suggested directions for future research are presented.

Chapter 2

Review of the Literature

2.1 Chapter summary

This chapter discusses the literature related to the collection and communication of ergonomics requirements in product design. It considers the product development process and the role of design and ergonomics within this cycle. Literature is discussed regarding the collection and communication of customer requirements, and the particular issues affecting the inclusion of overseas customer information in product designs.

2.2 Introduction

The successful integration of customer ergonomics requirements into the design of new products is dependent on a wide range of issues which affect the product development process, such as the organisation of a company, or the approach taken to design activities. Different aspects of these factors have been addressed by researchers from a number of fields of research, including marketing, engineering, design, new product development and ergonomics (or human factors). The work presented in this thesis acknowledges the cross disciplinary nature of the area and this review therefore draws on literature from wide range of disciplines. Figure 2.1 shows how this chapter fits into the overall structure of the thesis.

The review begins by examining the literature related to product development, models of design and the role of the Ergonomist in this process. It continues by discussing methods which can be utilised to ensure that users are considered during product development, including user-centred design, and then goes on to present tools and techniques, from a number of fields, used for collecting customer requirements. Next, issues associated with working on a

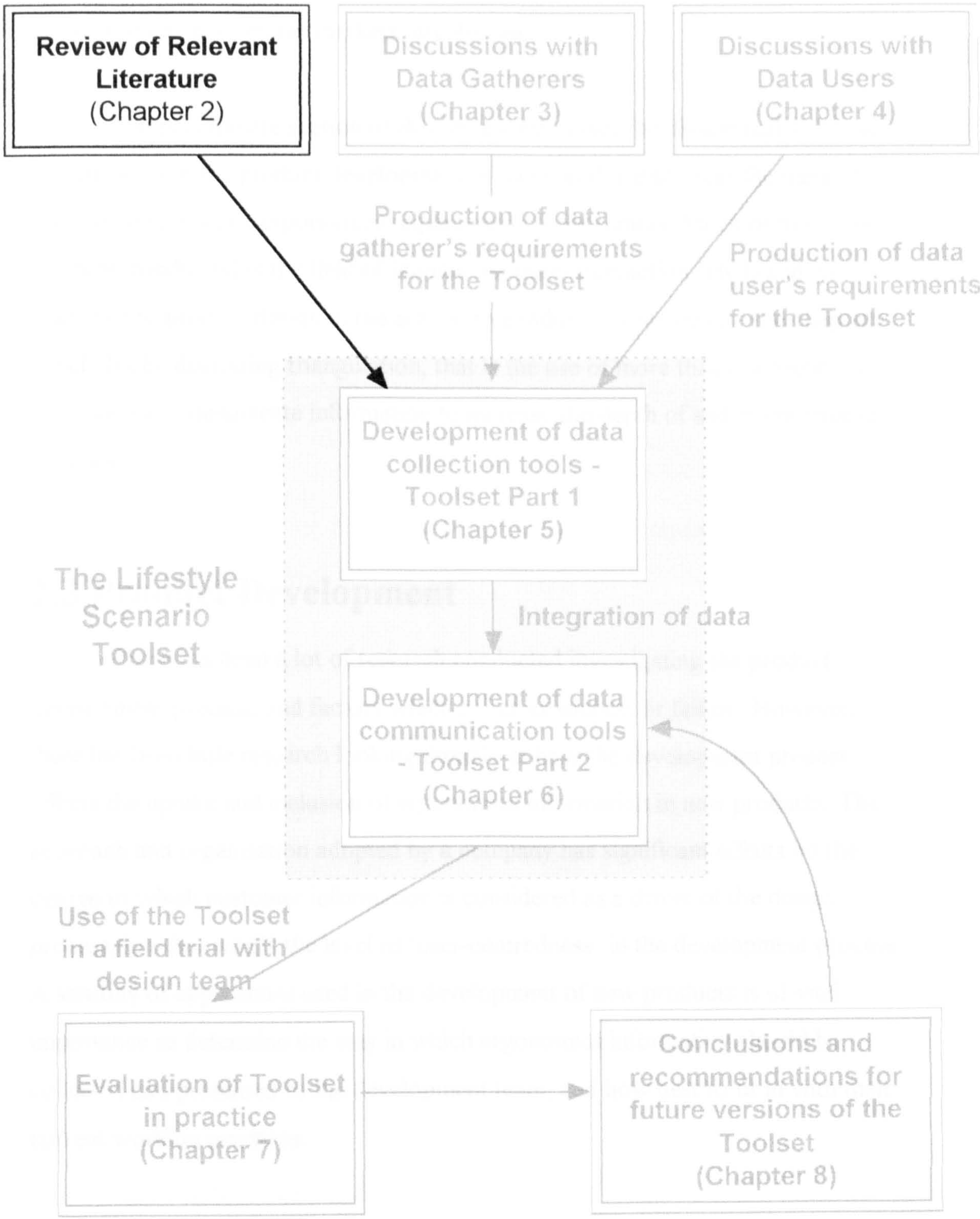

Figure 2.1 The context of the literature reported in Chapter 2

project developing products aimed at a global market are outlined. Factors which can affect the type of information, and the data collection process when gathering information from overseas markets, are discussed.

The penultimate section of this review addresses the dissemination of user requirements in the product development process, and in particular the methods used to communicate ergonomics requirements to Designers. Much of this work has been conducted in the field of human-computer interaction (HCI) and its relevance to product design in the automotive industry is reviewed. The chapter concludes by discussing triangulation, that is the use of more than one technique to gather or communicate information to increase the depth of and confidence in the data.

2.3 Product Development

There has been a lot of research conducted investigating the product development process, and factors which affect its success or failure. However, there has been little research looking directly at how the development process affects the uptake and inclusion of ergonomics information in new products. The approach and organisation adopted by a company has significant effects on the degree to which customer information is considered as a driver of the design process, in other words the level of 'user-centredness' in the development process. A scrutiny of approaches used in the development of new products is of vital importance to determine the way in which ergonomics information should be collected and presented to the development team, and how best to fit in with their current working practices.

The term 'product development' can encompass a range of activities within a company which aim to bring a new product into the marketplace. Booz, Allen and Hamilton (1982) suggested six different types of product development which come under the umbrella of new product development.

1. *Improvements and revisions to existing products.* This refers to new products which provide improved performance on existing products.

2. *New product lines.* These are new products which allow a company to move into a market for the first time (although other manufacturers may already have a presence in the market)

3. *Additions to existing product lines.* New products which supplement an existing product range.

4. *New-to-the-world products.* These are completely novel products designed to be introduced into entirely new, untapped, markets.

5. *Cost reductions.* New products which provide similar performance to older products at a lower cost.

6. *Repositionings.* Existing products that are targeted to new markets or market segments.

Johne (1995) argues that the last two types of product development are not distinct types in their own right. They can be applied to any product and do not involve redesign of the product as such. Johne considers these to be variations of development types 1-4. Therefore, in the work presented here no distinction is made between the development of entirely new products and upgrades of existing products, because customer and ergonomics information is needed to support all design activities.

2.3.1 The product development process

The product development process is a complex one which involves many departments within a company, and which for most is a core activity of the business (Cooper 1993). It is a process which has been analysed and interpreted in many ways by researchers from a wide range of disciplines including marketing, management, design and engineering. Craig and Hart (1992) conducted a review

of the new product development literature and identified a number of key themes which are considered to influence the process, see figure 2.2. These themes fall into two main areas; those relating to the organisation of the new product development process within a company, known as 'strategic' issues, and those concerning the development of individual products, known as 'project' level issues. Both types can exert an influence on the uptake and integration of customer information into new designs. The relevant issues associated with each area are discussed below.

2.3.1.1 Strategic themes affecting the product development process

The themes of strategy, management and organisational structure, seen in figure 2.2, are interrelated and considered to be strategic themes. These are discussed below in order to provide an understanding of some of the large scale issues which can affect the product development process within a company.

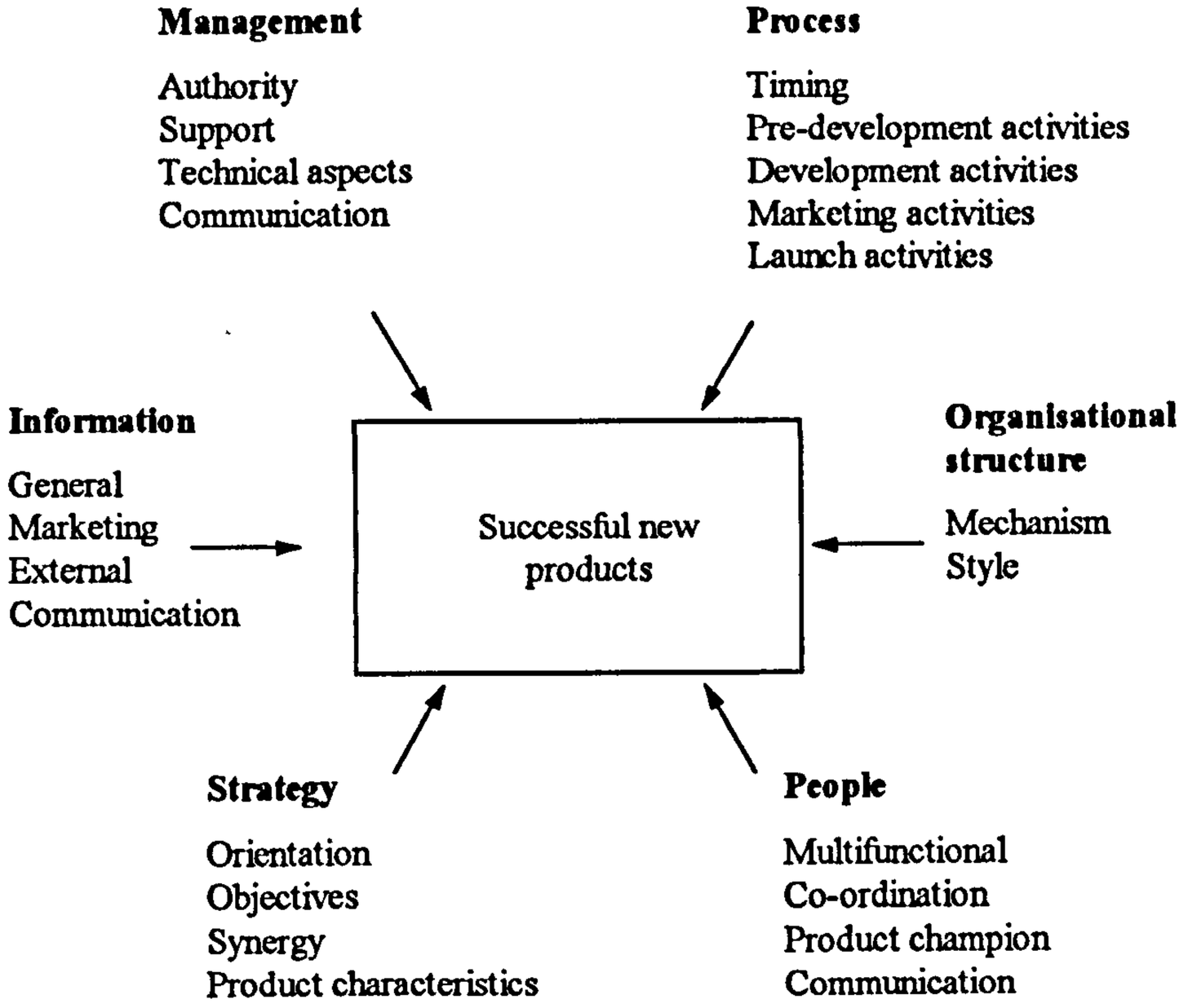

Figure 2.2 Key themes from the product development literature (Hart 1995)

Strategy.

This dictates how a company operates both internally and towards the outside world. A body of literature (e.g. Hart 1989, Olins 1986) indicates that this will affect the product development process. Some of these authors (e.g. Veryzer 1998, Adams, Day and Dougherty 1998) believe that the development process must be guided by the corporate goals of a company, which should in turn place product innovation at the heart of the strategy (e.g. Cooper 1984). Recognition of the role of customer information and clear guidelines on how to ensure that a company is user-focused, can help to create successful products. Nevertheless, as Hart (1995) points out it is important to ensure that company strategy does not become so rigid that it stifles the creativity which is so vital in the product development process.

Product development management and organisational structure

Some literature has focused on the role of management in the process of developing new products (e.g. Cooper and Kleinschmidt 1987). Issues addressed have included managerial orientation within a company and involvement of management in the design process (Urban & Hauser 1993). Additionally the role of management in communicating company culture throughout the rest of the organisation has been researched (Gupta, Raj and Wilemon 1985). As in the case of company strategy, management approach to and organisation of the new product development process can have a marked effect on the inclusion of customer ergonomics information in a new product. If the role of customer data is promoted by the management and the structure of the new product development process, it is more likely to be included in new designs.

2.3.1.2 Project level themes which can affect the product development process

The project themes of process, people and information, see figure 2.2, are also interrelated. The areas of process and people are closely linked because the process used in developing a product is so dependent on the people involved in

the activity and vice versa that in some literature they are discussed together as one theme. Here they are discussed separately.

The product development process at project level.

Models of the development process are numerous but most have followed a similar pattern since early versions identified the key phases in the process as market analysis, design and development, production planning, manufacturing and sales and distribution. However the process itself has changed considerably over the years (Wind and Mahajan 1997). Early models developed in the 1960's proposed a phased review development process, and assumed the process was sequential. Development passed from department to department with work being signed off by one department before moving on to the next stage. This approach is considered to be counter-productive by some (Takeuchi and Nonaka 1986) and in some cases actually increased the length of the development cycle. It is also known as a 'hands off' process because once each department completes their part of the work the project is passed on and their input finished. This leads to a lack of commitment or accountability for the finished product (Cooper 1993), and can cause bottlenecks in the process (Hart 1995).

More recent models of the product development process acknowledge that it is often multidisciplinary and multifunctional and utilises teams of people to implement the work. Although the process proposed in these models essentially passes through the same phases as the traditional models, the activities which make up the phases overlap or are conducted concurrently with involvement from many people with diverse backgrounds. Hart (1995) suggests that there are a number of 'soft advantages' relating to the personnel involved in the sequential process including that of shared responsibility, co-operation, involvement, sharpened problem solving focus, diversified skills and heightened sensitivity towards market conditions. All of these can help to bring a wider range of information, including customer and ergonomics data, to the development process.

Cooper (1993) proposed a development process based on a system of stages and gates, see figure 2.3. This model divides the product development

process into a set of predetermined stages. Each of the gates in the model is in practice a sign off point at which the decision as to whether or not to continue with the development process is made, based on a number of criteria which must be met at each stage (Veryzer 1998). This model, and similar versions have been adopted by many commercial companies in their product development process (e.g. McClelland and Brigham 1990).

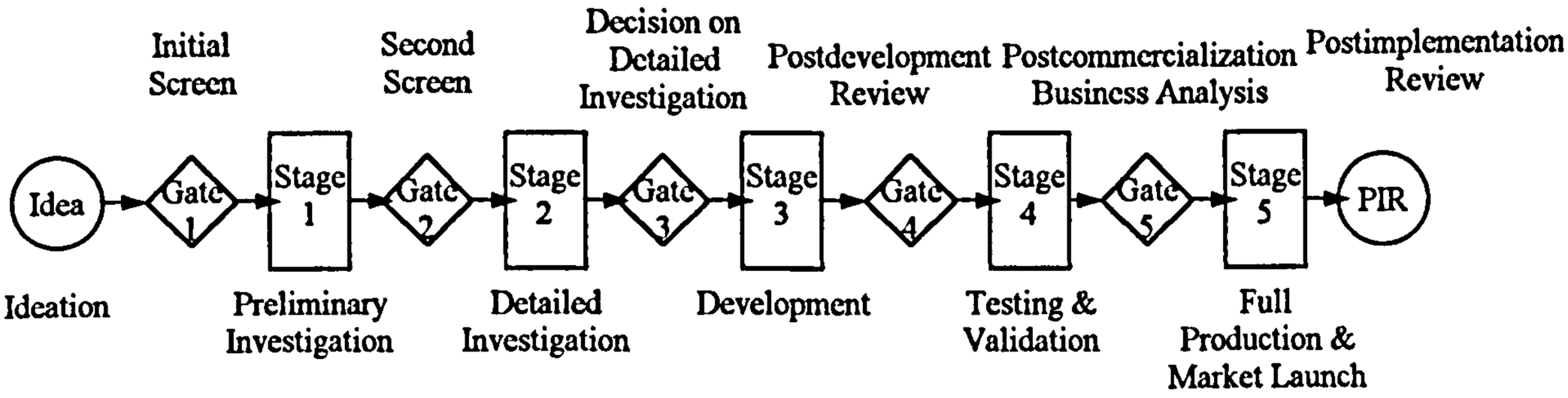

Figure 2.3 Stage-gate product development process (Cooper 1993)

Although the model recognises the non-linear, iterative nature of the development process, it does not aim to model the throughput of information into and between elements of the system. An alternative model proposed by Pugh (1986) which takes account of the information exchange process is shown in figure 2.4. This model was devised from an engineering perspective, but serves to illustrate the general design process. Within this model the design activity is placed at the core of the development process and other disciplines exchange information with this central activity. Pugh is one of a number of authors who see the product development process as being synonymous with the design process itself, and he recommends that design activities take place throughout the whole cycle. As design impacts on all the features which serve to differentiate one product from another, such as performance, durability, reliability and style, it should be considered as being central to the product development process (Kotler 1991). Thus, in order to make the whole development process more user-centred the needs of customers who will use the end product must be placed at the centre of the design activities.

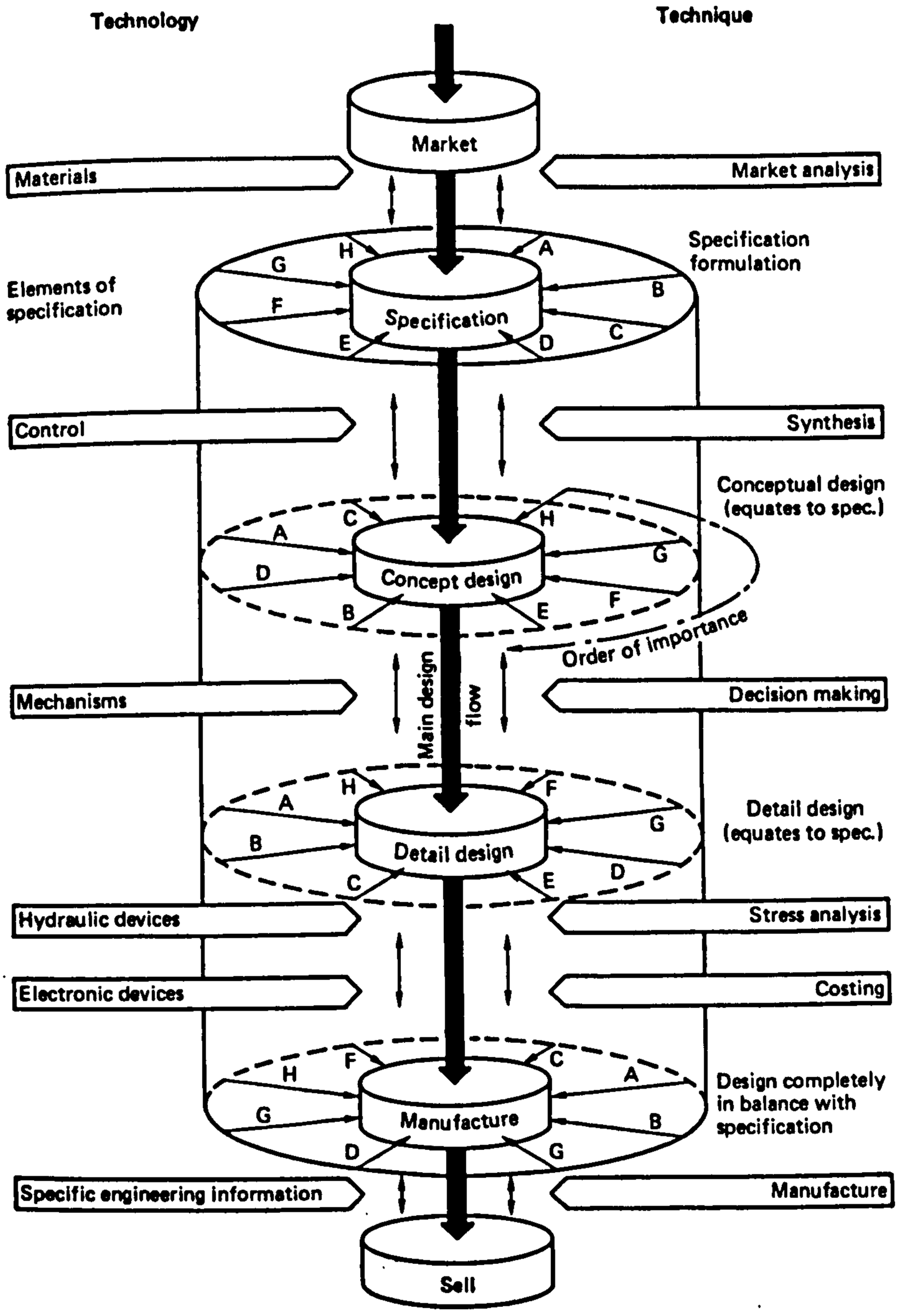

Figure 2.4 Pugh's (1986) model of the product development process

Many research activities have focused on the inclusion of marketing research in the product development process, and in particular on the role of customer information at the early stages of the design process. The importance of introducing customer data at this early stage in order to produce a successful product is well recognised (e.g. Cooper 1993, Bruce et al 1995). However, there

has been little documentation regarding the specific introduction of customer ergonomics information and how to achieve this in the context of real world product design, that is design as it is practiced.

The theory-practice gap: It is well recognised that models of the product development process are idealised versions of the activities which take place within a company. Dougherty (1992) argues that there is little relationship between the theories of the new product development process as part of organisational renewal and the complex day to day realities people face. Cooper and Kleinschmidt (1986) conducted a study investigating the practice of new product development within industry. They listed 13 key activities which formed part of the development process and found that in reality many companies did not follow the steps advocated. In some cases steps were missed out, collapsed together, conducted in the wrong order or poorly executed. Figure 2.5 shows the percentage of the 203 companies involved in the research who actually carried out each of the steps in the process. Thus it is important to ensure that research investigating the introduction of information into the design process is based on the *realities* of the design cycle rather than the idealised models described above. Methods developed to collect or present data to design teams are more likely to be accepted if the team do not have to significantly alter their working practices in order to use them. This can be achieved by focusing on the actual needs of the design team when developing methods and techniques for collecting customer data.

The study by Cooper and Kleinschmidt (1986) also shows that one of the most neglected areas in the product development process is the detailed analysis of a market which should take place before proceeding with the development of new products. This is a very important part of the development process and deficiencies at this stage can lead to product failures (Cooper 1993). It is therefore vital to gather and communicate information about a market and the requirements of its customers as early as possible in the design cycle. There has been little research conducted looking at tools and methods to support the introduction of

customer ergonomics data in the earliest stages of design. Therefore one of the aims of this thesis is to address the issues in this area.

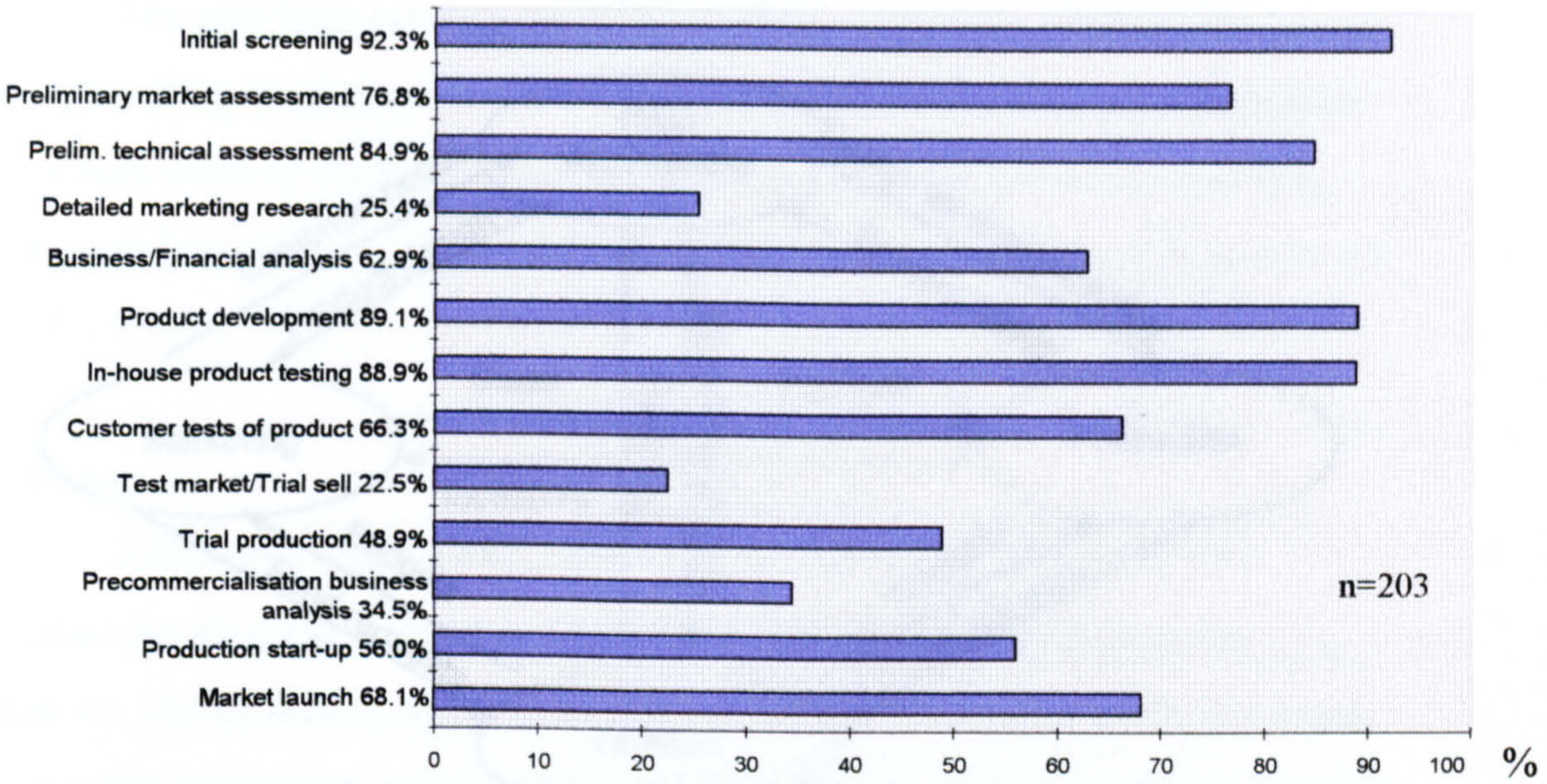

Figure 2.5. Frequency of Activities in New Product Projects (Cooper and Kleinschmidt 1986)

The Role of People in the Project .

The people involved in new product development activities and the way in which they are organised has a marked influence on the process (Urban & Hauser 1993) and the success of new products may depend on the cross functional integration of different departments. Maidique and Zirger's 1984 study investigating product development in a high technology industry found that "simultaneous involvement of the create, make and marketing functions" i.e. Design, Engineering and Marketing, was a distinguishing factor between product successes and failures. If this is the case then it is important to improve communication between the various people and departments involved in the product development process. Urban and Hauser (1993) suggest that functional co-ordination, that is planning between the different disciplines in a company, can help to improve communication between departments throughout the process and reduce the development cycle time and costs. Figure 2.6 shows the links between marketing and research and development which are so important in the pre-concept stages of product development in order to facilitate the exchange of customer information. Consequentially, links between marketing, research and

development, and ergonomics are also vitally important at the early stages of design to ensure that ergonomics information is considered from the outset of the design process.

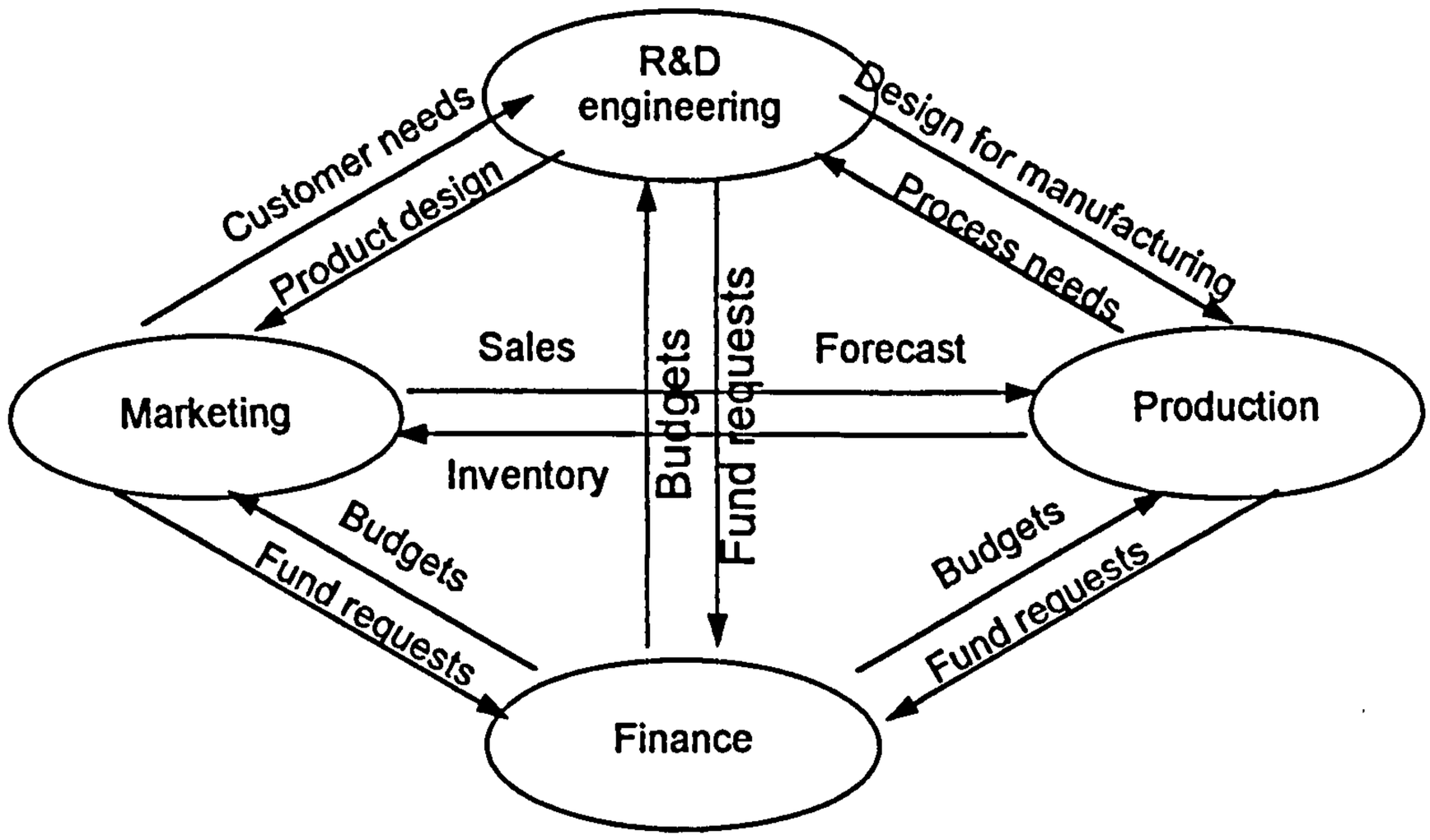

Figure 2.6 Cross-functional integration in the product development process (Urban & Hauser 1993)

Cooper (1993) suggests that cross functionality is achieved through the use of multifunctional teams in the development process. The teams should have a core group of committed people responsible for the project from start to finish, but the structure must still be flexible enough to allow new members to join or leave the team as required (Hollins & Pugh 1990). It is also important to maintain some degree of differentiation between members of the team, i.e. maintain specialist knowledge, rather than complete integration and homogenisation of the team. By maintaining differentiation high quality individual knowledge can be fed into the process (Hart 1995). This promotes the inclusion of experts such as trained Ergonomists who have a wealth of in-depth knowledge to bring to the design process. The co-ordination of different functions involved in product development can have a pronounced effect on the success or failure of the team. Research has shown that a feature of most successful projects is the presence of strong project leaders who have the formal authority to take important decisions about the development process (Cooper 1993, Bertodo 1993). Strong leadership can help design teams to focus on a task and by implication, the presence of a

'champion' to promote the use of customer information would help to focus a team on the needs of the customers who will use their product.

The interfaces between disciplines in the new product development process can also affect the success of a team (Cooper 1995). Some of the most important interfaces occur at the front end of the design process, e.g. between marketing, design and ergonomics. These interfaces are discussed in more detail in section 2.5 of this review.

Information.

Information plays a major role in the facilitation of an effective new product development process and functional co-ordination throughout the process. The collection and dissemination of information is particularly important, as it is this information which serves to inform the development process and builds credibility between functions in the product team (Gupta, Raj and Wilemon 1985). The transfer of information between functions is discussed later in this review with respect to communication methods, see section 2.8.

2.3.2 The design process

Design activities play a vital role throughout the product development process and Besford (1987) has drawn up a table of activities which fall into the design remit at different stages of the development cycle, see table 2.1. The table includes activities in the areas of engineering design, product design and design trends, and illustrates the wide range of information Designers require to make design process decisions. It can be seen from this table that ergonomics information plays an important role in the design of new products and it is therefore vital that this information be incorporated. The research presented in this thesis aims to address the introduction of ergonomics into the design cycle, and in particular the introduction of customer ergonomics requirements into the earliest stages of the design process.

Engineering design	Product design	Fashion design
Mechanical Electronics Hydraulics Other	Industrial design Appearance design Physical design Ergonomics / Human Factors	Style Consumer expectations Marketing
Engineering solutions	**Form concepts**	**Design trends**
Functional design Cost effective Production Engineering	Form Colour Product graphics Ergonomics / Human Factors	Fashion Style Emotions
The Designers		

Table 2.1 Design tasks in new product development (after Besford 1987)

A large body of literature has focused on the design process itself and the mechanisms used by Designers to design new products. In order to work effectively with Designers and design teams it is essential that Ergonomists understand how Designers use information and integrate it into the design of new products. Understanding the way in which Designers assimilate and use knowledge whilst designing a new product helps when developing methods for introducing ergonomics information into the design cycle. Techniques can be tailored to fit in with the working practices of the Designers, thus increasing the likelihood of their acceptance and use by the design team. The following section provides a context for the research presented in this thesis.

2.3.2.1 General models of the design process

The design process has variously been described as one which converts information from the general to the particular, or from the abstract to the concrete (Wallace 1990). One of the most widely recognised models of design activity is the analysis - synthesis - evaluation model as proposed by researchers such as Watts (1966), and Jones (1963), see figure 2.7.

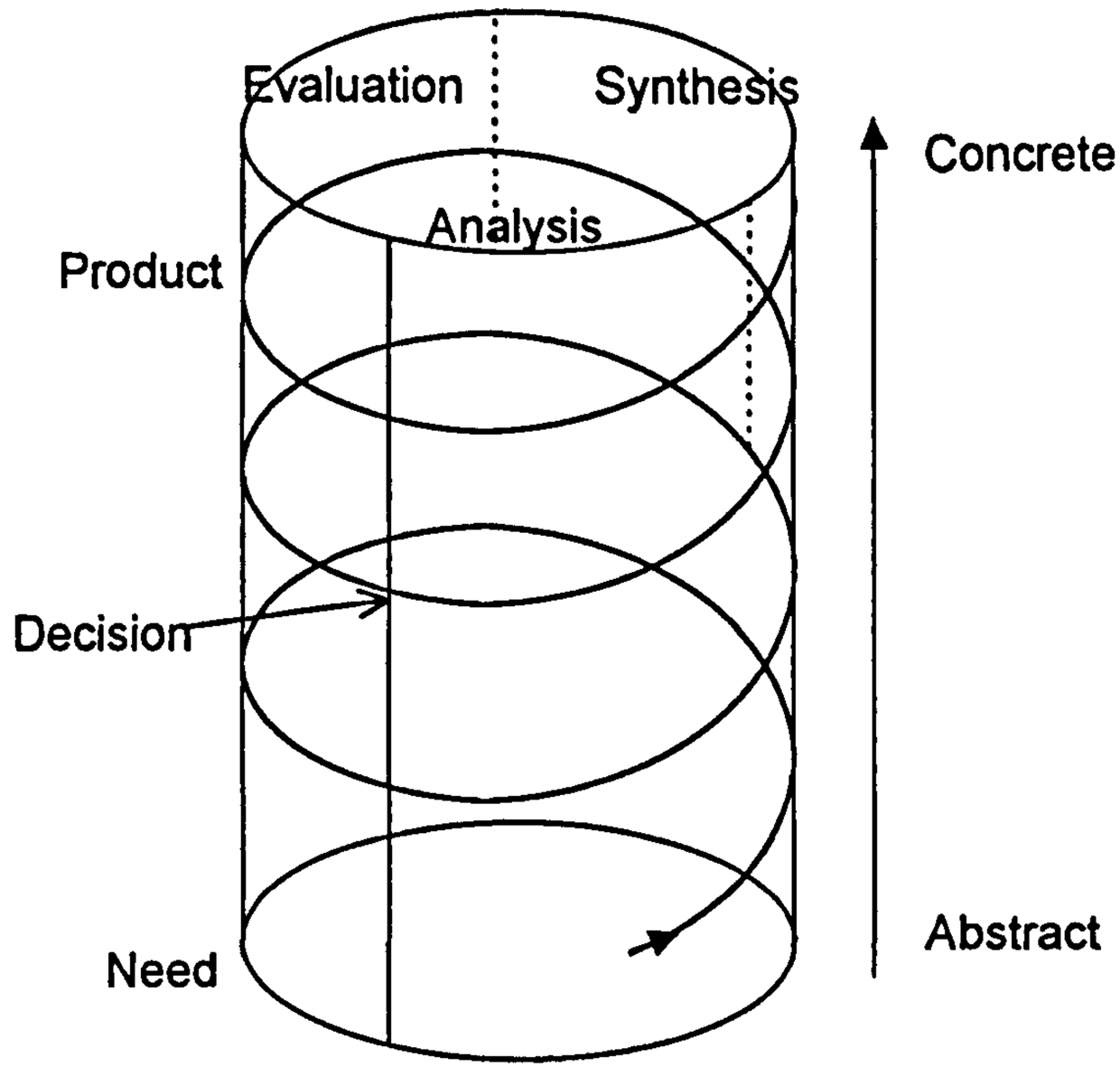

Figure 2.7. The analysis-synthesis-evaluation model of design (e.g. Jones 1963).

This model suggests that the design process takes place iteratively along a continuum, moving from the abstract to the concrete in a systematic way. The initial stage of the process involves the analysis of design requirements for the product and the reduction of these into a set of specifications which must be met by the final design. The second stage focuses on the synthesis of design solutions, initially to the individual specifications set during the analysis phase, and secondly integrated and built up into complete designs. The third phase is concerned with the evaluation of proposed designs against the performance criteria set in the analysis phase. This enables the Designers / design team to determine which design should be selected for further development.

Although the model shown in figure 2.7 is widely recognised, some authors (e.g. Darke 1984, Broadbent 1973) have criticised it for being too simplistic and rigid. They suggest that the above model assumes Designers will have all the relevant information needed to make design decisions available to them before they start to develop a design. In reality this is unlikely to happen as Designers do not always know what information they will need before they start to develop a design. Further to this, styles of designing may vary amongst the design

community and depend on a number of factors such as the individual Designers involved, the type of artefact being developed and the time / financial constraints. Some designs will be solution-focused, that is the Designers will start from a possible design solution and see where and how this needs improving to fit the requirements of the specified design. Other designs will be problem-based, where Designers initially focus on the problem to be solved and then develop designs to meet the problem (Lawson 1972).

A more recent model proposed by Hiller et al (1972) replaces the analysis - synthesis model with one of conjecture - analysis. This model views design as a process of 'variety reduction' where a large number of potential solutions are reduced by external constraints and the Designer's own opinions and experiences. This reduction is greatest at the early stage of the design process. Gill (1987) suggests that design is a process of moving from a problem to a solution within a design space, see figure 2.8. The process is an iterative one, which may involve many false starts and dead ends, and often requires the Designers to make a creative leap from problem to solution (e.g. Archer, 1984, Hartfield, 1996, Staufer, et al 1987).

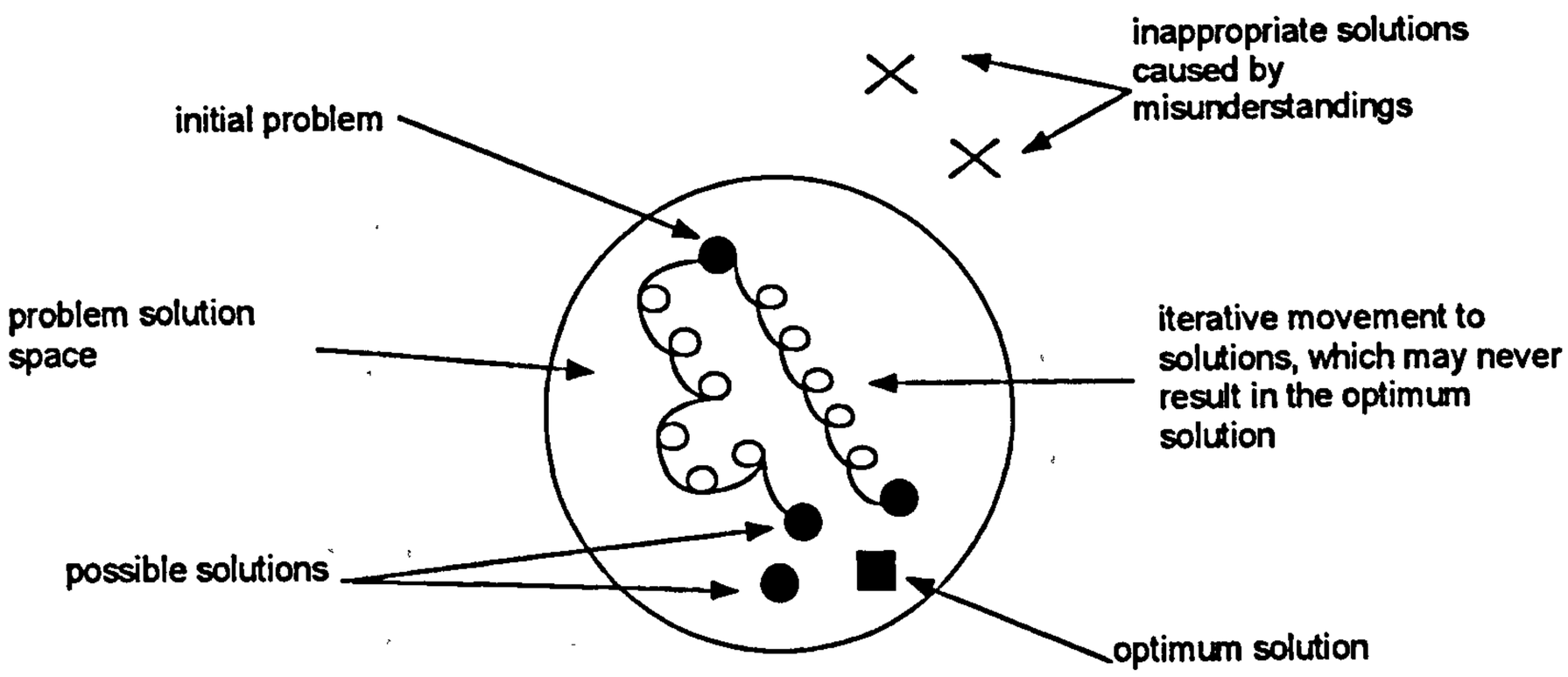

Figure 2.8. Movement through the solution space (Gill 1987)

The problem solution space is defined by the specification of the design goal, that is, what is trying to be achieved in the final design. Specifications may be external as in a design brief, or they may be internal as in the Designer's cognitive map. Internal specifications are the result of the Designer's experience

and knowledge, and may include unfounded biases and beliefs which will affect the designs produced. The external specification should provide information about the attributes which must be included in the design (those which bound the problem space), as well as desired attributes in the final design. Although it is important to provide enough information in the specification to enable the problem space to be reduced, too much, or misleading information can cause over specification of the problem space. This may lead to the exclusion of possible designs which would have met the solution criteria, see figure 2.9. It is therefore important that design specifications intended for use by Designers and design teams are presented at appropriate levels to ensure that suitable solutions to problems can be developed.

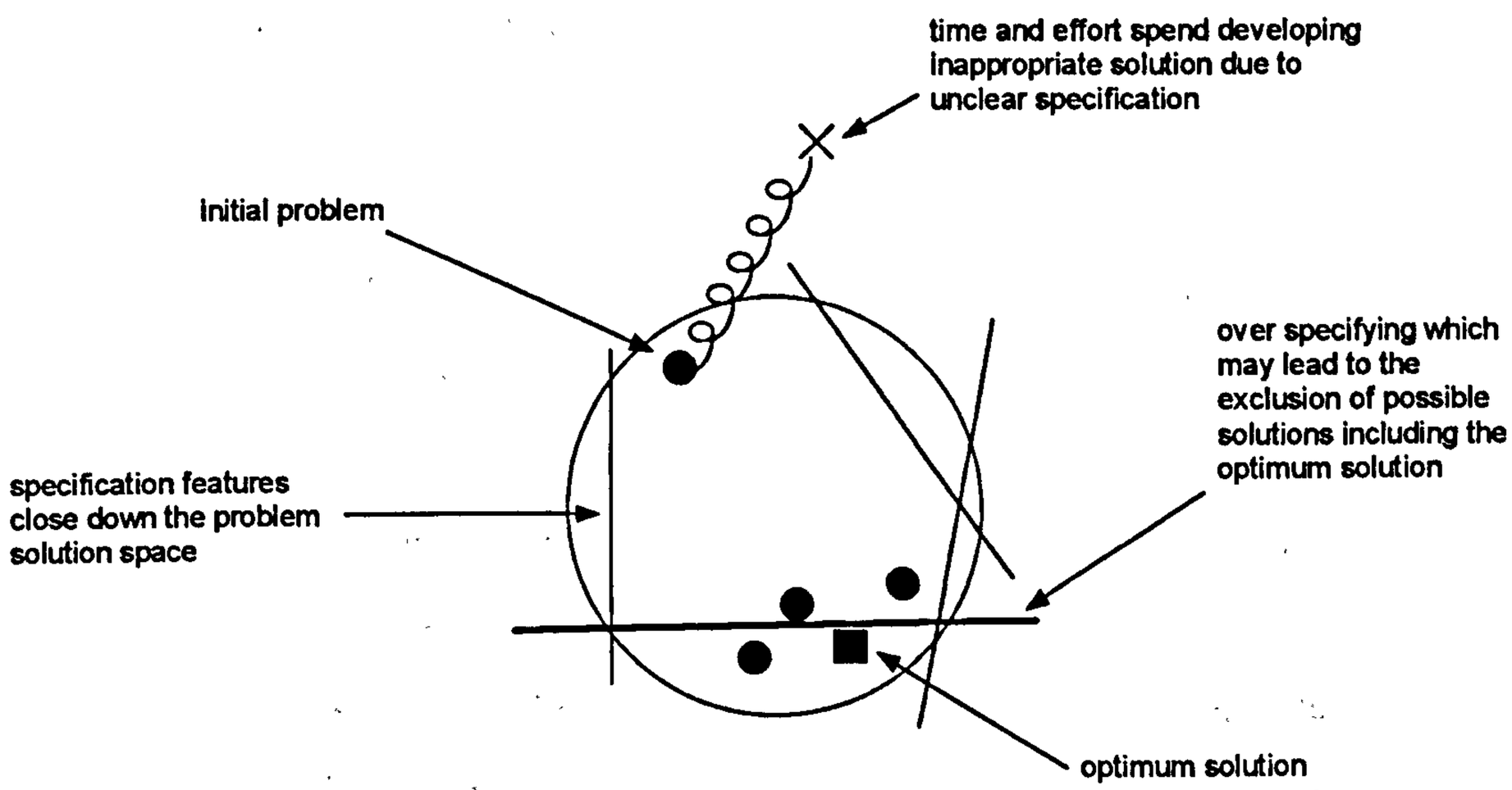

Figure 2.9. The effects of specification on the problem space (Gill 1987)

As already discussed in section 2.3.1.2 the gap between models proposed by researchers and the reality of everyday design and development activities can be significant. In the case of Designers they can be under great pressure to create new designs in as short a time as possible and with the least resources. External specifications usually include a wide range of information such as legal documentation, product life span, cost, performance, and market politics, constraints etc. much of which must be considered in the design. This can leave Designers experiencing information overload and in practice many Designers do not work according to design procedures in a systematic way (Mossink 1990).

Instead they consider only a few aspects of the product to be designed and rely heavily on previous experience and intuition (Staufer et al 1987).

Regardless of whether one accepts the analysis-synthesis-evaluation model or the conjecture-analysis model to be true, the importance of introducing relevant information into the earliest stages of the process can be seen. It is at these early stages, before more concrete decisions about a product have been made, that information may influence the design to a greater extent. Therefore to improve the likelihood of customer information being incorporated into a design the data is best presented to the team at the earliest, pre-concept stages of the design process.

Another issue which arises from the models of the design process described in this thesis is that of information overload. Although it is necessary to provide enough information at the early design stages it is important not to provide so much information as to stifle creativity or force Designers to think of solutions in only one particular area of the design space. Further, the level of information presented must be addressed. If the information at this stage is too detailed and rigid it may again stifle creativity, or be ignored completely during the design process. This means that information should be presented as early as possible in the design cycle, but in not too much detail at this stage. The information should be clear and concise so that it can be understood and used by the design team quickly and easily.

2.3.3 Ergonomics in the design and development of new products

Part of Besford's (1987) table of design activities (table 2.1), includes the use of ergonomics information in the product design process. The integration of ergonomics into the design process is an area which has generated a great deal of discussion, and Ergonomists have long stressed the importance of considering and integrating ergonomic issues throughout the product design and development cycle (e.g. Stanton 1998, Taylor 1999). Ergonomists in a design team may be faced with a number of general tasks (Haubner 1990):

- Analysis and description of user groups and tasks
- Input of information into the design of alternative concepts
- Ergonomics evaluation of prototype solutions

Berns (1984) suggests that the incorporation of user activity is the main purpose and goal for using ergonomics in the development and design process, and Stanton (1998) proposes that given user activity is central to design it needs to be captured and incorporated into the design cycle. Why then if the need and usefulness of including ergonomics information at all stages in the design process has been recognised (Gould and Lewis 1985, Allison, et al 1992) and is considered a key 'measure of success' (e.g. McClelland 1990, and Chapanis 1985), is it that the uptake of ergonomics data is still patchy, and a lot of Designers feel that their ergonomics needs are not being met (Woodcock and Galer Flyte 1998).

In many cases ergonomics and user information is still only brought in at the evaluation stage of a design, after the constraint space has been explored and the degrees of freedom considerably reduced (McNeese and Zaff 1991). Research aimed at explaining what seems to be a 'utilisation problem' has focused on factors at both the individual and organisational level (Slappendel 1994). Berns (1984) suggests that some of the most important factors influencing the use of ergonomics in design projects are:

- Commitment of top management
- (Uncertainty in) cost and benefits
- A positive attitude of the Designers towards human factors

Organisational factors such as communication flow and organisation structure have been researched as a possible cause of the poor uptake of ergonomics knowledge (Liker, et al 1984, Evans and Chaffin 1986). Liker et al identified some of the organisational barriers to the use of ergonomics as being poor inter-departmental communication, organisational politics and unfavourable perceptions of cost versus benefits at the organisational level. Slappendel (1994) conducted a study which focused on the extent to which companies were familiar

with, and utilised ergonomics knowledge. She found that where companies did have ergonomics expertise within the organisation it was most often initiated through the employment of Industrial Designers who had ergonomics experience. This in effect meant that most ergonomics expertise was introduced unintentionally, and the field of ergonomics did not have a high profile of its own. The study also found that the focus of company management strongly influenced the introduction and use of ergonomics, a view which is consistent with the product development literature reporting research into organisational effects on the process discussed in section 2.3.1.1 of this review.

At the individual Designers level research has been conducted to investigate the effects of such variables as approach to designing, attitudes to ergonomics and the knowledge and skills of the Designers. McClelland (1990) compared a number of papers which discussed traditional concerns of Designers with those concerning specific design projects. He found that the knowledge and skills derived from the traditional areas such as legislation, standards, codes of practice, design guidelines, professional education etc. faded into the background when Designers were focused on the development of a specific product. The day to day activities of the Designers tended to be driven by high profile demands which could easily be justified in business and technical terms (Elliot et al 1999).

Thus when all the other demands which can take precedence over ergonomics information, such as material costs, durability, ease of manufacture, conformity with regulations, compatibility with other products in a range and profitability, are considered it is easy to see why ergonomics can be forced to take a back seat during design (Brown 1985). This position is further reinforced by the fact that many ergonomics issues don't come to light until the final design is on the market. By this time the Designers will usually have moved on to another project and be unaware of the problems experienced by users of the product. Therefore the Designers consider the project to have been a success, without any input from an Ergonomist. If user problems are picked up by consumers, the Ergonomist may then be cast in a 'remedial or retrospective' role to remedy problems, which at this stage in the product development process may be difficult

to change significantly (McClelland and Brigham 1990). Thus the usefulness of ergonomics may be questioned because the Ergonomist has not been able to fully eliminate the problems which should have been addressed earlier in the development process.

2.3.3.1 Barriers to the inclusion of ergonomics in new designs

Several authors (e.g. Gould and Lewis 1995, Woodcock and Galer Flyte 1997, and Pheasant 1996) have investigated the reasons why ergonomics is still considered by some Designers to be an expensive and time consuming luxury as opposed to an essential part of the design process. Pheasant (1996) presented five fundamental fallacies which are often used by Designers to justify why they do not use ergonomics. These fallacies can be summarised as follows:

1. "This design is satisfactory for me - it will therefore, be satisfactory for everybody else." Although many Designers would not openly admit that they base their work on this premise, in reality many do. Often a Designer will picture him/herself using the product they are designing and develop their designs to meet their own needs. A study by Woodcock and Galer Flyte (1998) reported that Designers claimed to use ergonomics information at all stages of the design process. Some of this information came from books, local experts and training. However the majority of the Designers stated that they usually asked colleagues or relied on their own experience when considering ergonomics issues. This would seem to contradict the Designers' claims, and indicate that although the importance of ergonomics is recognised the exact nature of what constitutes ergonomics and how to incorporate this data into actual designs is far less well defined.

2. "This design is satisfactory for the average person - it will therefore, be satisfactory for everybody else." This premise is often used because the Designers will mistakenly assume that a person who is of average height will be average in all their other measurements. Obviously this is not necessarily true, a person may be of average height but have very short

legs and a very long body, alternatively they may have very long legs and a very short body. If an average value is used to set a design parameter it may exclude up to 50% of the potential user population. If this is done for each parameter the Designers may in fact exclude a much larger proportion of the population from using the final product. Obviously it is important that a design should accommodate the largest possible percentile of its user population to maximise its usability.

3. "The variability of human beings is so great that it cannot possibly be catered for in any design - but since people are wonderfully adaptable it doesn't matter anyway." It may be true that people are adaptable, but this is not an acceptable excuse to design products without considering the user. Adapting to products can cause great frustration and in some cases lead to health and safety problems. In addition to this users are unlikely to repeat a purchase of a brand of product which they find difficult or annoying to use. Gould and Lewis (1995) addressed the issue of Designers ignoring customer issues on the basis that users are too varied. They accept that people are so diverse that gathering information from a relatively small sample may not reveal all the differences in users, however, they suggest that it is better to identify some of the differences and problems rather than ignore them all. In addition they propose that where problems occur in designs the same issues often crop up for user after user.

4. "Ergonomics is expensive and since products are actually purchased on appearance and styling, ergonomic considerations may conveniently be ignored." This implies that all the customer wants is an attractive, stylish product. However, if customer input and ergonomics are ignored how can the Designers know that this is all the customer wants from a product. It is entirely possible that the customer would like to see other features which would make the product easier and more pleasurable to use, but they do not have the opportunity to express these desires. Therefore the customer puts up with the products which are currently available. Gould and Lewis

(1985) point to a genuine problem in that sometimes customers do have a problem verbalising what they want in a new product, perhaps because they have never considered in any great depth how they use a product, or thought about alternative ways of carrying out a task. These issues need to be addressed when using customer information.

5. "Ergonomics is an excellent idea. I always design things with ergonomics in mind - but I do it intuitively and rely on my common sense so I don't need tables of data or empirical studies." This is closely linked with the first fallacy and it is the ability of Designers to put themselves in someone else's shoes. It is very difficult to imagine that a Designer could put him/herself in the position of the whole range of possible users of a product. The amount of empathy between a Designer and the product user may also be affected by the similarity of one to the other, e.g. having the same background, height, gender. If there is little similarity between the Designers and the user, as is often the case when products are intended for global markets, it can prove difficult for a Designer to picture someone else using the product, especially if it requires training or learning, This becomes a bigger problem when it is considered that the majority of Designers are young or middle aged, able bodied males. Problems arising from these designs may in fact lead some potential users such as females, children and disabled people, to reject a product, or be unable to use it.

The question then is how can these problems be overcome to ensure that ergonomics and customer information is incorporated into new product designs? Since, for the most part, users are still little understood by the Designers who develop products for them, making the design process more user-centred helps to overcome these problems. By focusing on users the emphasis in the design process is shifted away from a purely technical consideration of products' capabilities to a more encompassing perspective considering the way in which products fit into a user's activities (Margolin 1997). This is equally true for the company as a whole, and studies have shown that making a company more market or user orientated improves the success rate of new products (e.g. Moorman 1995, Narver 1990). In

addition, making a company user focused provides organisational support for individual Designers and encourages them to become more user focused in their work (De Young 1996). The following section explores the literature relating to user[1] focused product development.

2.4 The user focused product design process

Sanders (1993) suggests that in order for products to be successful they will have to simultaneously meet consumer needs along three perspectives: usefulness, usability and desirability. A useful product is one which consumers need and will use, a usable product is one which customers can use or learn to use and a desirable product is one which consumers actually want. In order to achieve these goals companies must first identify who their customers are, find out what the customers want from the company's products and decide how to incorporate these needs into future designs. These activities place an increasingly important focus on customers during the development of products and systems and have led to a wealth of research being conducted in diverse disciplines such as ergonomics (mainly in the field of human-computer interaction), cognitive psychology, design theory, engineering design, marketing, organisational theory, product development management and quality management (Kaulio 1997). The research presented in this thesis concentrates on the inclusion of customer ergonomics information at the early stages of the design process, that is the pre-concept stages. As discussed in section 2.3.2 this is where the introduction of information can have the greatest impact on the final design. A representative range of methods, principally from the fields of quality management, marketing research and ergonomics, are discussed in order to provide an overview of some of the main techniques employed to ensure the user is considered from the early stages of product development. The main focus of this section will be on the literature emerging from the field of ergonomics.

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[1] The terms user, customer and consumer are advocated by different disciplines to identify the person using a product. In the context of the research presented in this thesis they are considered to be interchangeable, and no distinction is made between the terms unless otherwise indicated.

2.4.1. Approaches to user-focused product development

There are many approaches to the development of products on the basis of user needs and requirements. Table 2.2 summarises some of the possible approaches, emanating from different disciplines.

Discipline	Examples of approaches and techniques employed in the field
Quality Management	Quality Function Deployment (QFD)
Marketing and Innovation Management	Market analysis, Consumer idealised design, Lead user method
Participatory Design	'Scandinavian approach'
Human factors / Ergonomics and Consumer Research	User-oriented product development, Contextual design, User-centred design

Table 2.2. Examples of methods to ensure a user focus in product development

A review of the techniques presented in table 2.2 is given in the following sections.

2.4.1.1. Quality management

Quality function deployment

Quality management techniques are exemplified by the use of quality function deployment (QFD). This technique was developed in 1972 at Mistubishi's Kobe shipyard, and modified for use in the Japanese automotive industry (Hauser and Clausing 1988). The aim of QFD, according to Akao (1990) is to convert consumers' demands into design characteristics which can be used to develop a new product. This is done by systematically assessing the relationships between consumer demands and the design characteristics, starting with the quality of each functional component and extending the evaluation to the quality of each part and process. It is a development method which is based on inter-functional teams and uses a series of matrices, which are described as houses (see figure 2.10), to ensure customer input throughout the design, manufacturing, and service delivery (Griffin and Hauser 1993).

The first matrix focuses on the needs of the customer and how these can be achieved through different design attributes, see figure 2.10. Discussions with customers usually identify 200-300 requirements.

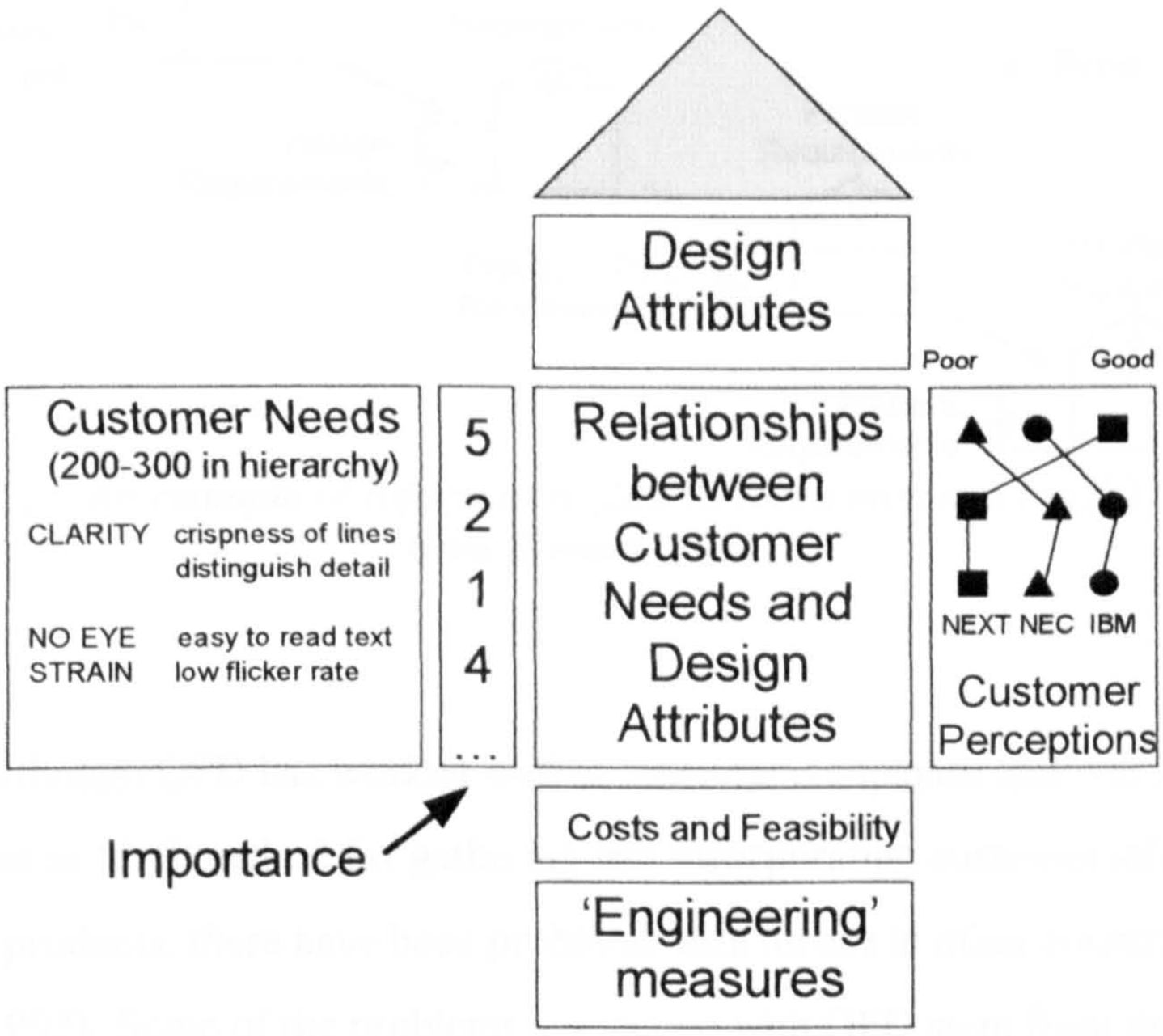

Figure 2.10. The Voice of the Customer House from Quality Function Deployment (Griffin and Hauser 1993)

Griffin and Hauser (1993) identify three different types of needs captured:

- Basic needs (what a customer assumes a product will do)
- Articulated needs (what a customer will say they want a product to do)
- Exciting needs (those needs which if fulfilled would surprise and delight the customer) .

Each customer need is given a rating so that they are weighted according to how important they are perceived to be. In order to ensure that the voice of the customer is carried through the design and production cycle a series of matrices is used to bring forward important issues at each stage of the process, i.e. the engineering and manufacturing stages, see figure 2.11.

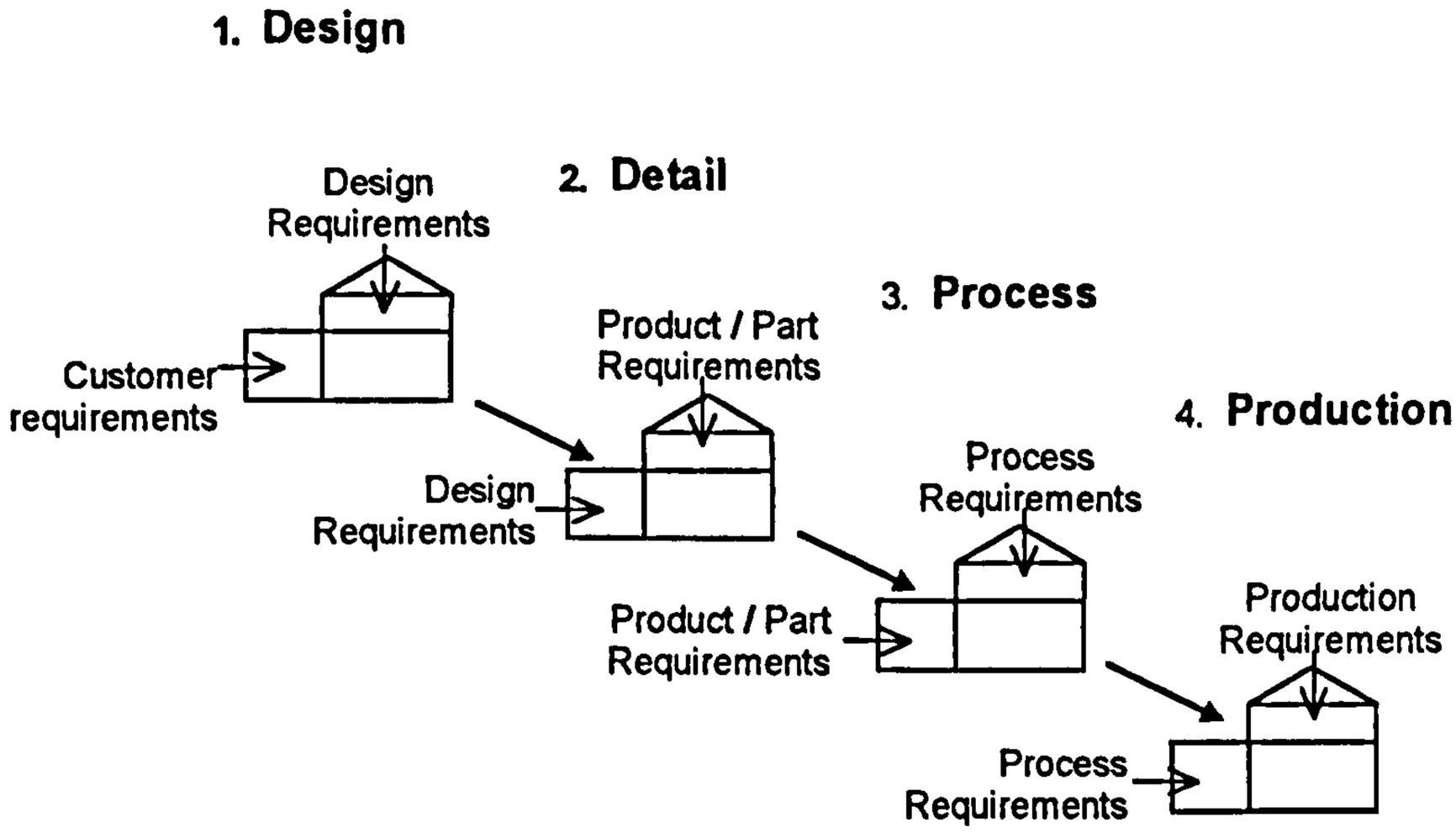

Figure 2.11. An example of information flow between matrices in QFD (adapted from Bossert (1991)

Although QFD has worked well in Japanese companies and was at one time hailed as 'the' method for gathering and incorporating customer information into new products, there have been problems with its use in other countries (Griffin 1992). Some of the problems associated with QFD stem from the fact that it was developed in a very different philosophical and cultural background from most European and American companies. The Japanese have traditionally placed high importance on team work and full inclusion of people from all stages of the design and production process (Kalargeros and Gao 1998). In Europe QFD is often implemented by an outside expert, which can add to the widespread opinion expressed by non-specialists that it is complicated and resource intensive (Trygg 1993).

The process needs commitment from all members of a team to ensure that it is carried through from start to finish, and can require considerable changes to both the organisational strategy of a company (Goodrich1994) and individual working practices. In effect it necessitates changes in working practices rather than fitting in with them. Further to this QFD can be very time consuming to set up as it requires a great deal of effort to collect all the data needed to feed into the numerous interaction matrices (Bruce et al 1995). Matrices can quickly become very large and unwieldy, especially with complex products which can be used in a

wide variety of situations, e.g. automobiles. The analysis of every one of these inputs into a matrix would not be time efficient (Hunter and Van Landingham 1994) and usually some type of hierarchy of needs must be applied to the process (Armacost et al 1994).

Analysing customer inputs can also be a major cause of problems in the QFD process. For example, if a customer states a need in their own language, e.g. it should be easy to switch a device off, the Designers may interpret this as the device should turn off in one easy operation, or it may mean that the device should be easy to disable to stop it being turned off. The Designer's interpretation of customer needs may not be those intended by the customer (Nichols and Flanagan 1994). If a Designer is required to translate the customer information into design attributes they will need to be trained as to how to do this effectively. In some cases they will need to learn how to collect and analyse customer requirements using QFD tools such as affinity diagrams / KJ Method (a method which gathers large amounts of ideas, opinions etc. and organises them into groupings based on the natural relationship between items) (Bossert 1991). Further, linking the customer needs with technical data through the matrix can sometimes give false confidence in the results. Usually a small number of people will use their own experience and judgement to determine the strength of a link between customer and technical data, and use this to produce a detailed specification for the final product. Thus the specification which appears robust is only as good as the skills of the people who completed the matrices.

QFD does not place great emphasis on the tools used to collect the customer requirements to feed into the matrix, nor on the methods of presenting the results of the matrix to the design teams. The process tends to consider the customer as a series of requirements statements taken out of their natural context. This can dehumanise the customer and does nothing to help bring their needs and requirements to life in the context of their environment, that is it does not help to create empathy between the Designers and customers who buy their products. Thus research to address the collection and communication of requirements in a

way which helps Designers to appreciate the needs of their customers in the context of their everyday lifestyle is needed, and is addressed in this research.

2.4.1.2. Marketing and innovation management

Market analysis

There are a wide range of methods available for analysing customer inputs into product development from the field of marketing and marketing research. These include concept testing and consumer product tests (conducted after the product has been developed), market segmentation techniques and the use of databases of customer information (Blankenship and Breen 1993). Some of the most commonly used methods include:

Concept testing and consumer product testing. These techniques use product clinics to test customers' opinions of concepts and new products, either before or just after market launch (Davis 1993). They usually assess attitudes towards products, and may compare a number of options which could be designed into a new product. Some researchers advocate the use of expert customers for this type of research, because they are better able to explain what they feel about a product and what they want it to achieve (Schoormans et al 1995). However, this can lead to biased results because the expert users become familiar with product testing and concepts and no longer represent the 'average' consumer.

Further, the concepts presented will have already made assumptions about the needs of customers and how they will use a product. Therefore if a Designer has not recognised, or has chosen to ignore particular customer requirements whilst designing the concepts, the need will not have been met in those designs. In effect it is already too late to begin addressing customer needs at this stage.
Lastly, this technique is not suitable for use in the development of all products. Some products, e.g. automobiles, are too expensive to market test, the designs too confidential to show to the consumers or too complicated to explain or build for a concept test. Thus the technique is not considered suitable for collecting customer

information to feed into the pre-concept stages of design because there would be no concept or test product available at this stage.

Market segmentation. There are many ways in which the customer base for a product can be segmented, in order to provide information about different groups of customers, see table 2.3.

		Customer characteristics	
		General	**Situation specific**
MEASURES	**Objective**	• *Demographic factors*: age, gender, stage of life cycle, etc., e.g. Mitchell and McGoldrick (1994) • *Socio-economic factors*, e.g. Wind (1982)	• *Consumption patterns*, e.g. Shugan (1986) • *Brand loyalty patterns*, e.g. see Worcester and Downham (1988) • *Buying situations*, e.g. Woudhuysen (1994)
	Inferred	• *Personality traits*, e.g. Sukhdial, et al (1995) • *Lifestyle*, e.g. Kamakura and Wedel (1995)	• *Attitudes*, e.g. DeSarbo and Ramaswamy (1994) • *Perceptions and preferences*, e.g. Kamakura and Novak (1992).

Table 2.3 Types of segmentation used to analyse a market (Frank, et al 1972)

However, this technique normally focuses on segmenting customer statistics rather than actually exploring consumer requirements. Consumer needs may be derived from the data collected but they are not collected explicitly in this kind of research. Further segmentation does not usually provide customer ergonomics information in enough detail to allow Designers to make decisions based on the information. Nevertheless, segmentation has been used to provide different products for different segments of the population through:

- production of totally different product types for different sections of the population
- production of product variants within the same overall types

- production of different brands within the same specific product variant.

Marketing researchers have also traditionally used a range of techniques to uncover associations and groupings in customer data (Kinnear and Taylor 1987). Some of these include:

- Multivariate analysis such as multiple regression, analysis of variance, analysis of covariance. These techniques are used frequently by marketing researchers to simplify large amounts of data and uncover underlying trends in the information.
- Conjoint analysis which is used to describe a broad range of techniques primarily used to measure the trade-offs that consumers make on product attributes by specifying the particular values consumers place on different features. Some of the techniques include choice modelling, card sorts, trade-off matrices and preference based conjoint analysis.
- Affinity diagrams and cluster diagrams which are used to group data into clusters with similar attributes, e.g. people who are confident, enjoy driving and buy sports cars may be clustered in a group together because they score similar results on a questionnaire about attitudes towards driving.

All these techniques are useful for providing broad analyses of large amounts of data. However, the techniques are complicated and need to be analysed using statistical packages, which may necessitate training. Thus Designers are unlikely to use the techniques to analyse data themselves. Once data has passed through these techniques a lot of detail will already have been lost from the data set, because the analysis will abstract general results. Further it is not always clear to non-specialists in the area of market research exactly how the results have been derived or where they came from. This can make it difficult for Designers and design teams to incorporate the information they receive because it must be taken on trust that the Market Researcher has come to the correct

conclusions about the results. It tends to make the customer a faceless 'consumer' far removed from the Designers, and if this is the case the degree of user focus in the development process may not be as high as expected. Issues relating to the communication of customer information to design teams are discussed more fully in section 2.5 of this chapter.

Although the above techniques are very useful for simplifying complex data, there is also a need for more detailed, transparent information to be presented to design teams. This gives a clearer indication to the non-specialist of exactly how the conclusions arising out of a data set were reached. It also enables them to see where they could get hold of more information about the results if they want to. Detailed information helps design teams to understand the needs of their customer in more depth and to develop a rapport with the users of their products.

Consumer idealised design.

This is described as a 'process for involving customers in the actual design of new manufactured goods or services' (Ciciannteli & Magdison 1993). The technique involves consumers from different market segments who take part in a type of focus group to design their *ideal* product or service. The aim of the process is to consider new products from scratch without considering the feasibility of design (Kaulio 1998). However the participants are instructed that the product they develop must involve only current technology, not that necessarily associated with the product being developed but available none the less, and the product must conform to the law. The consumer design session takes place at the earliest stages of the design process, ensuring that the voice of the customer is heard from the start of the new product development. However, this technique is not suitable for use in all situations. People may have varying degrees of knowledge about the types of technology which exist, or how to develop their ideal product. This becomes even more of a problem when designing for overseas customers, because their experience of existing technology will be very diverse, and they may not be aware of the availability of particular technologies in the home market where the product is being developed.

Lead user method

This is an approach to the inclusion of customer data which uses a variety of market research techniques to gather information from lead users. Lead users are carefully chosen customers who are considered to be 'trend setters', that is they adopt new products before the rest of the market. The process passes through the following four steps:

1. Specifying lead user indicators - that is identifying what characteristics lead users should posses.
2. Identifying lead user groups - once the desired characteristics have been identified appropriate customers must be found to take part in the research.
3. Generating concepts or products with the lead users - finding out what products and features lead users want to see developed.
4. Testing lead user concepts on ordinary users - once the lead users have identified products which fulfil their needs they need to be tested on the rest of the consumer group.

This method relies entirely on finding the right lead users, that is those consumers who do actually reflect the needs of the market. It is important to ensure that lead users are as similar to the ordinary consumer in as many ways as possible to avoid the possibility that they may be lead users because they have different characteristics to the rest of the user population. Further to this the use of lead users as the sole providers of data will not give a representative picture of the needs of 'ordinary' consumers. Lead users are only a small sub-set of the user population and do not constitute a representative sample of the users of a product.

2.4.1.3. Participatory design

According to Noro and Imada (1991) the earliest use of participatory design was in Norway in the 1970s. Computer professionals worked with three unions to provide them with knowledge about how new information technology

could affect their working conditions and jobs (Clement and Van den Besselaar 1993). Participatory design continued in the 1980s primarily in the Scandinavian countries, hence it is sometimes known as the 'Scandinavian Approach'. The basic premise of participatory design is that workers/users become actively involved in designing their own working environment or living space. Bannon (1991) claims that "traditional human factors is often limited in scope with respect to its view of the person". The human is considered only in terms of their characteristics and abilities, e.g. attention span, body size. Participatory design views people as more than a sum of parts, that is it also takes account of their values, goals, beliefs about life and work, etc., to develop systems which fit the needs of users more fully. The term human actors has been used in participatory design to signify that people play an active role in the development of systems and work design.

Participatory design demands commitment from workers, management and the whole organisation to ensure its success (Kuhn and Winograd 1996). Group workshops play an important part in the process (Macaulay 1997) as much of the information used is gathered through participation in small groups. As with many of the approaches incorporating users' needs in the design process the amount of actual user involvement can vary. Erickson (1994) proposes four dimensions along which the amount of participation by users can be measured:

1. Directness of interaction with the Designers
2. Length of involvement in the design process
3. Scope of participation in the overall system being designed
4. Degree of control over the design decisions.

A number of techniques have been developed to assist the inclusion of user needs and wants in the participatory design process including:

- Envisionment, future workshops and future games - used to consider future possibilities (Greenbaum and Kyng 1991).
- Co-operative prototyping - the inclusion of users in both the development and evaluation of prototypes, e.g. Harker (1993) used

prototyping to evaluate both the social and technical structures within a government department.

- Design mock-ups - used to generate ideas and gather feedback from users, e.g. Ehn and Kyng (1991).
- ETHICS - a method which emphasises job satisfaction, good job design and organisational design, through user involvement (Mumford 1993).

Although early work focused on employees and unionists in order to make working life more democratic and to some extent produce technology developed from the workers' perspective, more recently participatory design has been used in an organisational setting involving users, systems Designers and management. Nevertheless the focus has still been on the design of technology, usually in the form of computer systems, and there have been no reported studies documenting the use of participatory design in the design and development of mass produced consumer goods (Kaulio 1997). This is due in part to the nature of some consumer goods. Product development is often a highly secretive process and it is not feasible to bring in members of the public at the sensitive early stages of design. Further some products, e.g. automobiles, are highly specialised and complex and involving customers in their design is impractical. Nevertheless, some of the philosophy and techniques of participatory design can be adapted for use in the development of consumer goods, and the work presented in this thesis adopts some of these, for example the consideration of consumers as more than the sum of their abilities and characteristics.

2.4.1.4.Ergonomics and Human Factors

User-oriented product development

This approach is very similar to that of user-centred design (see later in this section), but where user-centred design grew out of the field of human-computer interaction and software development, user-oriented product development originated in the area of consumer technology, and most notably in

the design of working / military clothes (Rosenblad-Wallin 1985, 1988 cited in Kaulio 1997). The approach is based on:

- an analysis of the user and use requirements, initially looking at the use situations in order to develop the user needs.
- transformation of the user requirements into measurable engineering requirements.
- iterative design, with prototype testing by users.

Requirements are analysed by the Designer / developer of a product, and focus on the requirements of usage rather than product features themselves. Different prototypes are developed and tested in the field by consumers to determine their suitability for meeting the consumers' needs.

Contextual design

This approach focuses on data collection in partnership with users, and in the context of users' work (Wixon et al 1990). Contextual enquiry is used to gather information by talking to users whilst they work. This enables information about users' interpretations, language and structuring of their work activities to be collected, and leads to a shared understanding of the user's perspective. The inquiry is usually conducted with as few workers as is needed to gain a good understanding of the user requirements, and to ensure that the information provided is cost effective and timely.

Contextual design is similar to participatory design, described in section 2.4.1.3 of this review, in that users of a product are considered in a design by actually involving them in the development process. However, contextual enquiry focuses mainly on the interaction between a user and the product they are using, whereas participatory design looks at the wider issues of working in an organisation. Further, contextual enquiry usually takes place whilst the person is interacting with the product, thus data is gathered as it happens rather than relying on recall at a later date. In parallel with participatory design, contextual enquiry has focused mainly on the introduction of computer systems into work places, and

there have not been any studies published which indicate its use in consumer product development. Nevertheless, the technique would be suitable for use in the development of most consumer products, apart from those where it is dangerous to take the user's attention away from the task by verbalising what they are doing, e.g. the driving task. Also the method is labour intensive because each interviewer can only work with one participant at a time on a one-to-one basis, and this may restrict its use in some cases.

Kansei Engineering

Kansei engineering (Nagamachi 1995) or 'sensory engineering' (Lauglaug 1993) is an approach which aims to link the design characteristics of a product with users' responses to the product. By altering various aspects of a product the consumer's response to the overall product can be assessed. The products are rated on a number of descriptive dimensions, e.g. hard, soft, showy, calm, masculine, feminine, and the results are analysed using cluster analysis. A similar technique known as Sensorial Quality Assessment (SEQUAM) has been used to investigate user's responses to tactile contact with a product (Bandini-Buti et al 1997).

These methods can become quite complicated if a large number of dimensions are considered, and some authors have criticised them for focusing too much on the elements of a design rather than the overall design itself (Jordan, 1998b). It would be very time consuming to use Kansei engineering on an entire automobile because of its complexity and the number of features to be assessed. The use of SEQUAM as a tool for collecting data about particular aspects of a vehicle has been documented by Bandini-Buti et al (1997). Whilst this is a valuable approach it is not suitable for use in the research presented in this thesis because it focuses on individual features of the vehicle, and is not easily used by a non-specialist in a short time scale.

User-centred design

User-centred design is an approach which places the user at the centre of the design process and has been described as 'designing from the human out'

(Woodson 1981). The focus is on creating products which are easy to use and match the real needs of the user, that is the products should fit the needs of the users rather than the other way round. Much of the work focusing on user-centred design has emerged from the field of human-computer interaction (HCI) and the design of information technology (e.g. Allison et al 1992, Karat 1997a). However the approach is equally applicable in many design and development situations, where people are intended to use the final product, such as consumer product design.

The HCI community has adopted the term 'user-centred design' to describe approaches to developing usable systems. However, the term user-centred design (UCD) has become widespread since the 1980s when it was first coined. When Karat (1997b) conducted an informal survey of usability specialists in 20 companies and asked them for their definition of UCD, he found that most were still trying to come up with a working definition. Nevertheless, a number of authors have suggested principles which should guide the user-centred design process, and among these Gould and Lewis (1985) have presented three high level principles of good design which are universal to all user-centred design (although Gould and Lewis do not actually use the term user-centred design). These principles are:

1. Early focus on Users and Tasks - Designers must understand who the users of a product will be. This principle is often expanded in user-centred design to include all the stakeholders in a system or product, that is all the people who will be involved with the product in some way. For example a computer system may be designed for its users, but it should also be designed to take account of those people who will set up and maintain the system.
2. Empirical Measurement - early on in the product development users should actually use simulations and prototypes to carry out real work. Their performance should be observed, recorded and analysed.

3. Iterative Design - problems encountered in the design and development of a product need to be addressed using iterative design to test, measure and redesign the product as many times as necessary.

User-centred design is considered to be systems oriented, in that it recognises that the interaction between a product and user takes place in the context of a socio-technical system. In designing products it is important to look at the relationship between a person, a product and the tasks they wish to complete using the product, in the wider context of the environment in which they will use it, see figure 2.12. Each of these factors will interact and affect the others, thus the context in which a product will be used is, in some cases, as important as the product itself.

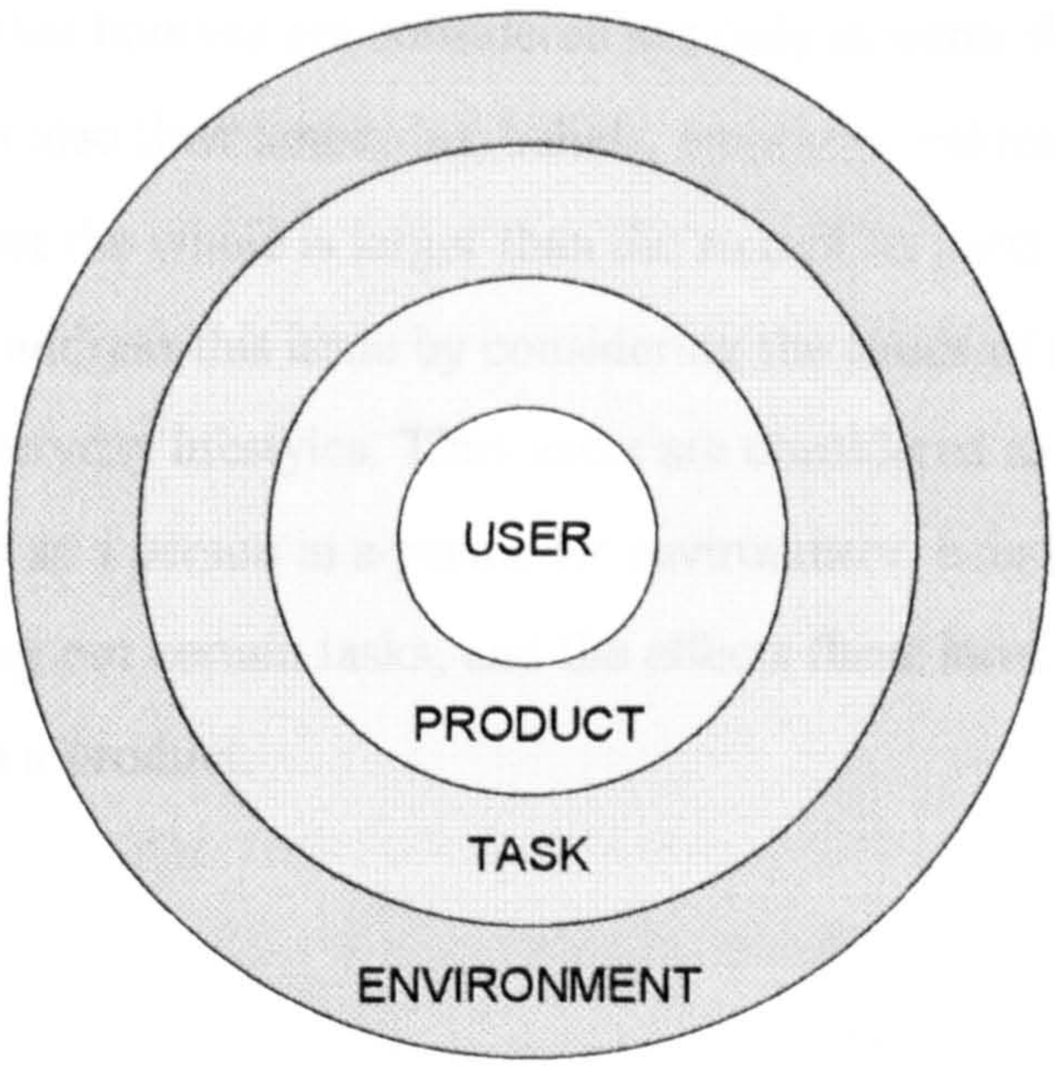

Figure 2.12 Systems oriented user-centred design

Eason (1992) describes three alternative views of the term 'user-centred'. These approaches are 'design for users', 'design by users' and 'design for users with users' (or 'design with users' (Kaulio 1997)). These definitions were principally developed in relation to the introduction of new systems in organisations, but they can be applied equally successfully to the area of consumer product design.

Design for users

In designing for users, researchers and technical experts use empirical methods to collect data with which to test hypotheses about human behaviour. Information about peoples' size, capabilities, strength etc. is used to design systems or products which match the relevant characteristics of the user, and enable them to use the product safely and effectively. Knowledge bases can be built up from the data about users, and general theories and models of customer behaviour. However, the Ergonomist acts on behalf of the user, deciding which data to gather and how to use that data in the development process.

Designing for users has been criticised for focusing on human factors as individual entities rather than as a whole in the context of the environment, culture etc. people work in. Branton (see Oborne et al 1993) advocates 'person-centred design' to ensure that humans are considered not only in terms their abilities and measurements, but also their ambitions, beliefs, emotions, values and satisfactions. This is the view that the whole is larger than the sum of its parts. The research in this thesis aims to address this issue by considering the needs of users in the context of their everyday lifestyles. Thus users are considered as more than a set of statistics, rather as a person in a particular environment, using particular equipment, carrying out certain tasks, and the effects these have on their requirements from a product.

Design by users

Design by users moves the user-centred design approach closer to that of participatory design, as discussed in section 2.4.1.3 of this review. Users themselves are involved in the design of systems which are compatible with their goals and beliefs etc. Design by users, like participatory design, is not suitable for use in all cases of design. Some products may need specialist knowledge to ensure that they are designed safely and effectively, as is the case with automobiles. Further, there are some situations where it is not possible to bring users themselves into the design process, for example where the users are in overseas

markets and there are cost and language barriers to their involvement in the process. In its most extreme form the role of the Ergonomists in the design by users approach is that of a facilitator; they help the stakeholders articulate their aims and values, enable discussions and seek mutually acceptable solutions to design issues.

Design for users with users

This strategy combines 'design for users' with 'design by users' and involves the Ergonomist as a kind of change agent, supporting the users as they develop solutions, but supplying information, methods and theory where appropriate (Eason 1995). Users are allowed to make the decisions which are of importance to them, and they should have relevant data to enable them to do so. The user community also evaluate system and product ideas presented to them against their requirements, with the Ergonomist supplying additional expertise if necessary. Kaulio (1997) uses the term 'design with users' when discussing this approach as applied to the consumer product development process. He describes the process as one in which information about customers' wants and requirements is used to develop a product, but which in addition presents customers with different solutions or concepts to enable them to input their ideas to the process.

This approach, like that of 'design by users' is limited in its use for designing certain products. As before if a product is being developed for overseas markets it can be difficult and resource intensive getting users involved in the design process. Further, if users are to comment on different concepts or solutions they need these to be available to look at and use. At the very early stages of design, that is those addressed in this thesis, there may not be a physical concept or solution to evaluate. A drawing of the concept is not always enough to assess how suitable a feature will be on a finished project, e.g. how comfortable a seat will be. However, this approach has been adapted for use in the work presented in this thesis. Consumers are asked to evaluate existing products which are similar to the new product being developed, in this case vehicles which are already on the market. This establishes customer needs created when using the product in a

particular environment, and helps the Designers to identify where solutions must be found for the next generation product.

Although user-centred design advocates the involvement of users as fully as possible in the design process, the approach is pragmatic (Pheasant 1996). It recognises that there may be limits to what can be achieved in any particular case, and aims to reach the best possible outcome within the limits imposed. Thus user-centred design can be seen as a philosophical approach which underpins the collection and incorporation of user requirements in the design cycle, but is not prescriptive in its methods.

2.4.1.5 Position of user focused methods in the development process

Kaulio (1998) uses Eason's (1992) categorisation to develop a framework showing the position of the different user focused methodologies discussed above in the development process, see figure 2.13. This framework places each approach according to the stage of the development cycle and how much user participation is involved in the process.

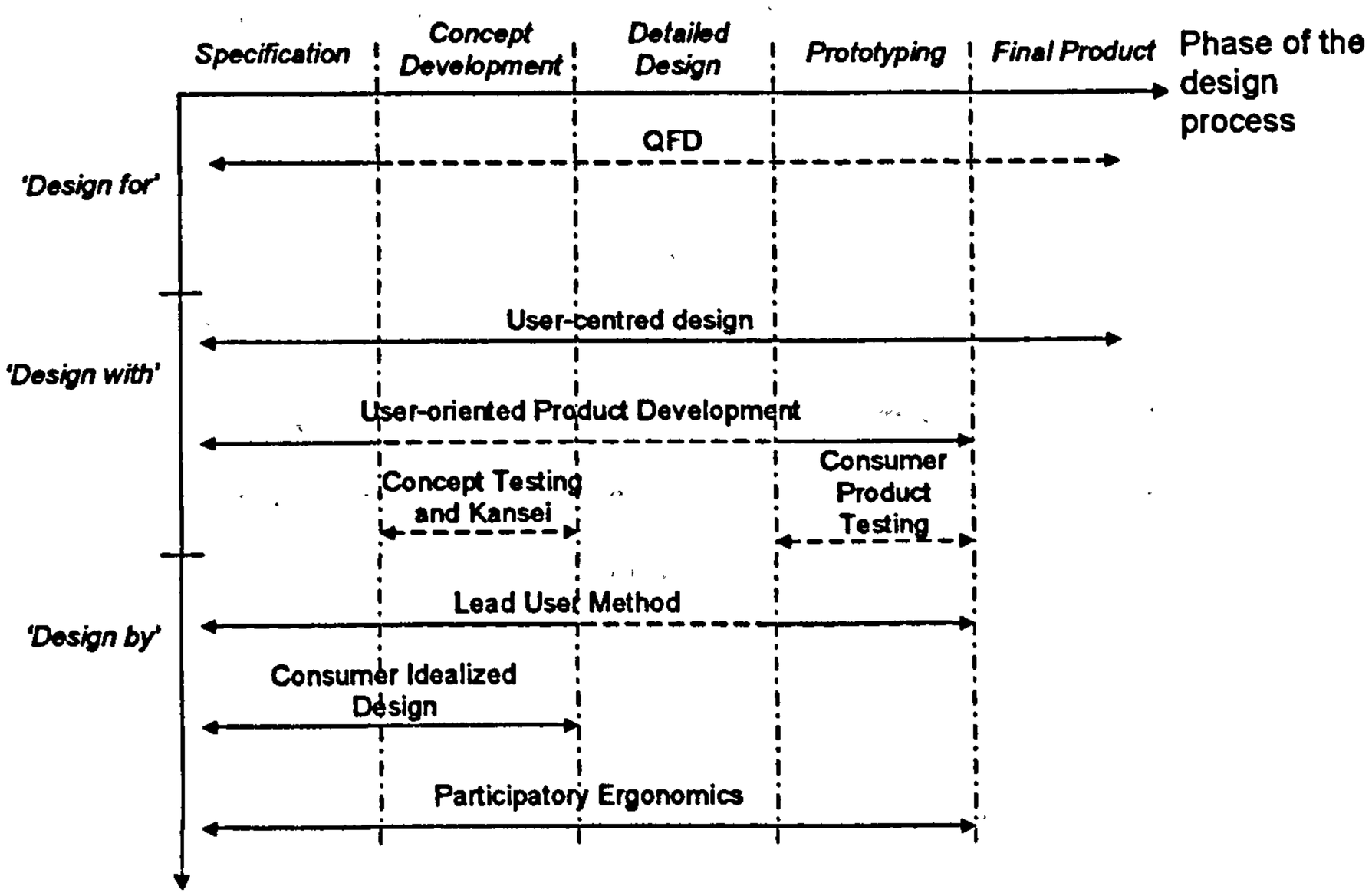

Figure 2.13. Position of different methods for bringing customer focus to design in the development process (adapted from Kaulio 1998).

Decisions as to which approach, or approaches, to adopt when gathering user requirements are based on a number of factors including (Kaulio 1998):

- The stage of the development process into which the consumer data will feed.
- The depth of customer involvement in the development process.
- The length of contact between the design team and the customer.

Thus for the research in this thesis there are a number of reasons for choosing a user centred approach, leaning towards the 'design with users' perspective:

- The thesis addresses the introduction of customer ergonomics information into the earliest, pre-concept stages of the design process. Since there are no concepts available at this stage consumer product testing is not suitable for use in this work.
- The work aims to incorporate requirements from overseas customers, thus it is not feasible within the resource constraints of the company, e.g. financial, time and secrecy of the process, to bring consumers in to work directly with Designers in the development process, or send design teams out to the markets. Therefore, the use of a 'design by' approach is ruled out.
- Due to the complexity of the products being developed, that is automobiles, concepts on paper are not sufficient to assess the impact different features may have on the consumer. Additionally the designs are too costly and time consuming to be made into realistic mock-ups for testing with the consumer. Thus concept testing, Kansei engineering and user-oriented product design are not considered suitable for use in this research.
- This research aims to address consumer issues as more than a list of requirements. It considers the requirements of the consumer produced through the interaction of themselves, the product they are using, i.e. their vehicle, the environment they are in and the tasks they want to carry out. In other words it is the customers' ergonomics requirements

collected in the context of their lifestyle. Further to this the research covers the communication of the customer requirements to design teams in such a way as they consider the customers' needs holistically rather than as a list of statements. For these reasons QFD was not utilised in this work.

Thus user-centred design is considered to be the most suitable approach to take to this research. The combination of an overseas focus and the desire to gather more than basic facts and figures, that is to include more lifestyle information in the customer requirements, indicated the need to move towards the 'design with users' approach advocated by Eason (1995) and Kaulio (1998).

The next section of this review covers the use of design and ergonomics information in the automotive industry. This is followed by section 2.6 which focuses on the range of methods available for gathering requirements from customers, and section 2.7 which addresses some of the issues associated with the collection of information from overseas markets. Section 2.8 discusses the communication of customers' ergonomics requirements to design teams and methods which can be used to achieve this successfully.

2.5 Design and ergonomics in the automotive industry

Automotive companies are increasingly under pressure to produce better designs in half the time. Whereas it used to take up to 48 months to develop a new car in the 1980s this figure now has fallen with some Japanese companies producing designs in approximately 30 months, and the figure is still decreasing (Done 1991). Time compression of the new product development process enables manufacturers to bring more models onto the market and in today's fast paced climate consumer preferences change rapidly. Therefore the more new designs a manufacturer can produce the more chance they have of creating a best seller, albeit a short lived one (Brookes 1992). This has led some automotive companies

to introduce techniques such as QFD (see section 2.4.1.1), Design for Manufacture and Assembly (DFMA) and Taguchi methods (Jaskolski 1992). These techniques aim to improve the time taken to develop new products by integrating different functions within the process, such as the manufacture and assembly of vehicle components only once the car has been ordered by the customer. However, many of these techniques require a fundamental change at the organisational level of the company and require considerable time and commitment by all employees to implement effectively. The consideration of these techniques is outside the scope of this thesis.

Traditionally there has been little information sharing between customer, dealer and manufacturer in the automotive industry (Bertodo 1991). The customer was seen as a distant figure who would adapt to the vehicles Designers wanted to design (Ludvigsen 1996). Even today when the focus on meeting customer requirements is becoming far more widespread customers' ergonomics requirements are often sacrificed to styling and economics (Woodcock and Galer Flyte 1997). However, the study by Woodcock and Galer Flyte (1997) shows that Designers are becoming far more aware of the benefits offered by ergonomics such as increased usability, safety, feature content and customer satisfaction with the product. Ergonomics is used throughout the design process with respect to such issues as ease of use, comfort, and interior packaging. Nevertheless, there was general consensus amongst the Designers interviewed that ergonomics information was not easy to find, a lot of it was inappropriate and the way in which it was presented was not compatible with their needs.

Companies have introduced a number of methods to try and incorporate customer requirements into their designs. For example at Mazda Kansei engineering has been used to evaluate customers' perceptions of a number of issues including vehicle motion and vision using a driving simulator (Horiguchi and Suetomi 1995). Fiat have used the SEQUAM technique, described in section 2.4.1.4 of this review, to assess customers' reactions to the feel of vehicle components such as door handles and seat covers (Bandini-Buti et al 1997), and Ford made use of the Internet by putting a customer questionnaire on one of their

web sites to gather customers' ideas for future products (Colgan 1995). Rover have utilised a type of QFD matrix to segment some of their markets and produce targeted products rather than actual customer requirements. The segments are based on the perceived image of the customer in each segment (Bertodo 1991). Chrysler have introduced a system for providing Designers with relevant ergonomics information about a user population, such as age, gender, educational level, and lifestyle (Thompson 1995), although this information is provided at a general level, rather than being market specific. Nissan have introduced a Principal Product Designer (PPD) who co-ordinates the collection of information from customers in the marketplace (Narita 1994). This process involves interviews with customers concerning their likes and dislikes about a particular vehicle, and typically involves evaluation of, for example, the look of the instrument panel, the feel of the seats, and the powertrain and chassis characteristics.

Whilst these are useful techniques it is only the method used by Nissan which actually involves contact with customers in the marketplace in order to discover their requirements for a vehicle. Other manufacturers may use similar techniques to gather requirements from their customers, but there is still much room for improvement in the processes used to collect and disseminate customers' ergonomics requirements in the automotive industry. Hence the emphasis in this thesis is on gathering and communicating real customer ergonomics requirements based on the needs and desires as expressed by customers, and in particular those from overseas markets. The next section covers some of the methods which can be used to collect customer information from the customers themselves, which can then be used by design teams in the development of new vehicles.

2.6 Gathering customer requirements

The process of gathering information from customers can take a wide range of forms. Jirotka and Goguen (1994) distinguish between four different ways in which customer requirements may be collected:

1. Captured: this implies that requirements may be elusive but are 'out there' somewhere waiting to be captured.
2. Specified: in this case the requirements are seen as technical specifications waiting to be defined.
3. Elicited: implying that requirements are 'among people', but effort may be needed to ascertain exactly what these requirements are.
4. Constructed: this is a view which suggests that requirements may not be present among people, and are instead a product of a requirements engineering process.

Each of these approaches is appropriate depending on the stage of the development process and the level of detail needed by the design team. This thesis looks at capturing requirements for use in the early stages of development whilst the design is still fluid. Therefore precise technical specifications which impose rigid constraints on the design, are not suitable for use at this stage. The research presented here adopts the approach that requirements need to be both captured and elicited. Some requirements are salient and can be obtained using relatively standard methods. Others may need, for example, to be collected in context during or shortly after an activity has taken place in order to prompt users to consider their requirements.

There are also a wide range of methods which can be adopted to collect customer requirements. Again the suitability of these varies according to the stage of the development process into which customer information will be input, the form the product will take, the amount of access to end users and the time pressures on the project (Stanton and Young 1998a). Since the research presented in this thesis focuses on the collection and communication of customer ergonomics requirements at the very early stages of the design and development process the following section explores some of the methods which can be used to collect customer requirements for incorporation at the specification and concept stages of development. Some of these techniques have been adapted for use in the Lifestyle Scenario Toolset.

2.6.1. Questionnaires

There are two main types of questionnaire, open-ended and fixed response. Open-ended questionnaires ask respondents to fill in their own answers to a series of questions, and can be very useful if a researcher wants to explore the issues surrounding a topic, but is not yet sure of the main points which should be discussed. Open-ended questions gather a broad range of information, which can be used to identify issues needing further investigation via other methods. In contrast fixed response questions help to simplify the situation being investigated and clarify respondents' answers (Sinclair 1975). Some fixed response questions give a number of alternative answer categories from which a respondent can choose, others use rating scales to find peoples' opinions on a subject. A questionnaire may include all open-ended questions, entirely fixed response questions, or a combination of these.

Mail questionnaires are suitable for collecting information from large groups of people, and from people who are widely dispersed (Oppenheim 1992). They afford the respondent time to think of answers to questions, and the anonymity which can be achieved using a questionnaire may serve to reduce the bias in responses which is sometimes caused by the presence of an interviewer. However, mail questionnaires can suffer from very poor response rates because they are remote and often anonymous. Although the low response rate can mean a lot of questionnaires must be sent out to receive the desired number of returns, it is not the low response rate per se which is problematic. It is the fact that those people who take the time to complete and return the questionnaire may not be representative of the population being investigated as a whole (Moser and Kalton 1971). A number of techniques can be used to try and increase the response rate of mail questionnaires including offering incentives, assuring confidentiality, inclusion of a paid return envelope in with the questionnaire and follow up or reminder letters (Oppenheim 1992).

2.6.2. Interviews

Interviews, like questionnaires can take a wide range of formats from the completely informal, exploratory interview to the formal, standardised interview (Oppenheim 1992). An unstructured, informal interview consists of a series of open ended questions which are used to explore issues around a central theme. The questions provide a loose agenda to guide the interview but respondents are free to give any information they feel is appropriate. Unstructured interviews are useful at the beginning of the design process when a researcher may have little idea of what issues are important to the user, and the interview can be used to explore a range of issues.

Semi-structured interviews are suitable for collecting more specific information, when a researcher has a better idea of which issues are important to the user. The framework for the interview will have a number of topics which the researcher wants to ensure are discussed, however there is still room for respondents to bring up other issues which they feel are important.

Structured, formal interviews are more like face-to-face questionnaires, in that the researcher will ask respondents to answer a series of questions from a number of pre-set responses. These could form part of a rating scale or be a set of categories. Structured interviews make the analysis of data much easier, but they often loose a lot of the depth of detail which is elicited in unstructured interviews.

Flores (1993) advocates the collection of customer information by listening not only to the stated requirements of customers, but also to the non-verbal aspects of communication. Approximately 80% of human communication is non verbal (Weiser 1988) and this can tell a researcher a great deal about a person, e.g. the way someone dresses can indicate a lot about how they want to be perceived. By taking account of a person's background, attitudes, beliefs, etc. the customer's stated requirements can be enhanced, although careful interpretation of the results is needed because the technique relies heavily on the skills of the researcher at reading these clues (Zaltman 1997).

Interviews can be labour intensive compared to questionnaires, because someone must always be present to administer the interview. This presence can also influence the responses of participants to the questions. Participants may tell the interviewer what they think he/she wants to hear, they may moderate their views if they think their ideas will seem too extreme, or they may feel intimidated by the researcher and not be open with their views. However, interviews tend to have a better response rate than questionnaires, they are less prone to self-selecting bias and are more interactive thus there is less chance of misunderstandings or misrepresentations occurring because clarification can be sought immediately (Jordan 1998a).

2.6.3. Group interviews / Focus groups

These techniques bring users together to consider issues relating to their requirements for, and use of products. The format and content of the discussion can vary widely. In their traditional role as a tool for market research focus groups are typically used to discuss abstract concepts (Caplan 1990) and examples of this approach include:

- Brainstorming sessions - groups involving a diverse range of individuals who come together to discuss and focus intensively on a topic. Sometimes methods such as role playing, card sorting and projective techniques are used to encourage creative thinking (Byrne and Barlow 1993).
- Synectics groups - synectic literally means 'the joining of different and apparently irrelevant elements'. In the group interview sense it means bringing together participants who come from diverse backgrounds yet are all able to think creatively. The participants may be screened for 'high creativity', 'divergent thinking' or 'lateral thinking' in a number of ways, and are asked to direct their creative potential towards the solution of specific problems.
- Extended focus groups - these may last 6-7hrs, and provide sufficient time and opportunity to explore beyond the superficial and conscious rational level achieved by many conventional group interviews. They

may use a selection of techniques to focus on the topic in question, e.g., playing with products, projective techniques, psycho drawing, role-playing.

Focus groups can be used to discuss customers' ergonomics requirements at the earliest stages of the design cycle, and can provide a great deal of useful information. They enable in-depth discussions about issues which affect people when using products in real life situations, and can provide incontrovertible evidence of user needs which can be used to 'sell' ergonomics input into the design team (Caplan 1990).

2.6.4. Diary studies and logs

In the context of requirements capture diary techniques can be used to keep a record of certain activities carried out by respondents (e.g. Eost and Galer-Flyte 1998). Diaries used for this purpose usually deal with behaviour rather than attitudes, interests or emotions (Oppenheim 1992), unlike personal diaries which may record feelings, emotions and thoughts about situations. Diaries can be used to analyse activity over a period of time, providing temporal information about customers' product usage and allowing patterns to emerge from the data. Since most diaries are portable they enable respondents to record activities as they occur, rather than having to recall the information at a later time. This and the fact that respondents are able to correct missing, incomplete or incorrect information before returning their diaries should make the data more accurate (Chan and Charlebois 1996). However, diaries are subject to a number of biases which can affect the data produced. Some of the main problems include low response rate, a fall in respondent's motivation to fill in the diary as time passes, respondents forgetting or not bothering to record an activity if it doesn't take very long, and misunderstandings about the type of information to record. These problems have been found in travel diaries used by transport planners when planning new road systems, etc. (Stopher 1992, Golob and Meurs 1986, Barnard 1986).

The low response rate may be due in part to the amount of commitment needed from participants to record all their relevant activities over a period of several days or longer. Golob and Meurs (1986) showed that the number of trips recorded in a seven day travel diary reduced over the recording period. In addition the number of days on which respondents reported making no trips increased over the duration of the diary study. These biases increase with the amount of detail which participants are asked to record. Thus detailed diary entries may be restricted to one or two days (Goodwin 1979). Non-response may be tempered by the use of incentives and follow up letters sent to participants reminding them to complete their diary (Oppenheim 1992).

Stopher (1992) reports that people can sometimes have difficulty deciding which activities constitute a trip, i.e. when completing a travel diary, whether going to the drive-in restaurant and home constitutes one or two trips. Asking people to record the purpose of their trip and the activities undertaken during the journey can help to clarify the situation to a certain extent, because it places the focus on the activities rather than the travel element of the trip (Barnard 1986). In order to reduce misunderstandings of what to record in the diary it is important not to use ambiguous or technical language, and to explain the purpose of the study as clearly as possible (Stopher 1992). However, it is better for respondents to record too much data rather than too little, as redundant information can be filtered from the results.

Robson (1993) suggests diaries should not be used as the sole method for collecting information, because of the methodological difficulties associated with them. However, the temporal information collected using diaries can be validated by combining it with data from other methods such as interviews, questionnaires or observation. This is the approach adopted in this thesis, where diaries are used in conjunction with other methods to increase the depth and validity of the data.

2.6.5. Observation

Observation can be conducted in a laboratory or in the field. Laboratory observation usually involves customers using a product to carry out a number of tasks, which can be observed and recorded for later analysis e.g. time taken to complete a task, or number of errors made during the task. Field observations involve watching a customer carry out a task in the environment in which they would normally use a particular product. This may involve the completion of tasks by customers, watching the customer using the product in any way they wish. Field observations provide more ecological validity than laboratory observations, but are less easy to evaluate because they are not standardised (Jordan 1998a)

However, field observations fit in better with the user-centred approach to product development, because they include information about the interaction of customers and products in their natural environment. Customers do not need to be able to verbalise what they do in a situation because it should be apparent to the researcher conducting the observation (Moser and Kalton 1971). Nevertheless, field observations may not be suitable for gathering information about product prototypes which are not yet on the market, but observing customers using existing products can lead to an understanding of their requirements for future products.

Japanese Market Researchers have taken observation techniques one step further by conducting customer visits (Johansson and Nonaka 1990). This technique involves personnel from management, Designers and / or marketing research visiting shops and outlets which sell their products. They talk to the distributors and customers about their company's and competitor products, discussing how they are used, problems, etc. The aim of the visits is to observe the type of people buying different products and the culture and environment in which they do so. Although the visits collect a great deal of information, because it is interpreted by the small group of people who visited the market it may be subject to biases and misunderstandings. Further the number of people observed may be low and not representative of the whole user spectrum for a product.

2.6.6. Murmur of the customer and Private camera conversations

The 'murmur of the customer' is a technique which was developed in Japan (Urban and Hauser 1993). It involves placing products in public areas, such as shopping malls, and allowing the public to try them out. Customers' comments about the products are recorded either by a covert researcher standing near the display, listening to the responses, or consumers inputting data into a computer terminal next to the display. By not formally interviewing the customers it is hoped that they will feel less inhibited and more able to discuss their opinions of a product.

The private camera conversation technique invites participants to talk to a video camera set up in a private booth (de Vries, et al 1996). People may be asked to discuss how they feel about a product, or how it fits in with their way of life (Jordan 1998a). Sometimes two customers are asked to discuss the product with each other, which may help to prompt participants to remember more things about a product. As in the 'murmur of the customer' technique the absence of a researcher is intended to minimise any potential researcher/participant interaction effects. Both of these techniques require a product to discuss, although this could be an existing, or competitor, product. However, it is not practical to use these techniques for all products, For example some products may be too large or expensive to leave unattended in a public space. In addition because there is little control over what is recorded, customers can sometimes deviate from the subject in question and analysis of the data can be complex and time consuming.

2.6.7. Benchmarking / Evaluation of competitor products

Benchmarking and evaluation of competitor products can be used to assess a company's own product in the context of other market products (Bowman and Faulkner 1994). This technique can take many forms, from simple aesthetic evaluations by customers, to direct observations of product use, and evaluations (or audits) by experts in the field (Cushman and Rosenberg 1991). Although it is difficult to involve customers in benchmarking or evaluation processes if the

product being developed is commercially sensitive, it can still be useful to ask them to assess competitor products, and the company's own existing products in the market, to uncover which features customers particularly like and dislike about current products. The data collected can be used to guide the design process during the development of new products.

2.6.8. Repertory grids

These can be used to determine customer's opinions of a product or series of products. A number of products will be analysed in terms of the aspects which are important in their operation, these aspects are known as constructs. Customers then rate each product along each of the constructs using a series of line scales. The data produced is analysed statistically and a construct map plotted showing where each product lies in relation to each other and the constructs. It is also possible with this technique to ask consumers to identify where their ideal product would sit on each of the constructs, and plot this on the map to see how near current products are to the ideal. This method may give information about how customers view products, but it provides little information about the problems people have using products in real life situations (Stanton and Young 1998a). Also for products as complex as automobiles the number of constructs needed to cover all aspects of the vehicle in detail would be very large, Therefore the technique is not considered suitable for use in the research presented in this thesis.

2.6.9. Prototyping

Prototypes can range from cardboard mock-ups to highly sophisticated computer representations of a new product, and from partial prototypes to entire products (McClelland 1990). Their use is mainly restricted to the concept stage of development, and beyond, once ideas have been generated. However, there are some approaches which are suitable for use in the very early stages of design. One such method is that of Velcro Modelling (or the Mr Potato Head method (Green et al 1992)) which has been used to develop the layout of vehicle dashboards and panels. Elements of a panel e.g. switches, indicators, buttons, lights etc. are mocked up and given a Velcro back. This makes them removable and

re-positionable, so they can be used to explore customer preferences for the layout of the panel (Sanders 1993). The outcome of this technique is graphically expressed so it can be used to capture customer requirements in many situations regardless of language, custom, etc. However, its use is best suited to situations where there are a number of small features to be laid out, rather than for example trying to assess the seating layout of a vehicle where the pieces would be too large to keep moving them around.

Exploring prototypes with consumers can be difficult if the product being developed is complex and resource intensive; it is costly and time consuming to produce mock-ups which actually feel and work like the real product. In addition it is not possible to bring the public in to assess mock-ups of products which are commercially sensitive, e.g. automobiles. In some cases potential problems and issues which are of importance to the consumer can be identified by experts through the use of audits or walk-throughs (Christie and Gardiner 1990). These techniques are advantageous because they can be conducted by the expert at most stages in the design cycle, from the specification to the evaluation stages. However, the lack of direct customer input can make them less user-centred, and it is important to remember this when using the data. Combining these techniques with other gathering information directly from the consumer can help to maintain the user focus during the design process. Since the research in this thesis focuses on commercially sensitive products, customers cannot be brought into the early stages of the design process. Therefore to maintain a user-centred approach in the Toolset being developed, the data from an audit conducted by experts is enriched with data from other methods.

2.6.10. Background information

Background or secondary data is that which is already available for use, and which can be brought together for a particular project, e.g. anthropometric tables. Although it does not usually involve direct contact with customers at the time of using the information, it has been gathered from consumers and is useful for providing a context to other data collected. An example may be that

questionnaire results suggest that people in a market use their cruise control as a speed limiter. The importance of this information becomes clearer when background data shows the police in that country fine speeders very heavily and strictly enforce the law. For these reasons the research presented in this thesis links the customer requirements collected from the markets to background data which is already available within the company.

It can be seen that customer ergonomics requirements are heavily influenced by the context and environment in which they are generated, that is the market they are collected in. Thus it is vital that the differences which exist are considered in the development of new products, to ensure that they meet the needs of their users fully. However, the collection of customer ergonomics requirements in overseas markets can be complex, and there are numerous issues which must be considered when conducting research in overseas markets.

2.7 Issues relating to the collection of ergonomics data from overseas customers and markets

With the increasing globalisation of many companies overseas customer requirements are becoming more important (Kosaka 1992). Kleinschmidt and Cooper (1988) showed that successful international products were more global in orientation, that is there was more focus on international markets during the development process. However, this does not imply that international products should be of one all encompassing design. Companies need to be sensitive to local needs (Devinny 1995). The interaction of local people with their environment and the tasks they want to carry out with a product can have a major effect on their requirements for that product. Kaplan (1998) identified a range of human factors which may be influenced by national and cultural variables, including anthropometrics, approaches to safety, perceptions, and communication. Chapanis (1974) discussed a wide range of issues including physical, psychological and social factors which may be present in different nationalities and cultures. These differences can make designing a product for overseas markets problematic, but it

is precisely because of these diversities that overseas research is so important for companies hoping to sell their products globally (Douglas and Craig 1983). Ignoring the differences can lead to products which at best are annoying and uncomfortable to use, and at worse a danger.

Thus a truly international company can be seen to be one that is global in strategy and presence, but responsive to local conditions (Narita 1994). To achieve this goal it is necessary to collect customer requirements directly from local markets, although this can present many problems. Obviously the best way to investigate customer requirements in a country is to visit the country and ideally live and work there for a while (Braham 1993). However, the opportunities to do this are not always available. Companies may not have the resources or finances required for such a trip, they may not be sufficiently established in a market to ensure the visit is worthwhile, or they may not be willing to send several of their employees overseas for an extended period. Therefore most overseas customer requirements are collected remotely with the help of research agencies and where possible overseas staff.

There are a number of conceptual, methodological and organisational issues concerned with collecting data and conducting international marketing research. Many of these arise from the diversity of international operations and the problems associated with trying to co-ordinate these (Douglas and Craig 1983). In addition different market conditions, culture and environmental factors in each country can significantly affect the methods and processes used to collect information from customers. Some of the main issues are discussed below.

Complexity of research design.

It is not always obvious which group or groups of customers should be used to gather requirements. Although countries are convenient units of analysis to study because of their political and organisational boundaries, they may not be the most appropriate units from the research point of view. Sometimes it is more applicable to investigate certain types of people over more than one country, e.g. all owners of a particular model of vehicle, or sub-sections of a country, e.g. all

vehicle owners in Texas. However, it can be difficult to know which consumers form a sub-group until research has been conducted in the market.

Lack of secondary data.

In some countries there is a lack of, sometimes even basic, secondary data, and that data which does exist may not be as accurate or reliable as domestic data. This problem is dependant on the type of research and the information needed, but may force design decisions to be based on incomplete, limited information.

Costs of collecting primary data.

Conducting overseas market research is usually expensive, and costs increase with the number of countries being investigated. This is particularly the case in developing countries where although wages for local employees may be much lower, there is a poor marketing research infrastructure and little experience in carrying out research. However, more agencies are beginning to set up in these markets and many large international market research agencies are now well placed to collect overseas market information.

Literacy levels and the availability of different media

Language used and literacy rates can vary both between countries and within countries. In some situations such as in India, there are so many languages and dialects spoken that it is impossible to use one which will be understood by even the majority of people living there. Further the availability of communication media is not uniform throughout the world, nor is the effectiveness of each the same in different countries, i.e. in some places television may be the main medium for communication whereas in others radio, newspapers or word of mouth may be the most efficient, indeed only, methods of communicating. These issues can affect both the content of, and method used to collect data in different countries.

Co-ordination of research and data collection across countries.

It is important to co-ordinate overseas customer information effectively (Wilsdon 1996). There are several ways of co-ordinating research across countries; a company's own staff (from head office and/or local offices) can be

trained to conduct the research, local research agency staff can be directed by the company to carry out particular research, or the whole project can be handed over to an agency who plan the research from start to finish (Ferber 1974). Although controlling the research centrally tends to make co-ordination more easy than local control this has to be weighed against the fact that local personnel will have familiarity with and knowledge of their local market environment. Therefore using both central personnel and those in local situations to combine their expertise is often the best solution. In all cases however it is important to have a co-ordinator or champion, to collate and be responsible for the information collected, once it has been sent back to the home company so that people know how to obtain the data they need (Wilsdon 1996).

Difficulty of establishing comparability and equivalence.

It can be difficult to establish comparability and equivalence both with regard to the methods used to collect data and the data collected. Many of the concepts, measurement instruments and procedures developed in one country may not be relevant in another. There are also differences in the levels of reliability of techniques when used in different countries, e.g. in one country interviews may have a particular level of reliability but in another mail questionnaires might be needed to obtain the same level of reliability. In some cases it may be better to use techniques with comparable reliability rather than using the same methods regardless, although it is not easy deciding which methods are comparable (Douglas and Craig 1983). The problem can also be minimised by the use of methodological triangulation, utilising several different data collection methods to establish trustworthiness in the results. This is the approach taken in the work presented in this thesis.

Time scale of the research

International data collection takes much longer than domestic research, because of the co-ordination and communication difficulties. Therefore it is more resource intensive and the additional time and resource requirements must be recognised when setting up an overseas study.

Cultural bias in research design, communication and interpretation

Problems in cross-cultural bias can occur because international research typically involves researchers from one cultural environment conducting research in another cultural environment, or communicating with researchers from another cultural environment. Miscommunication can result from different styles or modes of communication which are used in different cultures. This can affect many aspects of the research including:

- Research design - poor understanding can lead to inappropriate or inadequate research design
- Communication - it may be difficult for a researcher to know whether tasks, meanings, etc. have been understood effectively by someone from another culture
- Interpretation - a researcher who is unfamiliar with a culture may misunderstand or misinterpret information about that culture.

Again these problems can be reduced by using several methods to collect customer requirements, which serve to build a richer picture of the data collected, and help to establish the reliability of the data collection methods used.

Although there are a great number of issues which must be addressed when collecting overseas customers' requirements, it is important that companies are not discouraged from collecting real information from real customers, because its importance in creating successful products is paramount (Cooper 1993). Nevertheless, it is not enough merely to collect user needs and requirements and expect people to use the data. Sharing market information across functional areas is also critical to success (Ottum and Moore 1997) and ensuring that ergonomics can be used effectively in the design process is vital. The next section of this review addresses issues pertaining to the communication of customer ergonomics information between disciplines within the design cycle.

2.8 Communicating ergonomics information

The amount of integration of customers' ergonomics data into the development of new products is dependent on many factors including the organisational structure of a company, how user oriented the design team is and the communication between members of the design and development team working on a project. Organisational issues which affect the new product development process were discussed in detail in section 2.3.1.1 of this review, and can be considered to affect the integration of ergonomics information in similar ways. The organisation of a company must be structured so as to facilitate the communication of data between different functions involved in the design process, and the company management where appropriate. This may involve restructuring the company, changing the process by which products are designed or repositioning design team members to be in closer proximity to each other enabling information to be exchanged more easily. Factors which affect individual Designer's use of ergonomics information were discussed in section 2.3.3 of this review.

Other research has focused on the interfaces between functions involved in the development process (Gorb and Dumas 1987, Ottum and Moore 1997, Woodcock and Galer Flyte 1995). Customer information needs to be shared between different functions of a design team to ensure that its existence is known and that its availability is timely in the development process. However, the effective use of this information has been identified as problematic for many companies (Deshpandé and Zaltman 1987, Moorman et al 1992). One reason for the poor integration of data between functions is the lack of understanding of each other's job (Ottum and Moore 1997), and this has often been the case between Ergonomists and Designers. Wood (1990) notes the following criticisms which have been levelled at Designers by Ergonomists and vice versa:

1. There is a mismatch between the available output from research and data needed by Designers.

2. Available ergonomic data is presented in a format or language that is unsuitable for Designers.
3. There is doubt as to the transferability of laboratory results to applied circumstances.
4. Ergonomics testing is perceived to be time consuming and expensive relative to the benefits derived.
5. Ergonomic input is often considered to stifle the Designer's creativity, or seen as an attempt to undermine the Designer's credibility by testing and evaluating a design.
6. Ergonomic considerations such as ease of use, ease of learning are not considered critical marketing features.
7. Ergonomists have long criticised the industrial design field for manufacturing unsafe products, and failing to emphasise the importance of usability.

A number of these issues were discussed earlier in section 2.3 of this review. However, there is no doubt that some of these criticisms are justified, and that the language and techniques used to share information and ideas between Ergonomists and design teams could be improved (Macdonald 1998). Ergonomics may be seen by some as a bridging competence between design and other disciplines involved in the product development process, e.g. marketing research, engineering and product management (Macdonald and Jordan 1998). In this case the Ergonomist may have to act as both a scientist and a specialised Designer in different situations on the same project (Lombaers 1990). Nevertheless, many Ergonomists still favour communicating via technical reports, which are often seen by Designers as 'dull, produced in a difficult to use format and more suited to a university laboratory than a commercial design studio' (Macdonald and Jordan 1998). Useful findings are often lost in reports couched in technical language and jargon, which non-Ergonomists find difficult and time consuming to understand. Therefore the use of tools which aim to develop a common language can help to bridge the gap between Ergonomists and these other functional areas. The Toolset being developed through this research aims to develop communication methods

using language which can be easily understood by Designers, Market Researchers and Ergonomists alike.

The following sections identify and discuss some of the methods which can be used to communicate ergonomics information to design teams. Some of these methods have been selected for inclusion in the Lifestyle Scenario Toolset.

Standards and Guidelines

Standards and guidelines present ergonomics information as a series of definitions and design principles, for example the International Standards Organisation (ISO) which defines usability as being:

"...the effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments." (ISO DIS 9241-11).

Also EC directives such as EC Directive (74/60/EEC) which places restrictions on the impact properties and the sharpness of the edges of products which are likely to be placed somewhere in a vehicle where they could be struck by a vehicle occupant in the event of an accident. However, standards and guidelines can be difficult to apply effectively in all situations. They are sometimes vague and general as can be seen from the usability definition above, and have not yet been developed for all aspects of product design. It would be difficult for a non-Ergonomist to know how to apply the information effectively.

Standards and guidelines tend to lean towards quantification, e.g. performance times, error rates, and are suited to communicating quantitative data, from for example user trials, which can be used to guide a design in progress (Jordan 1997). Their use to present the more qualitative aspects of customer requirements, e.g. focus group findings is inappropriate. Further to this the pre-concept stages of design, which are those addressed in the work presented in this thesis, are generally fluid, idea formulation stages. Standards and guidelines are more suitable for use in the middle and later stages of the design process once the

design has become formalised and can be tested against the principles proposed (Kanis 1997).

Textbooks

Textbooks are a useful way of presenting general ergonomics information to the design community. However, due to the large amount of time it takes between the collection and analysis of a set of results, and having them published in a book, it is not a feasible way of feeding information back to Designers working on real life projects. The time scales to which Designers work are short, and by the time customer requirements information has been published in a book it is already out of date.

Further to this Designers do not keep a large number of current ergonomics books in their design studio (Woodcock and Galer Flyte 1997). Some do keep a small number of standard text books of, for instance anthropometric data. Creating a library of useful textbooks in the Ergonomics Department is a good idea, however, it is probable that Designers would ask the Ergonomists to find relevant information for them, rather than searching for it themselves. This is because design culture does not have a strong tradition of reference and cross reference to research findings (Black et al 1994).

Structured design methods

These involve formally incorporating ergonomics into the design process and include approaches such as QFD, which was discussed in detail in section 2.4.1.1. Using these structured methods often involves a shift in the organisational strategy of a company, and extensive changes to the working practice of design teams. They involve input and commitment from many departments within a company, and create organisational issues which must be addressed before they can be implemented effectively.

The output from using these methods often involves matrices and may be quite technical and time consuming to use. As discussed in section 2.4.1.1.

structured methods can dehumanise consumers by producing a list of their requirements without any context. Further, Designers need training to use such methods before they can be put into place, thus effectively changing current working practice rather than fitting in with it. This thesis takes a more holistic view of consumer requirements and presents them to Designers in such a way as to help create empathy with the consumer.

Computer support

Computer support in the form of databases, CAD and support for the design process, are areas which will become increasingly important over the next decades. There are many ergonomics databases, e.g. People Size, Ergobase; CAD man-modelling tools, e.g. Ramsis, Jack, SAMMIE; and design decision support systems, e.g. HUFIT (Galer et al 1992), ADECT (Woodcock and Galer Flyte 1997, 1998) which can be used to present ergonomics information to design teams. They are particularly useful for exploratory investigations at the early stages of design, e.g. for structuring the design process or trying out design ideas to see if they are usable (Porter and Porter 1998). However, their use in the pre-concept stages of design, to communicate information about how customers in a particular environment utilise a product, is limited. The complexity of user requirements, especially in overseas markets, would be difficult to convey using for example a CAD package, or ergonomics database only. Nevertheless, computer databases can be useful for storing information gathered from customers, for reuse later in the design process and for supporting or encouraging user-centred design.

It is important to ensure that any database developed to store customer requirements is usable and easily accessible by Designers, and is presented in language which is appropriate to their needs. It should also fit in with the current practice of the Designers, the design team and the organisational practices of the company, for example if a team uses computer based communication, the database should be available on computer (McGrath and Hollingshead 1994). Further, introducing a greater number of independent databases into the design process can

lead to information overload for Designers. This may lead them to ignore the available data and design products based on their internalised knowledge and experience. Also incomplete and inconsistent data between databases can make it difficult to know which data to rely on and causes problems trying to update and maintain computer systems.

Designers involvement in user trials

Designers involvement in user trials serves to communicate and highlight problems which people may encounter with products the Designer has produced. Interaction with actual customers can often be an eye-opener for Designers because they may not use the product themselves, and only when they actually see problems experienced by the user do they realise that they are in fact genuine. Designers are exposed directly to the people they are designing for, instead of having the customers' requirements communicated to them via an ergonomics expert, although an Ergonomist may need to be present to guide the proceedings and clarify any problems.

This method of communication relies on the existence of a prototype which is realistic enough to be manipulated by the customer, although competitor and existing products can be used at the early stages of design to supply a lot of useful information. The most effective use of this technique in terms of collecting data from overseas customers is to involve the customers and Designers in overseas user trials with products. However, where this is not possible video taping the user trial and showing the footage to the design team can help. Obviously this is not as interactive as physically being at the trial, and there may be discrepancies between users' actions and the design team's interpretation of these, but video footage goes some way to highlighting customer needs. In this thesis Designers involvement in user trials in overseas markets would be difficult to implement due to the time and financial constraints of the project, therefore the use of video footage is suggested as an alternative method. The use of video footage is discussed in more detail later in this section of the review.

Manikins and dummies

Models, manikins and dummies have traditionally been used by Ergonomists, particularly those in the automotive industry, during the mock-up (prototype) stages of a design to evaluate its usability. They may be used to see whether certain aspects of a product are acceptable, or to ensure that standards and regulations are being met. These methods are good for illustrating problems and potential mistakes to Designers, through observation of the evaluation. Their use however, is mainly confined to the laboratory and restricted to the assessment of actual products or prototypes. They cannot be used at the pre-concept stages of design before design ideas have been formulated. Further, they cannot be used to show the interaction of customers with the product in real life situations.

There are also limitations as to what can be achieved with a manikin, some of the softer aspects of customer requirements, e.g. thoughts and emotions felt whilst using a product, can only be addressed using a human participant. Nevertheless manikins and dummies are particularly suitable for investigating issues which are too dangerous for a human being, e.g. crash testing.

The work in this thesis addresses issues related to the introduction of customer ergonomics information in the context of customer lifestyles, at the pre-concept stages of design. Thus manikins and dummies are not considered suitable for use in this research.

Video footage

As already discussed video footage is considered a valuable method for collecting and communicating customer ergonomics requirements to design teams. It allows the Ergonomist to demonstrate 'first-hand' the type of problems people encounter with their products. Showing customers struggling with a product, or talking about a product can convince even the most sceptical of Designers that the problems really do exist (Jordan 1998a). Video footage can be used throughout the design cycle, but is most powerful at the earliest stages of design when the concepts are being formed and customer information is vital. However, the over

use of video footage can be problematic. Most people do not have the motivation to sit through hours of video footage showing customers using a product. Therefore, careful editing to convey the main points in short film sequences should be used. This in itself is a time consuming and laborious process, which can make the use of video footage very labour intensive.

Video footage can quickly become overwhelming, especially if used to collect information from a lot of customers or in a number of different markets. The issues of which information to show, and how to ensure that information overload does not become a problem must be addressed. The use of video footage after an initial video presentation may be hindered by the availability of video equipment and the time taken to set it up. Further, if a point of interest arises in a section of video footage on one occasion, it can be time consuming to try and find that same information again at a later date if its position on the tape was not noted. However, the use of video footage to present customer information to Designers when they cannot experience first hand the problems consumers experience using a product, is used in this research.

Reports

Reports are one of the main ways Ergonomists use to communicate their findings, and they may vary in formality from a full scientific report to a one page summary of findings. In industry for example a design team would probably not be interested in the methods used to collect data, as they would see that as the role of the Ergonomist, therefore a short report detailing the results or recommendations would be sufficient.

Reports can be used at any stage of the design process to communicate information, however those at the beginning and middle stages of the development are likely to be less formal than those at the end of a project. It is important to try and make the data presentation in a report visually appealing, because Designers are visually orientated and respond well to this type of information (Porter and

Porter 1997, Kolli 1993). This could involve the use of graphs, drawings or pictures, which are more acceptable to Designers than entirely textual reports.

It is also important to report data from research in a way which can be stored and reused at a later date. Thus in this thesis the use of reports to present information for future reference, used in conjunction with high level summaries which present the main findings in a pictorial manner where possible, is encouraged.

Journals

Journals are a major way of presenting academic research. The time scale of publication in a journal can be short, therefore the information is relatively recent, but it is still somewhat out of date by the time it is published. Journals can be used throughout the design process to supply information to the design team. However, as with books, it is not common for a company, or a design team to have access to these types of academic journal. Designers often find the research reported in journals is not relevant to their particular needs and prefer to rely on their own knowledge or that of colleagues (Woodcock and Galer Flyte 1998, McLeod 1997).

For these reasons publishing the results of the work presented in this thesis in journals is not considered a suitable method of communicating the information to design teams in the first instance.

Presentations

Presentations can vary considerably in their level of formality, from a 'chat' to the design team, to a full blown presentation to all interested parties. They are an excellent way of communicating customer requirements, because they enable interaction between the audience and the Ergonomist (Jordan 1998a) and allow explanation and expansion of the issues addressed. Discussions of the information presented can help to reinforce and clarify ideas amongst the Designers. They are suitable for use at all stages of the design process, although

they are not often used as the sole method of communication because of the transient nature of a presentation. Back-up to the presentation is usually required, to remind people of what was presented, or explore the information in more depth. Presentation of customer ergonomics requirements is considered to be an excellent way of introducing a design team to the data at the outset of a project. The Ergonomist can explain the data, how it was collected, where it can be found in future and clarify any misunderstandings if necessary. Therefore the use of an initial presentation to the design team is recommended in this work.

Scenarios

Scenarios are descriptions of what people do and experience as they try to make use of a product (Carroll 1995). The description can take many forms and levels in terms of for example, completeness of the description, level of detail included, scope of the scenario, and the position on the concrete-abstract continuum. However, scenarios are usually written in language which can be understood and appreciated by Designers, Ergonomists, Market Researchers and management alike. People are familiar with this type of language because it is taken directly from the consumer and they use it everyday in conversations and writing. In addition scenarios are able to create strong mental pictures which can be easily understood, and successfully communicated.

Scenarios can be used in a wide range of situations and stages of the design process, and one of their advantages is their adaptability to different styles of working (Karat 1995). For example they can be used to summarise the insights resulting from a study, used to envision the expected use of a system or product, or to record a design team's shared understanding of anticipated usage (Carey and Rusli 1995). Some authors have used scenarios to present very detailed accounts of working practices (Robertson 1995) and others have used bullet point type descriptions of actions which were taken (Karat 1995).

The communication of customer data in the development of consumer products lends itself well to the type of scenarios advocated by Erickson (1995)

and Moggeridge (1993). These authors use scenarios as a type of story-telling activity either to relate individual user's stories, or to develop composite design stories combining data from more than one user. Erickson (1995) notes that stories are particularly useful for communicating within an organisation because they are extremely memorable, and have an informality that is well suited to the lack of certainty that characterises much design related knowledge. However stories are not always particularly accurate, and their use is often enhanced by information collected through techniques which gather more concrete data on customer requirements, such as observations, interviews, laboratory studies etc. Carey and Rusli (1995) promote the use of more concrete data to back up scenario type presentations and provide partial validation of the information in the scenarios. Additionally, the integration of different information into the stories can help to build a more comprehensive picture of the situation.

It is important to ensure that scenarios cover a complete and coherent set of tasks, which can be achieved in part by ensuring that customers are asked appropriate questions during data collection, using several techniques to collect different types of data, and careful analysis of the results. Another method utilised by Johnson, et al. (1995) used general scenarios to provide a detailed overview of a series of tasks, and supplemented these with particular task scenarios, which helped to provide a fuller account of the situation being investigated. This thesis suggests the use of scenarios to communicate information to design teams, and a fuller discussion is included at the end of the section covering the use of storyboards.

Storyboards

Storyboards include many kinds of two-dimensional visualisations from early sketches to photo-realistic computer renderings (Säde 1997). They can be used to present static information, or a sequence of events as in the presentation of stories or scenarios (Zaff et al 1993). Traditional theme boards used in many design studios represent ideas and concepts through pictures, colours, materials etc. to give Designers inspiration for their designs. A similar type of board has

been used by Macdonald and Jordan (1998) to communicate the idea of pleasure in product design, through the use of pictures from popular culture. However, these boards present mainly static information.

The use of storyboards to depict scenarios has been described by a limited number of authors. Hartfield and Winograd (1996) describe the use of cartoon sketches at a major design consultancy, to depict the interaction between a product and a number of imagined customers, carrying out a selection of tasks. Fulton-Suri (1995) uses storyboards to show scenarios of invented characters, with a range of personal characteristics such as age, gender, dexterity, impatience, using a product. Each board uses photographs and sketches to illustrate a day in the life of one of the characters. Black et al (1994) used storyboards based on data from several different observations of users. The data is distilled into stories about three different television users, showing their interactions with their television and the social and technical background to the interactions. This type of scenario is a good way to present customer requirements data, as it can show the problems encountered using a product and the context in which the data was collected.

Storyboards depicting scenarios of customer requirements and use of a product in context are considered for use in this thesis. Designers are familiar with the use of theme boards and the pictorial nature of the boards should help to increase the acceptance of the information. The scenarios presented should be short, leaning towards the bullet point type descriptions presented by Karat (1995). The use of levels of scenario as used by Johnson et al. (1995) is suggested, that is a series of overview scenarios, supplemented by more specific task based scenario. Each task scenario should form a coherent story which will make the information more memorable. The storyboards themselves should be pictorial wherever possible, and include photographs of real customers, their vehicles, the tasks they carry out and the environment they are in. These pictures will add context to the scenarios presented.

As indicated throughout this review the use of multiple research techniques can help to enhance data collected from customers. The final section of this review

covers the literature relating to the use of multiple research techniques in the field of product design.

2.9 Triangulation of methods

Each of the methods of data collection and communication described in sections 2.6 and 2.8 has its own inherent strengths and weaknesses. For example focus groups can never claim to be representative of a whole user population because they involve small numbers of people. The time consuming nature of the technique does not allow for large numbers of groups to be used, however the information gathered is rich in depth and content. Conversely, questionnaires lack the flexibility to cover issues in great depth but are able to collect information from a larger, more representative sample of the population (Wolff, et al 1993). Therefore the use of any single technique cannot give a broad, rich picture of the customer ergonomics requirements in a market. However, by using more than one method, through triangulation, the weaknesses in the data can be reduced and the overall quality of the data enhanced. The concept of triangulation in academic research refers to the use of more than one methodology in the study of a phenomenon (Lincoln and Guba, 1985). The use of different data collection and presentation techniques enables greater accuracy and affords the researcher more confidence in their interpretation of a phenomenon than would be the case if only one method was used. Denzin (1978, in Lincoln and Guba 1985) suggests four different types of triangulation. The use of multiple and different:

- methods - the use of multiple methods, such as interviews, observation, questionnaires.
- sources - the use of a variety of data sources in a study.
- investigators - the use of several different investigators in a study
- theories - the use of different perspectives to interpret a single set of data.

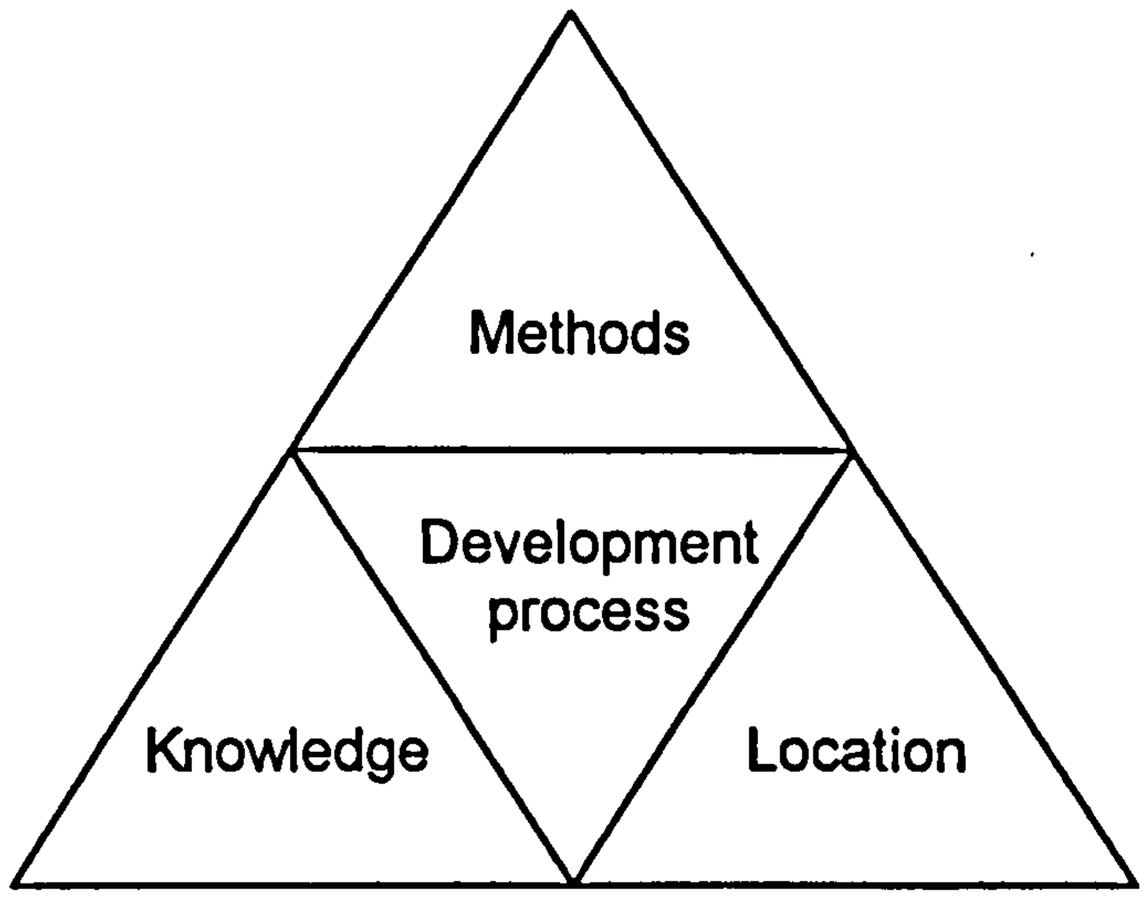

Figure 2.14. Triangulation methods proposed for use in product development (Kaulio and Karlsson 1998)

Kaulio and Karlsson (1998) identify three types of triangulation in the context of product development and user requirements, see figure 2.14. These are:

- Methodological triangulation - the selection of more than one data collection technique
- Knowledge triangulation - the collection of data from more than one user segment
- Location triangulation - the choice of more than one setting in which to collect the data.

The work presented in this thesis uses methodological, knowledge and location / source triangulation, in order to provide a rich picture of the way in which customers use a product and their requirements for future products. These are discussed in more detail below.

Methodological triangulation

Wolff (1993) identifies four different ways in which data can be used to complement each other, depending on the sequential order in which they are conducted.

1. A technique may be used as a precursor to the use of another technique. For example a focus group may be used to facilitate the

design of a questionnaire, or it may be used to anticipate survey non-response.

2. One technique may be conducted shortly after another using some of the same respondents, in order to evaluate the first technique. For example a face-to-face interview may be used to evaluate a mail questionnaire.
3. Techniques may be used in sequence in order to corroborate, or explore in more depth the initial data collected. For example a questionnaire may be used to gather more information about issues which arise from an expert evaluation.
4. Different techniques may be used to gather information from the same, or similar, respondents, simultaneously. For example a questionnaire and focus group may be run at the same time to collect information from a group of customers.

Methodological triangulation can be used to test the validity of methods for collecting customer requirements. Where the results from more than one method converge this is a good indicator of their validity (Butters 1998), and may increase confidence in the results. This thesis takes the approach that multiple methods of data collection should be used because the methodological issues associated with collecting data from overseas markets can decrease confidence in the information (see section 2.7). By using multiple methods the results from one technique can be validated by those from another. In addition this research aims to present a rich picture of customers' ergonomics requirements for a product. Since the focus of the work is on overseas customers and the Designers are not able to meet them in person, the data presented must be as rich and detailed as possible. This can be achieved through the use of multiple data collection methods because each technique collects a different type of information which enhances, and is enhanced by data collected using other methods.

Knowledge triangulation

Knowledge triangulation can also be used to cross-check findings from different data collection studies. If similar themes and issues arise in data from different user segments confidence in the validity of the findings is increased. Further, by combining requirements gathered from a range of user segments a much larger, more detailed picture can be developed (Kaulio 1997). The research in this thesis advocates the collection of data from a different customer group, within the target population, for each of the tools included in the Toolset. This information can then be combined to create a richer picture of the overall target population, and increase confidence in the findings.

Location / source triangulation

A major point of discussion when conducting user requirements investigations is whether they should be carried out in the field or in a decontextual setting such as the laboratory. It is argued that removing people from the context in which they use a product, and removing the product from its usual context will affect the validity of the information collected (Wixon et al, 1990, Whiteside et al 1988). Using a variety of contexts to collect customer data means that the information gathered will change character. For example in an expert evaluation of a product the features will be focused on more fully, in a diary study the action of using the product will be uppermost in customers' minds, and in a focus group emotions and issues surrounding the use of a product are more likely to be discussed. Therefore this thesis has adopted the approach of using several different locations or sources to collect information. This will provide a range of settings in which data is collected, e.g. in customers' homes, in their vehicle, in the laboratory. These should serve to elicit varied information as people are usually in a different 'mind set' when they are for example, at home than out driving. Thus in some contexts customers will rely on recall to remember which issues affect them, in other cases they will record activities as they happen, but they will not have time to consider their responses.

2.10 Chapter conclusions

Literature relevant to the collection and communication of customer requirements in consumer product development has been described in this chapter. It has presented models of product development and the design process, in particular in the automotive industry. The incorporation of customer information into new product designs was explored. Techniques for capturing customers' ergonomics requirements were discussed with regard to their suitability for feeding data into the pre-concept stages of the design cycle. In addition the constraints imposed on the choice of techniques for capturing overseas customer information were explored.

Communication methods between Ergonomists and non-Ergonomists in the design process were also identified and shown to be deficient in many respects. There was a need to present data to design teams in a more user friendly manner which had greater relevance to their needs, and took account of their approach to designing new products. The review identified a lack of research aimed at collecting and communicating overseas customers' ergonomics requirements to Designers in the automotive industry. The use of multiple data collection methods and locations for collecting customer ergonomics requirements was indicated to increase the depth and validity of the data collected. The following chapters describe research which addresses these outstanding issues and fills some of the gaps identified in the literature.

Chapter 3

Requirements Specification for Gatherers of the Toolset Data - Study 1

3.1 Chapter Summary

This chapter reports the research carried out to determine current practice in the company with respect to customer data collection[2] . It also discusses constraints which may affect the use of the Lifestyle Scenario Toolset, and considers the requirements of the data gatherers who will use the Toolset in the future.

3.2 Introduction

In order to increase the acceptance of new tools within an organisation it is important to ensure that they fit in with current company practices as closely as possible, and take account of the requirements of people who will use them. Eason (1995) has shown that the most successful introduction of new tools and methods (that is the most effective, enduring and widely disseminated) is achieved by combining the knowledge of people who will use the tools with the expertise of the Ergonomist. The people who will utilise the tools are those who have most knowledge of how they will probably be used, what environment and constraints they will be used under and also their own needs and requirements in terms of the information they want from the tools. The Ergonomist on the other hand has experience of the techniques and tools which could be developed to meet the needs of the users. However, they do not usually have first hand knowledge of the users' work practices. Therefore by using a combination of user input and ergonomics experience the design and success of any new tool or practice is maximised.

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[2] This information was correct as of 1997, but may have changed in the intervening period.

It is important to include the viewpoint of and input from all stakeholders who will be affected by the introduction of the new tool. Macaulay (1997) identifies the stakeholders of a system as including those who are responsible for its design and development, those who have a financial interest, those responsible for its introduction and maintenance and those who have an interest in its use. Study 1 addresses the needs and requirements of these stakeholders with respect to the Lifestyle Scenario Toolset. Discussions with those who will use the Toolset to collect data and those who are responsible for the funding of the new Toolset, that is the Ergonomists, are covered in this chapter. The following chapter addresses the needs of those people who will use the data from the Toolset in their work, that is the design teams and the Ergonomists who are responsible for the introduction and maintenance of the Lifestyle Scenario Toolset.

The purpose of the research presented in this chapter was to identify current tools and methods within the company, used to collect customer information. Also to identify possible areas where the Lifestyle Scenario Toolset could fit and build on current practice. The requirements of the data gatherers, and the constraints placed on the data collection process within the company are investigated in this chapter. Discussions were conducted with Market Research personnel, people responsible for running overseas operations within the company, that is Rover International and the National Sales Companies, and those responsible for the collection and provision of ergonomics information. Figure 3.1 shows how the research reported in this chapter fits in with the overall research methodology.

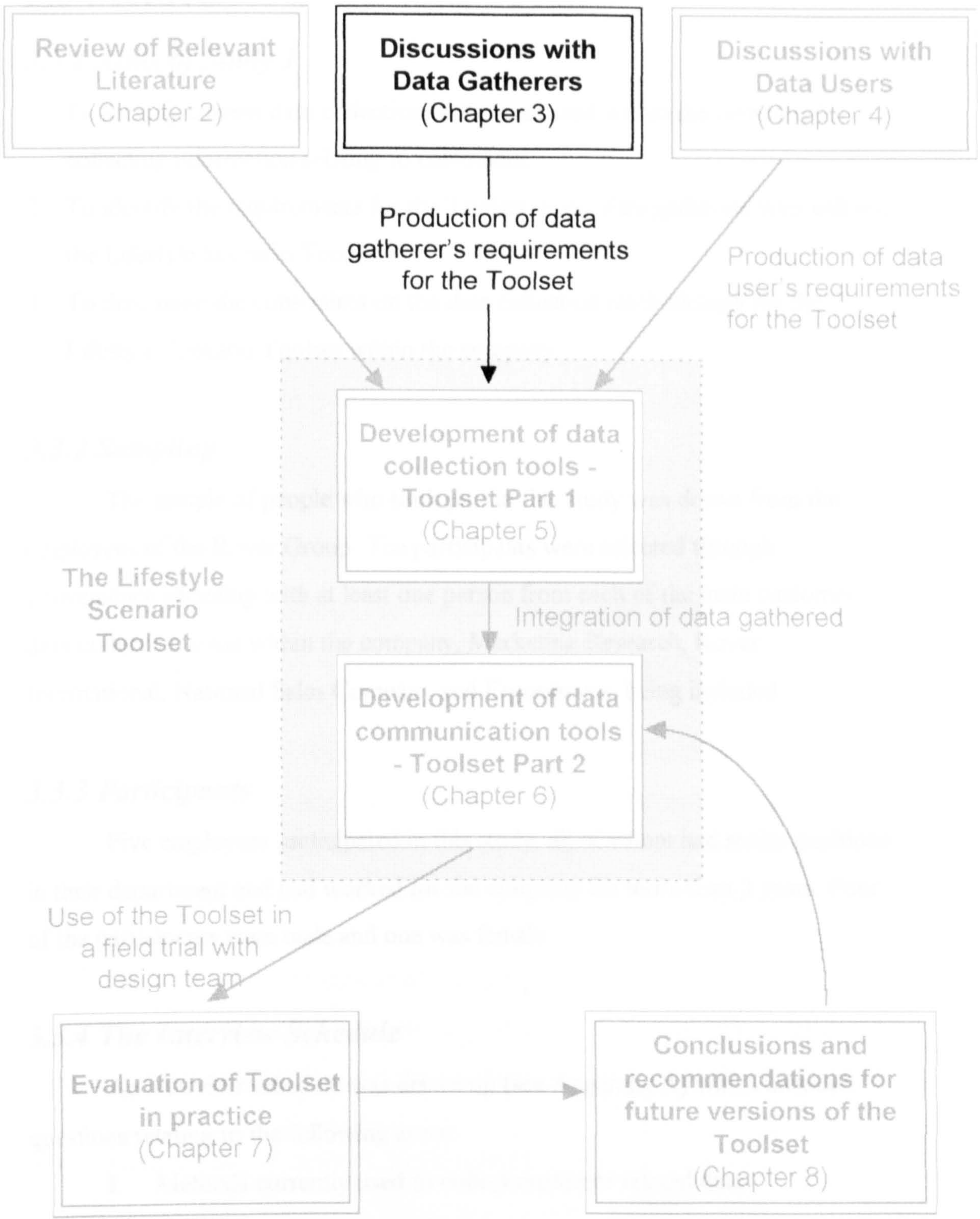

Figure 3.1 Context of the research reported in Chapter 3

3.3 Method

3.3.1 Aims of Study 1

1. To identify current data collection techniques used within the company for collecting information relating to customers.
2. To identify the requirements for the Toolset of the data gatherers who will use the Lifestyle Scenario Toolset.
3. To determine the constraints on the data collection methodology for the Lifestyle Scenario Toolset within the company.

3.3.2 Sampling

The sample of people who took part in this study was drawn from the employees of the Rover Group. The participants were selected through convenience sampling with at least one person from each of the main customer data collection areas within the company, Marketing Research, Rover International, National Sales Company and Ergonomics, being included.

3.3.3 Participants

Five employees participated in this study, all of whom had senior positions in their department and had worked for the company for more than 3 years. Four of the participants were male and one was female.

3.3.4 The Interview Schedule

An interview schedule was drawn up (see Appendix A) which included questions relating to the following areas:

I. Methods currently used to collect customer related data.
II. The nature of the data collected.
III. The frequency with which the data is collected.
IV. The selection criteria and number of customers involved in the research.
V. Methods used to communicate the customer information to the design teams.

VI. Constraints which may affect the collection of data using the Lifestyle Scenario Toolset.

VII. Any other data which is not collected, but which would be considered useful.

3.3.5 Interview Procedure

Each participant was interviewed individually in their workplace, and the interviews lasted approximately 1 hour. Participants were given the opportunity to discuss any aspect of customer data collection and communication with the above schedule used to guide the interviews.

3.4 Results and discussion

At present there are no methods within the company designed specifically to collect customer requirements for vehicles directly from customers. There are methods in place to collect information about customers and their vehicles which may be used to guide the development process, and which the Lifestyle Scenario Toolset data can build on. However, these methods do not provide the level of detailed information requested by Designers, and are not presented in a format which the Design teams find easy to use. Key findings from the interviews were organised into categories according to the study aims and by department.

3.4.1 Current data collection techniques

This section describes the current practice in each of the four areas of the company which collect customer related data.

3.4.1.1 Marketing Research Department

The Marketing Research Department is split into four sections:

I. *Product Research* - looking at customer needs in terms of new products.

II. *Quality Research* - looking at customer perceptions and opinions of quality and reliability in Rover products.

III. *Communication Research* - looking at awareness and perceptions of brands, and the effectiveness of advertising.

IV. *Dealership Research* - looking at customers' satisfaction with their dealer, and the dealer's opinions of Rover.

Customer data is collected within each of these sections using a number of research programmes. Most of the data collection activities are contracted out to marketing research companies, but the resulting data is usually analysed within the Marketing Research Department at Rover. Both quantitative and qualitative data is collected, however ergonomics data is not specifically collected at any stage in the marketing research process. The main research programmes initiated within the department are briefly described below.

Quantitative research: two main quantitative research studies are run by the Market Research Department in order to obtain 'snapshots' in time.

I. The New Car Buyers Survey (NCBS). This is a syndicated survey involving all the major European manufacturers. It uses a semi-structured questionnaire mailed, on an annual basis, to a random sample of new vehicle buyers approximately 2-4 months after the purchase of their new car. The sample size is over 30,000 participants, drawn from the major European and Japanese markets. Some of the questions covered concern dealerships, satisfaction levels, reasons for purchase and non purchase, and demographic information. There is no opportunity to probe answers given to questions. The results of this study are published in bi-annual reports which Rover uses to produce its own internal reports. The Rover reports are produced for the 'Pan-European' and 'Rest of the World' markets. The data generated by the NCBS is sometimes further analysed on an ad-hoc basis if specific questions are asked of the department.

II. The Customer Quality Tracking Study (CQTS). This survey uses a telephone interview to gather the opinions of purchasers of new vehicles 30-35 days after purchase. Again it is a semi-structured interview, but unlike the NCBS it is wholly owned by Rover. This affords the opportunity to be more flexible in the

questions asked, and to probe the responses. The sample size for this survey is much smaller than that of the NCBS, at around 300 respondents compared to over 30, 000. This research is conducted quarterly for each of the Rover brands (Rover brands refer to the different models of vehicle produced, e.g. Rover 200, Rover 800, Land Rover Discovery). The participants are mainly from the UK, although a small number from European markets are included. The results of this survey are analysed and presented in three different formats: data tables and verbatim books, which are sent to a small core group of Current Engineering Quality Managers; a main report, given to managers in selected departments, e.g. Current Engineering and Marketing; and a much shorter executive summary provided for Directors and board members who have a broader interest in the results.

Qualitative research: A variety of qualitative research programmes are undertaken by the department, including focus groups, workshops and car clinics. The focus groups are mainly used to track consumer trends in a wide range of topics such as the environment, safety issues and general vehicle design. These focus groups are run every month, brand by brand, with 2-3 groups spread around the country. The groups are usually videotaped for future reference. Other focus groups are held on an ad-hoc basis to discuss particular issues. A series of focus groups conducted in early 1998 were coupled with extended test drives of new vehicle proposals. Although this research picked up some ergonomics issues, the ergonomics was incidental and the main focus of the programme was to compare vehicles in general terms and discuss the types of people who might drive them. The monthly focus group programme is run by in-house facilitators. The ad-hoc research is usually carried out by market research agencies.

Workshops are mainly run with Rover employees and provide an opportunity for brainstorming new model concepts and images. Car clinics are conducted with customers, but at present are very much styling-led. These clinics are important for collecting information about forward models, that is those

models not yet available in the market. Comparisons of mock-up vehicles and driver image play a large part in the research.

There has been a very limited amount of work carried out with owners of Minis using diaries to record times when they considered their car to be a 'hero' or a 'nuisance'. However, the Market Research Department considered the results from this work to be disappointing and there has since been a reluctance to undertake similar projects.

3.4.1.2 Rover International

Data collection in the overseas markets for which Rover International is responsible, focuses mainly on competition analysis. This is principally carried out when setting up a new dealership or deciding which models to sell in a particular market. Analysis of the competitor vehicles sold in the market, together with legal and financial considerations are used to develop a market strategy. This data is usually collected by one of a number of market research agencies which Rover uses to cover its world markets. There are four main agencies which cover the Far East, the Middle East, Africa, and South America.

At present very little customer research is carried out by Rover International. This has created problems when design teams have presented Rover International with a new product model and asked them how it should be modified to suit specific markets. Rover International considered that its importers have not been actively encouraged to input ideas into the design cycle at an early enough stage. An example was given that the Asian importers are not shown any of the company's new products until the final version. However, a more recent programme designed to incorporate dealers' opinions at a slightly earlier stage in the design process has now been set up. Approximately 20 selected dealers around the world (3-4 importers from each sales section) are sent a mock-ups or prototypes of next generation vehicle models, asked to comment on the design and suggest any changes they feel would improve the product for their market.

In general Rover International uses Rover's Marketing Research Department to provide them with information if it is available, or arrange to conduct a research study if not. There is no programme of continuous customer data collection within Rover International.

3.4.1.3 National Sales Companies

The National Sales Companies (NSCs), which are companies in their own right operating under the umbrella of the Rover Group, vary greatly in their size and sophistication, and also in the research programmes they organise. The North American NSC is the largest operation and carries out its own independent research programmes. The Portuguese NSC, like a lot of the other companies, is too small to organise its own research. All the market research at Rover's NSCs, apart from the North American operation, is co-ordinated through the UK Marketing Research Department, and any research commissioned from Britain is usually conducted by an agency. Most of these are large multinational agencies, and have their own local agencies which use local employees to carry out the work.

The Australian NSC, which is typical of one of the larger companies, was surveyed to determine typical types of research carried out in overseas markets. In the Australian NSC a single person was responsible for organising the market research programme, and the research relating to customer requirements collection was quite limited. A programme was in place, and run on a regular basis, to assess people's satisfaction with their dealerships. Another study had been implemented to collect data about markets, e.g. sales volumes of particular vehicles, and the types of people buying vehicles. Additionally the NSC had been asked to indicate future directions, strengths and weaknesses of Land Rover products against other vehicles in the market. Customers were not directly involved in this work. Customer contribution in the Australian market has mainly been through car clinics and focus groups, although as in the UK these are mainly styling-led, and do not usually include any ergonomics content. All the data collection in the Australian market is conducted through market research agencies,

and co-ordinated by the Australian NSC before being sent to the UK Marketing Research Department for analysis and reporting of the data.

3.4.1.4 Ergonomics Department

At the outset of this research the Ergonomics Department consisted of two people, who were dealing mainly with current vehicles. They also answered ergonomics questions from design teams etc. on an ad-hoc basis. At this stage there was no formal recording of ergonomics research undertaken. However, the department now includes many more Ergonomists, has substantial facilities with which to carry out ergonomics research, and is systematically logging all work completed, for future reference. Assessment of vehicle bucks (mock-ups of proposed designs), and evaluation of competitor vehicles are now carried out routinely, although, much of this work is conducted with company personnel as opposed to actual customers because of its confidential nature. Nevertheless, the expansion of the department provides more opportunities for the Lifestyle Scenario Toolset to integrate with and build on current research. Communication of ergonomics data is usually in the form of presentations, meetings and discussions. Data collection regarding overseas customer's ergonomics requirements is still very limited within the department, although the CAD system used addresses some of the anthropometric issues, and there is some collaboration with BMW in Germany.

3.4.2 Data Gatherers Requirements for the Toolset

This section describes the data gatherers requirements for the Toolset as revealed in the interviews.

3.4.2.1 Marketing Research Department, Rover International and National Sales Companies

The requirements of the data gatherers in the Marketing Research Department, Rover International and the National Sales Companies are intrinsically linked, because of the structure of the data collection process. The

main requirements data gatherers in these departments have for the Toolset are discussed below.

I. Most of the data collection carried out in Rover is conducted through market research agencies, and it is expected they will be involved in collecting data for the Lifestyle Scenario Toolset. However, they will not be ergonomics experts, and as such cannot be asked to collect data needing specialist knowledge, i.e. ergonomics assessments of vehicles. They will however be experts in the design and execution of surveys, focus groups and other data collection techniques.

II. The people co-ordinating the collection of this data in overseas markets will not necessarily have any experience of conducting market research. Although it is probable that the data collection will be carried out by an agency it is important that the co-ordinator understands what the research aims to do, which customers should be involved and how to conduct the study so that it is comparable in all countries. Therefore the reasons for collecting this data should be made explicit in the Lifestyle Scenario Toolset, and clear instructions provided to help in the running of the data collection and recruitment of suitable customers to take part in the research.

III. The Toolset needs to be usable in overseas markets without significant intervention from Rover in the UK. Once the data collection tools are in place there will be little opportunity to intervene or make changes to the study, therefore it should be easy to implement.

IV. The cost of the data collection must be kept to a minimum. Since the Tools will be used to collect data on a regular basis they should be cost effective and require only a small initial outlay.

V. The tools should be quick to implement, because most of the co-ordinators will have other jobs to do. If the Toolset takes too much time to co-ordinate there is the risk of non co-operation from some of the overseas people. This risk needs to be minimised, again because the remote nature of the study reduces the opportunity to intervene should problems arise.

VI. The data collection should require as few resources as possible. Not all countries will have the same access to facilities, or personnel.

VII. The Toolset should initially concentrate on customers who are easy to locate, for example those who are on existing company records.

VIII. The Toolset should be easy to translate into languages other than English. The wording of all the Lifestyle Scenario Toolset tools and Handbook should be simple, with a minimum of technical language, and without colloquialisms, the meaning of which are difficult to translate.

IX. The Toolset should be easy to transport overseas, or easy to reproduce in other markets. Since technology availability varies from country to country the Toolset should not use equipment which may not be available overseas.

3.4.2.2 Ergonomics Department

The requirements of the Ergonomists for the Toolset are presented below.

I. The Toolset needs to cover a wide range of topics in as much depth as possible.

II. The Toolset should produce figures, in order to assess the importance of various issues and to produce evidence from actual customers of problems encountered.

III. The Toolset should also provide information of a more qualitative nature to back up the figures.

IV. Information from the Toolset should be as easy as possible to communicate to the data users.

V. The data produced by the Toolset needs to be easy to manage, and in a suitable format for easy storage and retrieval for future reference.

VI. The method of data collection, storage and retrieval should fit in with current practice, that is mainly paper based, but backed up on computer.

VII. The costs in terms of money and resources should be kept to a minimum, to ensure commitment to the project.

3.4.3 Constraints on the Data Collection Process Using the Toolset

The constraints placed on the data collection process by the structure of the company and its data collection techniques are discussed below.

3.4.3.1 Marketing Research Department

Currently the Marketing Research Department collects most of its customer data through the two main studies, NCBS and CQTS, which are run on a regular basis. It was initially anticipated that some of the Lifestyle Scenario Toolset data collection could be 'piggy backed' on to one or other of these studies, however, both pose problems in trying to do this. The NCBS, due to the fact that it is syndicated, cannot easily be altered or have new questions added by a single manufacturer. The CQTS is more flexible because it is wholly owned by Rover, but it is a telephone interview and would be expensive to run effectively in overseas markets, from within the UK. Additionally, there would need to be enough people fluent in the language of a particular country to conduct the telephone interviews. The cost of this would be prohibitively high in the context of this research. Most of the other customer based research is conducted on an ad-hoc or irregular basis. There were no current or proposed research programmes which would have been suitable for linking into with the Lifestyle Scenario Toolset data collection. There may however be projects in the future which could incorporate some of the Lifestyle Scenario Toolset tools, once the Toolset has been proved in practice.

3.4.3.2 Rover International

The dealerships under the umbrella of Rover International are small, very diverse in nature, and widely dispersed. Alone each dealership would be too small to provide enough data for the Toolset, therefore several would have to be recruited to help with the project. Since each dealership is in direct competition with the others in the same country there is little unity or structure to these markets in terms of collecting customer data. Further to this the dealers are first and foremost car sales people, who are concerned with selling as many current vehicles as they can. Researching what their customers may want from a future

vehicle, or improvements which could be made to current products is not a high priority for them.

3.4.3.3 National Sales Companies

The National Sales Companies are, like the dealerships, diverse and widely spread. However they are more structured than the markets embraced by Rover International and more used to being involved in market research programmes. Most of the research they undertake is carried out by market research companies with a brief for the work being supplied by Rover. The tools to be used by NSCs must be easy to use by people who are not familiar with ergonomics or market research in any depth. There will not be any ergonomics experts involved in the data collection process overseas and therefore clear instruction and reasons for data collection must be provided with the Toolset. Since all the research will go through market research agencies the data collection tools need to be cost effective and some potential methods may be prohibitively expensive to use.

3.4.3.4 Ergonomics Department

At the outset of this research there was only a very limited ergonomics programme within the company. This afforded few opportunities for the Toolset to link in with current research. Therefore the Toolset had to be developed from scratch with entirely new tools. However, during the course of the project the Ergonomics Department has expanded considerably and versions of some of the tools developed for the Toolset have been modified and used in house.

Ergonomists traditionally deal with facts and figures whereas design teams are more visually oriented, and this can lead to difficulties in communicating ergonomics information in a format which is acceptable to Designers.

The Ergonomics Department is responsible for the funding of this research and is therefore concerned that the development and data collection costs were kept within agreed limits. This budget set the size and scale of the Toolset and data collection process.

3.5 Conclusions

3.5.1 Key Requirements Identified in Study 1

- The tools should not need expert knowledge to implement
- Clear instructions regarding to the use of each tool should be provided
- The tools must be suitable to be used by external market research companies
- The tools should not be labour intensive to implement
- The Toolset should be easy to translate into other languages
- The Toolset should use only the minimum amount of technology
- Detailed data covering a range of topics should be gathered
- The Toolset must produce hard data backed up with more descriptive information
- The data needs to be easily communicated to the data users
- Toolset data needs to be manageable, and in a suitable format for easy storage and retrieval.
- The Toolset must be cost effective

3.5.2 Key Constraints Identified in Study 1

- A lack of suitable current research on which to piggyback the Lifestyle Scenario Toolset data collection
- Inconsistent structure of many of the overseas operations
- Lack of ergonomics and marketing research expertise in overseas operations
- Limited budget for the development and data collection process
- The Toolset must fit in with product development time scales
- Limited access to overseas personnel
- Difficulty in identifying key personnel to assist with the project

Chapter 4

Requirements Specification for the Users of the Toolset Data - Study 2

4.1 Chapter summary

Following on from the review of data collection methods and data collectors' requirements discussed in Chapter 3, the research presented in this chapter investigated the requirements of the end users of the Lifestyle Scenario Toolset data. Discussions were conducted with the potential end users of the Toolset data, in this case Designers, Concept Engineers and Ergonomists, to identify their information and communication needs. The study identified the main requirements from the interviews and these were then used to guide the Toolset development process.

4.2 Introduction

As discussed in Chapter 3 the importance of identifying the requirements of people who will use any new tools is paramount to their acceptance and integration into a company. Chapter 3 investigated the needs of the data gatherers for the Lifestyle Scenario Toolset and this chapter discusses the requirements of the users of the data produced by the Toolset. Figure 4.1 shows how the research reported in this chapter fits into the thesis structure. In order to understand the full implications of the requirements elicited from the data gatherers and users they must be considered in the context of the design cycle within the company. This helps to locate the requirements within the organisational culture and structure and can have considerable influence on the type of tools considered for development (Holt 1989). The next section describes the design cycle at Rover and identifies the role of the individual departments in this process. The remainder of the chapter addresses the research carried out to establish the data users requirements.

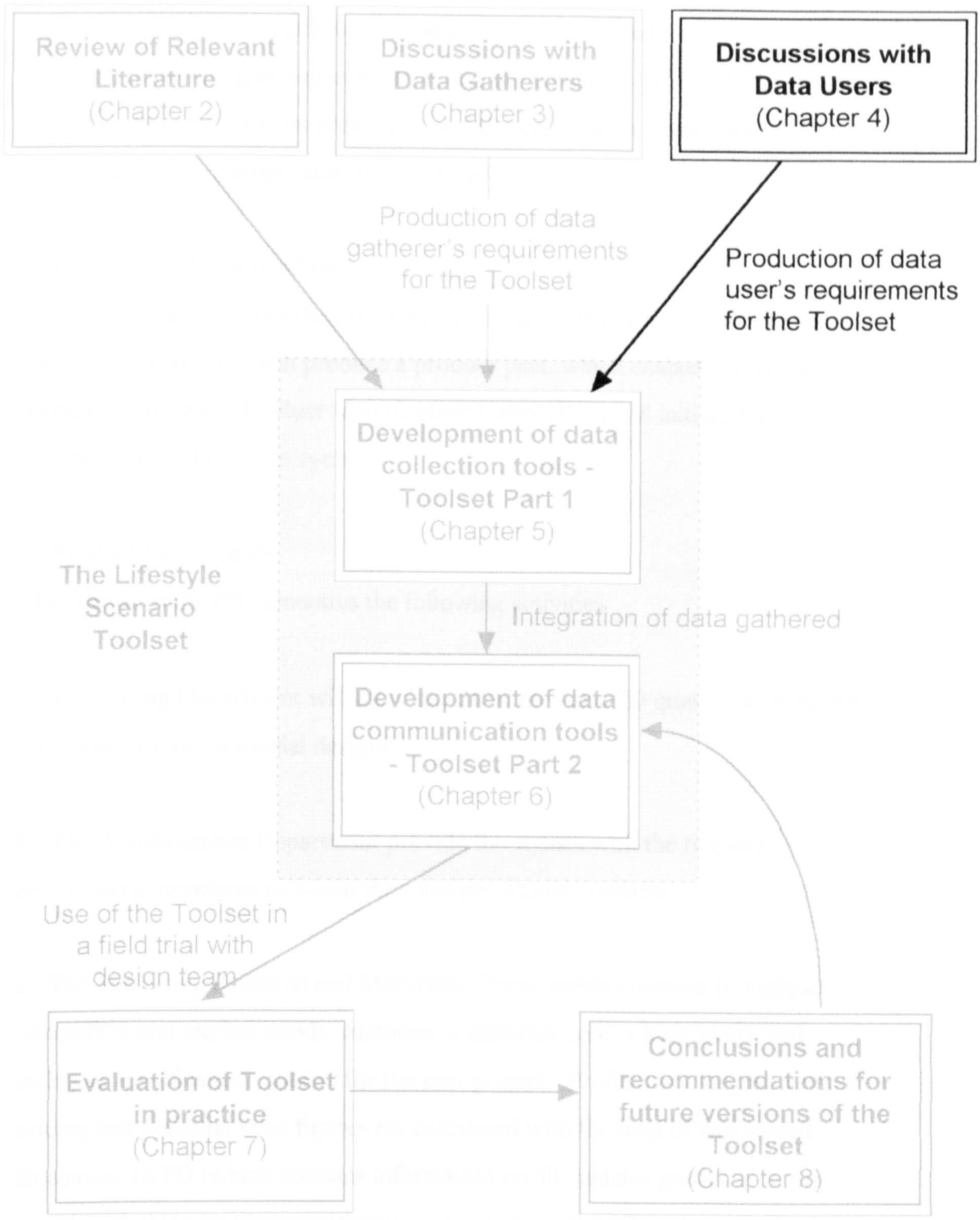

Figure 4.1 Context of the research reported in Chapter 4

4.2.1 The Design Cycle at Rover

The design cycle at Rover is a nine stage process[2] which involves co-operation between many departments within the company (Horn 1992). Figure 4.2 shows how this process progresses and the key players at each stage. The main stages of the design cycle are described below.

1. Production of a design brief

The design brief identifies the potential market areas that a new product should fall within. This stage will produce a product plan, which enables the project manager to release a Product Identification Letter (PIL) and initiate the continuation of the design cycle.

2. Product Investigation

The release of the PIL generates the following activities:

a. The Styling Department will carry out 2D sketch and 3D quarter scale model investigations into potential designs.

b. The Aerodynamics Department provide the stylists with the relevant aerodynamic principles to which their designs should conform.

c. The Marketing Research and Marketing Departments continue to analyse competitor and market trends, customer requirements (at a high level), and technical specifications needed for the new project. Profitability targets, vehicle pricing and potential sales figures are calculated with the help of two rented databases; JATO (which contains information on all vehicles produced in the world, and gives detailed specifications, e.g. sun-roof, ABS systems, and prices for these), and G.S.I. (which provides information on the sales figures and production volumes of all vehicles produced in the world). The use of these databases helps the Marketing division to identify the sorts of features which should be included in new products.

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[2] This description was accurate as of 1996, changes may have taken place since this date.

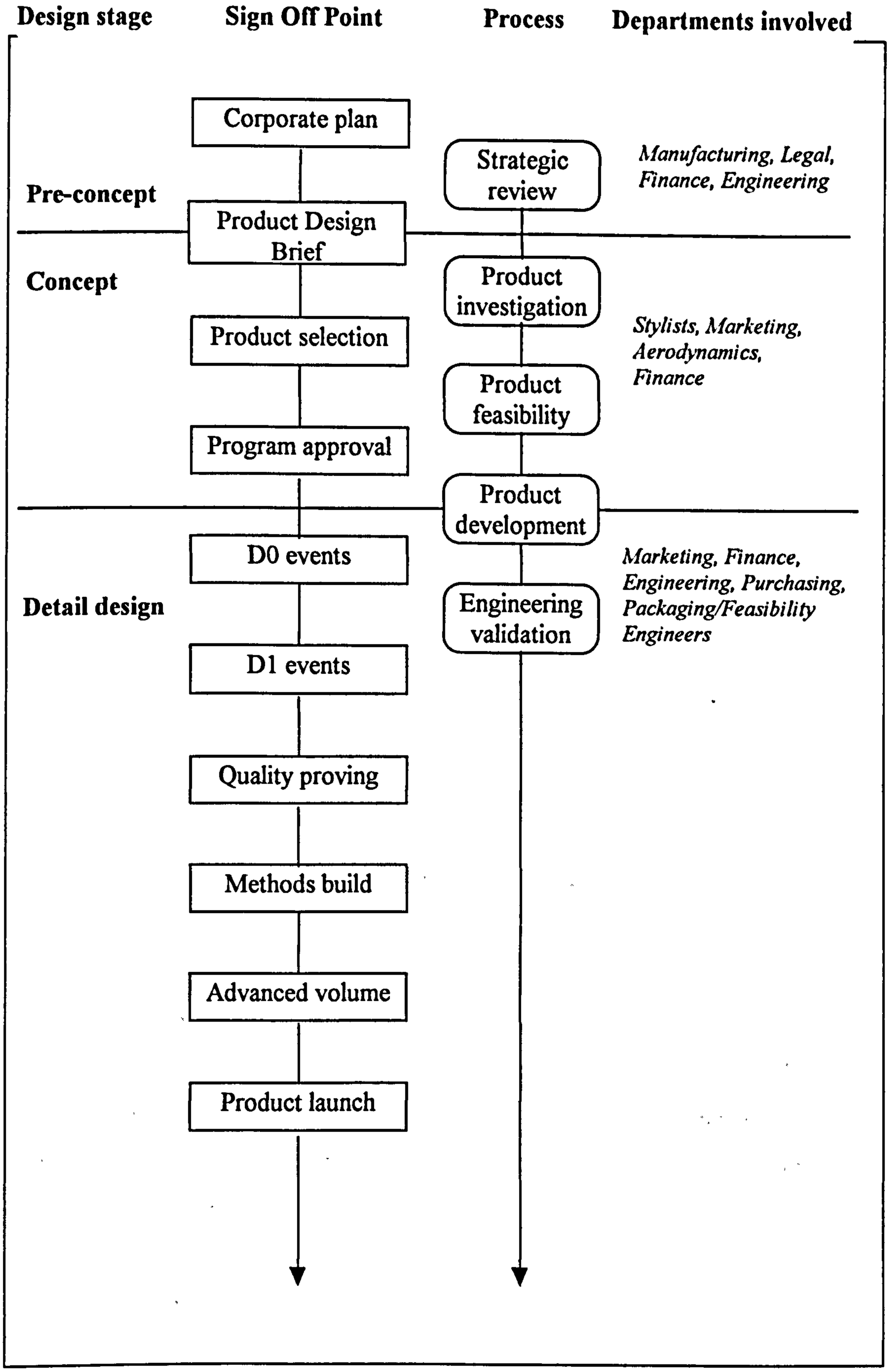


Figure 4.2. The concept to launch process at Rover (Horn 1992)

d. The Manufacturing Department decides which line to use, the layout of the line, investment, timing, etc. which will be used in the production of the new vehicle.

e. Finance and Engineering Departments calculate the Synthetic Model Costs, i.e. the cost which the vehicle must meet if it is to meet the corporate profitability targets. Finance confirm the source of funding for the vehicle, analyse profitability targets, cash flow, risks and opportunities and overheads.

f. Staff engineers with expertise in particular areas are brought in where necessary to advise on the possibilities for carry over from one project to another. Carry overs help to reduce the cost, and the number of problems encountered in producing the new vehicle.

3. Product Selection

This stage is where the proposed designs for a new product are reviewed, and one of the designs is approved as the new design to use.

4. Product Feasibility

A Product Development letter is then released, and specifies the vehicle's dimensions, engine, gearbox options etc. A Features List is also provided which details the parts and assemblies to be carried over, costing details, etc. The packaging and feasibility engineers must now scale up the models to identify the 'hard points' which must be adhered to in the full scale designs; conduct buck trials to prove the design; liaise with other groups involved in the development process to ensure the design is going according to plan; and together with other groups initiate talks with suppliers.

5. Style Ratification

Theme Approvals are held and bring together Stylists, Marketing and Marketing Research representatives and the Chief Engineer of Concept Engineering to discuss the project. The Marketing Research representatives try to ensure that the design is adhering to the perceived customer taste and requirements (although

these may not have been gathered from the customers themselves). The last Theme Approval leads to Style Ratification where the style is set and no further changes are made to it. Once the Ratification has taken place the models are digitised and a fibre glass model taken from the clay model. This model is then painted and can be used in the product clinics run by the Marketing Research Department, to help ascertain the reaction of the public to the new design. Problems which arise at the clinics can then be rectified, if this is considered to be cost effective.

Once the surface information has been completed a Surface Release is sent and initiates the start of Detailed Engineering or Design Development. All information is then passed to the Board for approval, and if given they will release the funds to begin production of the new vehicle.

4.3 Method

4.3.1 Aims of the study

1. To identify current sources and formats of customer data available to the design teams and Ergonomists.
2. To identify the provision and utilisation of ergonomics information in the design process.
3. To determine the requirements for the Toolset of the data users who will utilise the information produced by the Lifestyle Scenario Toolset.
4. To investigate the constraints on the data communication methodology within the company.

4.3.2 Sampling

This study used two different interview schedules to elicit information concerning the design teams use of ergonomics in the design cycle. The sample used in this study was drawn from the Design and Ergonomics Departments at the Rover Group. The participants were selected using convenience sampling, and an equal number of Designers and Concept Engineers (who make up the design

teams at Rover) were recruited. Ergonomists and a design team leader were also involved in the study.

4.3.3 Participants

Ten employees participated in this study, all of whom had worked for the company for over a year. The first sample consisted of three Designers, and three Concept Engineers who were interviewed using interview schedule 1, one Ergonomist was also interviewed using a slightly modified version of interview schedule 1. The other two Ergonomists and the head of the design team (who was a Concept Engineer) were interviewed using schedule 2. All the participants were male.

4.3.4 The Interview Schedule and materials

Two interview schedules were drawn up, the first to discuss the requirements of design teams for customer and ergonomics information and the second to explore the design team structure and how the Lifestyle Scenario Toolset would fit into this. The interview schedules included questions relating to the following topics, and the full schedules are included in Appendix A.

Interview schedule 1

I. Information needed for the design of a new vehicle for an overseas market, in terms of:
    - users
    - environment
    - activities for which the vehicle is to be used

II. The availability and format of relevant customer data

III. How a lack of timely information is dealt with on a project

IV. The types of design decisions the Designers have to make, and how trade-offs are dealt with.

V. Documentation showing where user requirements have been considered in past projects.
    - explicit, formal documentation

- implicit, informal documentation

VI. The presentation of ergonomics information to the Designers and the suitability of the Toolset for this purpose.

VII. Implementation and storage of the Toolset data

VIII. Any extra information/ methods/ communication media etc. felt to add value to the Toolset.

Interview Schedule 2

I. The composition, and physical structure of design teams

II. The structure and format of design briefs

III. The incorporation of information from the design brief into the design, how and when is this done

IV. The methods used to design, i.e. feature by feature or whole vehicle

V. The structure of designing, i.e. whether done on an individual basis or in groups

VI. The differences in this process when used for new and upgrade products

4.3.5 Interview Procedure

The participants were interviewed individually in the Ergonomics laboratory at Rover, and each interview lasted between ½ - 1 hour. Participants were given the opportunity to discuss any aspects of ergonomics in the design process and the provision of customer information, with the appropriate schedules used to guide the process.

The Ergonomists also provided data about the topics covered in the interviews on a more informal basis throughout the Toolset development.

4.4 Results

Key findings from the interviews are organised into topics and discussed below.

4.4.1 Design team structure and communication of data to the teams

The decision to produce a new product triggers the creation of a design team with relevant experience and expertise. New teams are brought together for each project and may or may not have worked together before. The team consists of members from several different areas including Design, Concept Engineering, Ergonomics and Brand Management. The Brand Manager is responsible for overseeing the general direction of a new product, and for providing information about the vehicle targets, including the target market, to the rest of the design team in the form of a design brief.

The design brief is officially a document which outlines all the specifications, including target customer information, models of vehicle to be developed and potential markets for the product. The brief can include information from numerous company departments including Marketing, Industry Affairs and Legislation, Group Engineering, and Business Strategy and Forecasting. This brief is given to the head of the design team who then interprets the data and uses it to shape the new design. Not everybody in the design team sees the document and the level of detail in each design brief can vary widely. Information regarding customer requirements for a new vehicle is provided in the first instance by the Marketing Research Department, and taken mainly from the NCBS and CQTS surveys. The information is at a very high level and is often vague, but provides some guidance as to the customer base which is the focus of the product. The design brief is used at the very earliest stages of the design cycle to steer the process and also throughout the design cycle to check that ideas and concepts conform to the brief.

General vehicle shapes and styles are developed and a number of different groups work on the vehicle once the overall dimensions have been set. The outside is developed by one group of Designers and the interior by another, and others work on the details such as dashboard layout etc. Several designs are proposed for the vehicle and discussed at regular design team meetings and also between groups. After discussion two or three concepts are chosen for further development towards the final design.

The decision to introduce a new model or update is initiated in one of three main ways:

1. A strategic review of business leads to the introduction of a new project. This review may include economic, political, technological, ecological, social, demographic and consumer information. The strategic review is the most usual way in which new products are initiated.
2. A vehicle is usually updated after approximately two years to ensure that it does not become stale or lag behind in technological / competitor improvements. The refresh will utilise the same manufacturing processes already in place, but changes in design (based on technological developments and customer feedback) may produce a vehicle which looks very different.
3. Occasionally product ideas may filter up from the design group and initiate a new product or face-lift of an existing model.

4.4.2 Requirements of design teams for the provision of customer and ergonomics information

At present Designers receive all their information about who uses their products, the environments in which they are used and the activities for which they are used from Brand Management. Brand Management in turn are given the data by the Market Research Department, or informally on an ad-hoc basis from the NSCs and overseas importers. Additional data required by the design teams can be commissioned by Brand Managers through the Market Research Department. The

Market Research Department can supply structured data at a high level, but it cannot supply further in-depth details of overseas markets at short notice. For this type of information the Brand Managers rely heavily on informal word of mouth data from the overseas employees. This provides useful information but it is not a systematic method of collecting data and may be based on the subjective opinion of just one or two people. Further to this much of the in-depth information never actually reaches the design teams who would find it useful, and they do not necessarily know the extent of information that is available. Other additional customer information is available to the Designers via the NCBS or CQTS books which are provided for the principal Designers. However many of the Designers reported that they had never actually seen the data, and of those who had seen it some did not like the format, which is heavily based on figures and tables.

Ergonomics information is supplied to the design teams on an ad-hoc basis, as and when they ask for data. There is to date no structured program to supply ergonomic data to the design teams throughout the design cycle. There was not a culture of seeking out ergonomics information from the Ergonomists, in part due to the small size of the Ergonomics Department at the outset of this research. The Ergonomics Department has now been expanded considerably which may help to change the company culture somewhat, since there are more Ergonomists to cope with the amount of work to be done. Nevertheless, at this stage Designers still tend either to rely on outdated inappropriate ergonomics books, e.g. of military anthropometric data, or to work without it, relying instead on the standards set by other manufacturers to provide target data to work to.

If there is a lack of appropriate information at the required stage in the design cycle the design team will either design without it or, if there is sufficient time and money, commission Ergonomists or Market Researchers to collect the data. Where trade-offs in the design are necessary they are made by discussing the compromises at meetings and 'fighting it out' until a decision has been reached. There is no method in place to systematically make these trade-offs on the basis of, for example, customer information.

Regarding documentation showing where user requirements have been considered in past projects, there is no formal information recorded. Any documentation is informal, and kept by individual Designers in the form of notes and drawings. This creates a wide discrepancy in the type and amount of data available within a design team. Some of the Designers keep information, including that concerning design decisions, about all past projects they worked on whereas others feel they can sufficiently recall any information they need from their memory. Since new design teams are created for each model being developed there is no consistency in the information available, and usually no trail of design decisions which new members of the team can use to trace the design process.

Ergonomics information has traditionally been communicated to Designers in the company as facts and figures in reports, or in discussions at design meetings. Designers will sometimes come to the Ergonomists to ask for additional information, which will be researched and answers given verbally or in writing as appropriate.

When asked about the presentation of information from the Lifestyle Scenario Toolset Designers expressed a preference for pictorial information. The Designers did not want to wade through figures and tables of data in order to draw out useful data. However, the Concept Engineers also wanted more in-depth information in addition to pictorial presentations. The Designers were already familiar with the use of storyboards to present information, although the boards currently used consist entirely of pictures and images taken from magazines etc. They felt that storyboards would be a good way of presenting the new information and were happy to accept some text on the boards, as long as it wasn't too long or detailed. The suggestion of using a series of storyboards to show details of overseas customers and how they carry out tasks in their country was considered to be a good idea, especially as it would build up a pictorial database of tasks in different countries. The Designers also felt it would be helpful to them if the relevant data was shown in a presentation at the outset of each project. This would give them an overview of the data available and could be used to explain what other information was available.

It was considered that the Ergonomists should look after (be gatekeepers for) the data produced by the Toolset. This would ensure that the design teams know where to go to get further information and ensure it was all kept in the same place. Nevertheless, it was thought that the storyboards should be placed in the design team area so that the top level information would be in the forefront of Designers' minds as they develop a product, and therefore incorporated into designs more easily.

4.4.3 Constraints on data presentation

The constraints placed on the data presentation methods by the structure of the company are discussed in this section. Firstly it was necessary to ensure that the presentation of data was timely within the design cycle of a new product. This meant that the data had to be available and presented at the earliest possible stage of the design process, before any major decisions had been made about the new model.

The Designers and Ergonomists are situated in the design studio which is a large open plan building, however some of the design team, for example the Brand Managers, are located away from the studio. This creates distance between people within the design teams and although the teams have regular meetings they are not in constant contact. In addition to the distances between people outside the design studio, those situated in the studio can also be divided. Designers involved in designing for a particular vehicle marque, e.g. Land Rover or Rover cars, are located in one area of the studio, however interior and exterior Designers may be in different areas, as are the Ergonomists. People in each section of the studio tend to stay in their area most of the time and only mix when necessary. These distances create difficulties in communicating data to the design teams, because although people may know where the data is kept it is up to them to make the effort to go and look at the information. It was therefore decided to put some of the top level Toolset information in the area where the Designers work, at the opposite end of the studio to the Ergonomists. The raw and in-depth data should be kept in the Ergonomics Department because it was considered that the

interpretation of the information needed appropriate ergonomics expertise. The information is more likely to be used if it is within sight each day, however the company has a clear desk policy which hinders the communication of information as most documents have to be stored away at night. This means that data has to be brought out each day to be used, and unless this is done the information is out of sight and more likely to be out of mind. It was therefore important to try and create a dedicated space in which the Toolset information can be left at all times.

Ergonomics expertise was needed to analyse the results and extract the relevant high-level information to present to the Designers, in a format with which they were comfortable. Therefore the responsibility for the collation of the results would fall to the Ergonomists. The construction of presentation information may be time consuming given the small size of the Ergonomics Department, however, once the process has been completed the first time it should provide a template for future use of data collected using the Toolset.

4.5 Key requirements and constraints

4.5.1 Key Requirements of Design Teams

- The presentation tools should use language which is familiar to Designers, avoiding Ergonomics terms and jargon.
- The data should be presented pictorially where possible, and use only small amounts of text if necessary.
- The presentation tools should provide an analysed version of the results, showing the key findings.
- The data should be presented in a variety of formats and at a number of different levels of detail.
- Clear instructions about the availability and location of additional information must be provided.
- The top-level information must be easily accessible to the Designers, and preferably located in their day to day work area.

4.5.2 Key Constraints on Data Communication Methods

- The presentation tools must be ready at the appropriate stage of the design cycle of the vehicle identified for evaluation with the Toolset. This dictates when the data collection must take place.
- The Designers need the top level information to be easily available and close to hand at all times, this may be difficult with the clear desk policy.
- A decision as to which information should be kept in the Ergonomics area of the design studio and which in the design area must be made. Ownership issues and decisions about how much in-depth information the Designers should be given may make this difficult.

Chapter 5

Lifestyle Scenario Toolset Part 1: Data Collection Tools - Study 3

5.1 Chapter Summary

The research presented in this chapter covers the development of tools for inclusion in the Lifestyle Scenario Toolset. A general introduction explaining why particular tools were chosen, and how they fit together, is presented first, then the development of each tool is covered in detail. Finally examples of some of the data collected using the tools are given.

5.2 Introduction

The research discussed in Chapters 2-4 identified the key requirements and constraints to be considered during the development of the Toolset. Chapter 2 discussed the relevant literature relating to customer requirements capture, Chapter 3 addressed those issues relating to the people who would use the Toolset to collect data, and Chapter 4 covered the requirements of those people who would use the data produced by the Toolset. These three chapters provide the background to, and a setting for the development of the Lifestyle Scenario Toolset.

As discussed in section 2.3 of the literature review, new systems and methods must be tailored to meet the needs of their users, in this case those who will use the Toolset to collect data, i.e. those responsible for overseas market research and the Ergonomists, and those who will use the information produced, i.e. the design teams. Rubin (1994) states that the development process should "proceed with the user as the centre focus", a view supported by the literature as discussed in section 2.4. With this in mind a two part Toolset was developed in this research; the first part consists of a set of tools for collecting customer data

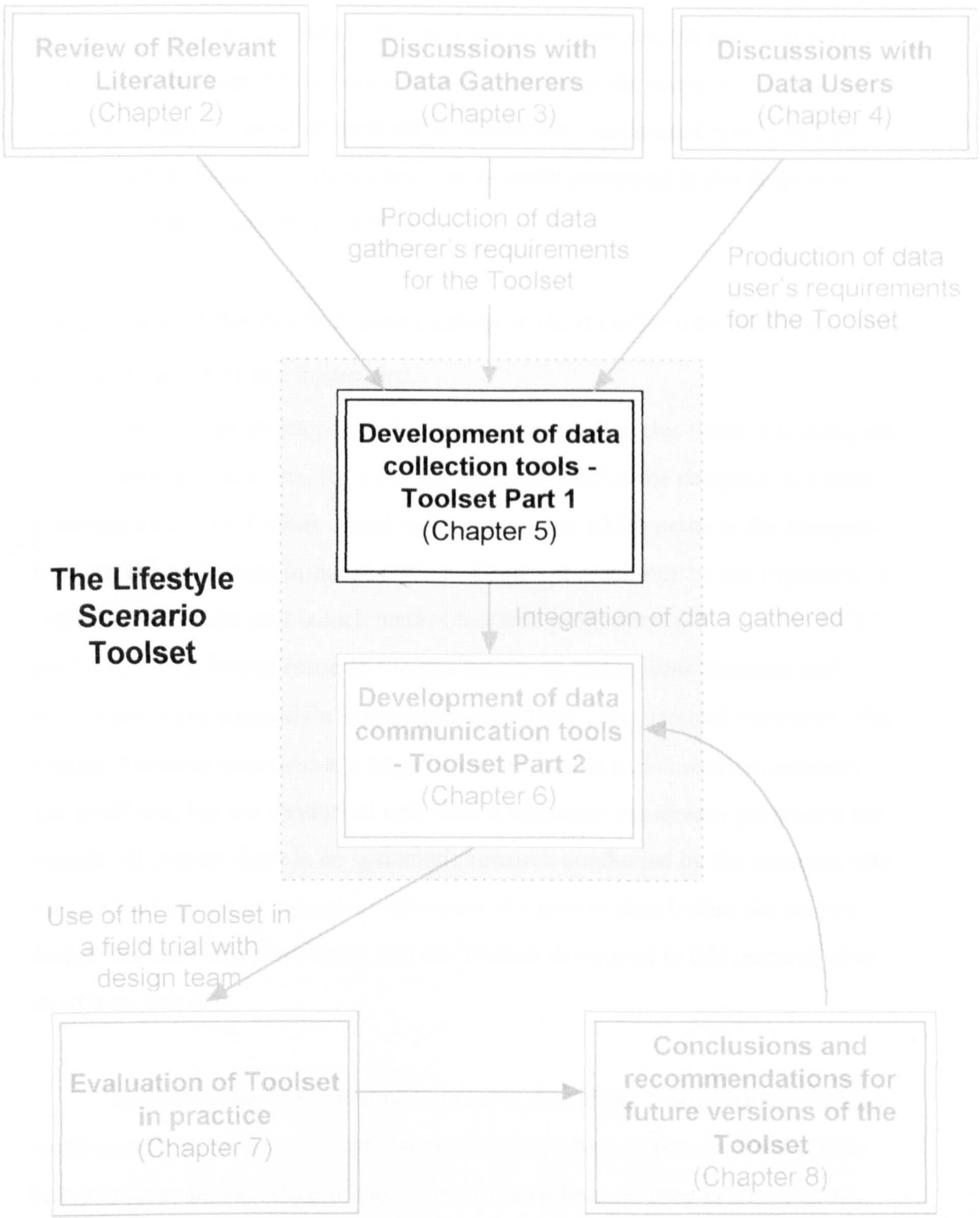


Figure 5.1 Context of the research reported in Chapter 5

from the market place. Part 1 of the Toolset is considered in this chapter and focuses on meeting the needs of the data gatherers. The second part of the Toolset is discussed in Chapter 6 and concentrates on meeting the needs of the data users, through the development of methods to convey information collected using part 1 of the Toolset. Figure 5.1 shows how the research presented in this chapter fits into the overall structure of the thesis.

Integration of the Toolset with customer data collection methods currently used in the company

The Toolset developed in the research reported in this thesis was designed to fit in with, and build on, the methods currently used in the company to collect customer data. The Toolset aimed to bridge the gap which exists in the company between the early stage in-house testing of concept mock-ups by the Ergonomics Department and the post launch market research programmes, such as the NCBS and CQTS. The former research focuses mainly on testing new products and prototypes in the company's Ergonomics laboratory using internal personnel. The Market Research initiatives are targeted more towards real customers opinions and problems, but are conducted only after a customer has already purchased the vehicle. At present there is no systematic research conducted by the company into the needs of actual, or potential, customers of a new vehicle before the vehicle design has been fully developed, and the Toolset developed in this research aims to address this gap.

In addition the Toolset aims to provide data about customers ergonomics requirements, at the pre-concept stages of design where at present there is little information available. Most of the Ergonomics techniques used in the company, such as testing of mock-up vehicle interiors or the use of computer manikins, are more suited for use once a design concept has been developed and can be tested. However, by this stage there is a less flexibility in the changes which can be made to the design without incurring additional cost, style or time penalties. Therefore the pre-concept stages of the development process, where there is still fluidity in a design, provide a good opportunity for the presentation of ergonomics information

which can more easily be incorporated into concept development. This is the stage at which the information from the Lifestyle Scenario Toolset will first be introduced into the design cycle. Nevertheless, the information from the Toolset can, and should, also be used throughout the design cycle, to provide additional information where necessary and facilitate back referencing by the design team to ensure that the designs they are developing fit in with the specified customer needs.

Finally, the Lifestyle Scenario Toolset aims to complement existing methods used in the company to collect customer information by focusing not only on aspects of the vehicle itself, but also on how customers' lifestyles and activities create different requirements for new vehicles. This is an area not yet explored by the company in its other customer research and the Lifestyle Scenario Toolset aims to bridge this gap by gathering a broad range of lifestyle information and customer requirements.

Rationale and Criteria for the selection of Toolset data collection tools

The tools chosen for inclusion in the Lifestyle Scenario Toolset were selected to provide a wide range of data types and formats, and designed to meet the needs of the data gatherers for the Toolset. Each of the tools was developed as a stand alone tool, but they additionally complemented each other in the data they provided, enabling a rich picture of consumers, their lifestyle and their requirements for a vehicle to be built up.

The literature review identified a number of techniques which could be used to gather customer ergonomics requirements, and the pros and cons of each of the methods was discussed in section 2.6. It was also important to ensure that some, or all of the tools were able to pick up information about consumers' lifestyle as well as their requirements for a vehicle. In this way the interaction between those aspects of customers' lifestyle which affect their use of a vehicle, such as the activities they carry out with their vehicle or their family size, and their vehicle requirements could be seen. Methods considered appropriate for the

collection of overseas customer requirements at the early stages of the design process, which met the needs and constraints of the data gatherers, as identified in chapter 3, and which were able to pick up lifestyle information were developed further in this study. A number of considerations were taken into account when deciding which tools were suitable for inclusion in part 1 of the Toolset. The chosen tools must:

1. Be able to collect data which can feed into the pre-concept stages of the design cycle.
2. Collect useful and usable data regarding customer ergonomics requirements.
3. Be appropriate for collecting information about customers' lifestyle in addition to their requirements for a product.
4. Be suitable for use where appropriate by non-Ergonomists, and in some cases non-Market Researchers, to collect data.
5. Be suitable for collecting customer requirements in overseas markets, where different constraints may affect the data collection process. See section 2.7 for a discussion of relevant issues relating to overseas data collection.
6. Collect data in a range of formats and of varying types, e.g. qualitative and quantitative.
7. Collect data in a cost effective and resource efficient manner.

Section 2.9 of the literature review explored the use of more than one method and location to collect data through triangulation. Thus to increase the validity and depth of data collected using the Toolset a number of methods were included. Five tools and a handbook were developed for inclusion in part 1 of the Toolset. These tools were an International Driver Questionnaire, Driving Diary and Photographs, Ergonomics Audit, Focus Group and Background Information. Each of the data collection tools was developed as a stand alone tool, so it could be used independently if required, but consideration was also given to the overall structure and linking between tools. Figure 5.2 shows how these tools fit together and how data can feed from one to another. The figure shows how the questionnaire, driving diary and background information can be used to feed in

information during the development of the audit and/or focus groups. However, all of the tools can be used to feed back information for the iterative development of future versions of the Toolset. In addition the figure shows how photographs and video footage, which were used to illustrate how customers use their vehicle and the problems they encounter, fit into the overall structure of part 1 of the Toolset. The handbook is intended to be used throughout the data collection activities, as necessary, to guide and assist in the process.

Choosing the design team and product with which to test the Toolset

In order for the Toolset to be of value to the company it was important that it collected useful, valid and reliable data which could be utilised by the design teams working on a new product. A suitable design team working on a product in the planning stages of the design process had to be found and invited to participate in the research. One such project team was working on the second generation replacement for the Land Rover Discovery. This project was in the pre-concept stages of design and the team involved were willing to give their time and assistance to the Lifestyle Scenario Toolset research.

Selection of the market on which to test the Toolset

It was also important to consider which overseas market the Toolset should be tested on. The choice of markets in which to prove the Toolset was made after consideration of a number of factors. Since there was a dearth of information from most of the non-European markets, company personnel felt that data from one or more of their major non-European markets would be of most use to them at this stage. Therefore it was decided to conduct the pilot studies in the Australian market and the main studies in the US market. This provided an opportunity to test the Toolset in two different overseas markets each with its own unique environment.

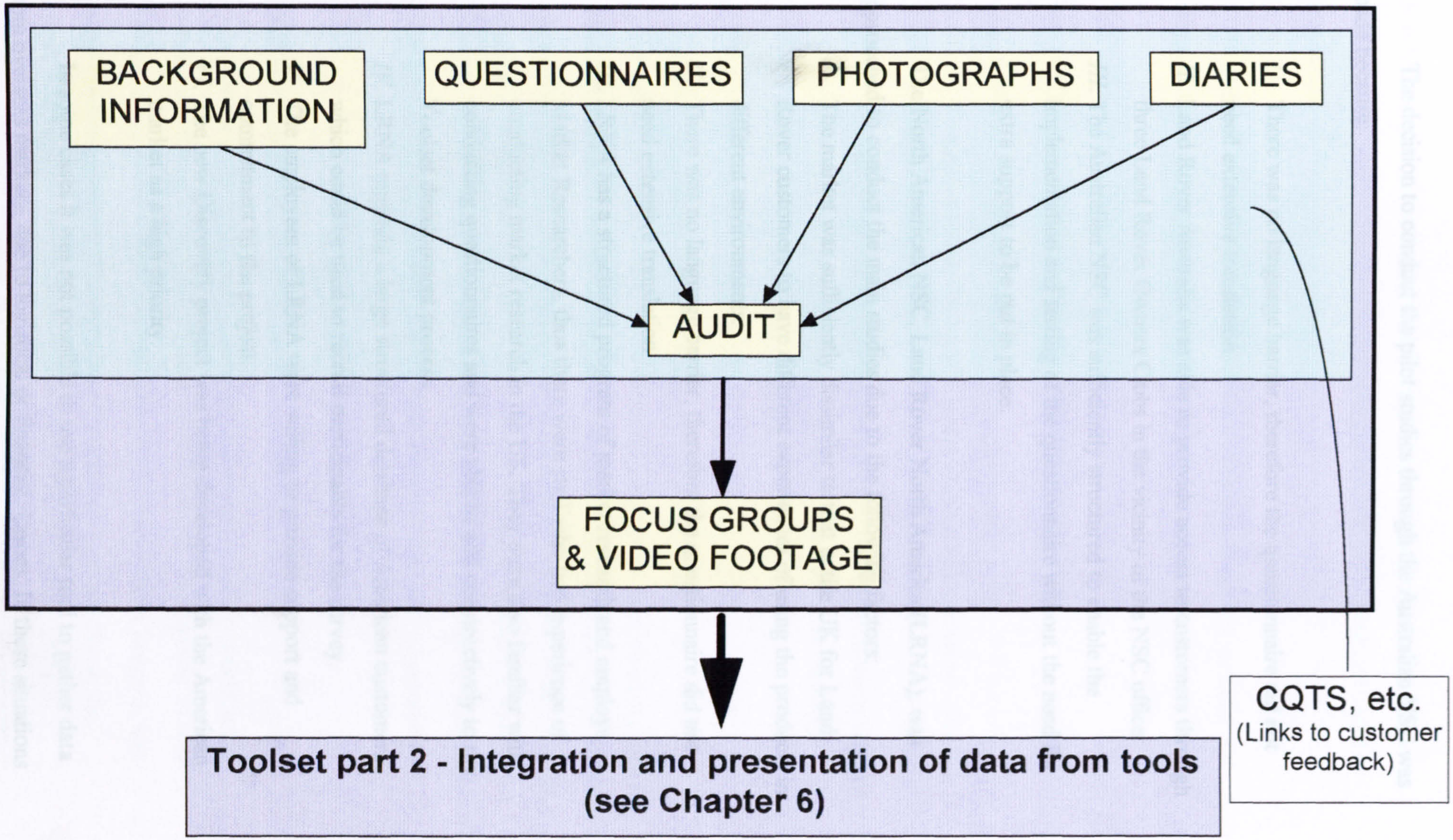


Figure 5.2. Structure of the Lifestyle Scenario Toolset Part 1

The decision to conduct the pilot studies through the Australian NSC was made because:

I. There was no language barrier, therefore the questionnaire did not need extensive translation.

II. Land Rover Australia was able to provide access to customers through three Land Rover Owners Clubs in the vicinity of the NSC office.

III. The Australian NSC was sufficiently structured to enable the implementation and testing of the questionnaire without the need for extra support to be put in place.

The North American NSC, Land Rover North America (LRNA), was approached to conduct the main studies due to the following factors:

I. The market was sufficiently dissimilar to that in the UK for Land Rover customers to have different experiences of using the products in different environments.

II. There was no language barrier, therefore the questionnaire did not need extensive translation.

III. LRNA has a structured program of market research and employs Market Researchers, thus there were staff who had experience of conducting market research in the US. They were also familiar with conducting questionnaires and were able to add constructively to the Toolset development process.

IV. LRNA maintain a large structured database of American customers which could be used to recruit participants for the survey.

V. The employees of LRNA were willing to provide support and commitment to the project.

VI. The new Discovery project was being developed with the American market as a high priority.

In some cases it was not possible to use a particular tool to gather data from overseas markets, due to logistical or financial reasons. In these situations the work was carried out in the UK in order to assess the effectiveness of the tool

for collecting data. Some tools, such as the ergonomics audit, were developed to be used by the Rover Ergonomists based in the UK and were therefore tested in this country.

The following sections discuss the development of each of the data collection tools chosen for inclusion in the Lifestyle Scenario Toolset.

5.3 International Driver Questionnaire

5.3.1 Aims of the questionnaire

I. To explore the positive and negative ergonomics aspects of using a vehicle and driving.

II. To collect semi-structured data which can be analysed in many ways to produce a rich picture of the population, tasks and environment studied, using descriptive statistics.

The questionnaire was included in the Toolset in order to meet the requirement of the Ergonomists in the company for a tool to provide figures which would enable them to assess the magnitude of a particular requirement, and which would collect data on a wide range of topics. In addition the questionnaire met the need for a tool which could be conducted through a Market Research agency if necessary, was not resource intensive to conduct, which needed little Ergonomics or Market Research experience to implement and was relatively inexpensive to use.

5.3.2 Sampling

For the purposes of this research the questionnaire survey was directed towards Land Rover Discovery drivers in the US market. The database of North American Land Rover owners, maintained by Land Rover North America, was used to randomly select 1000 customers. The database contains the names, addresses and vehicle details of all Land Rover North America (LRNA) customers. Only people who owned a Discovery less than two years old were

included in the sampling frame, to ensure that the newest model was being surveyed. People who owned a Discovery less than two months old were also excluded from the sampling frame, because they were considered to have too little experience of their new vehicle to contribute fully in the questionnaire survey. These procedures resulted in a sampling frame of 5132 Discovery owners, from which 1000 Discovery owners were randomly selected to receive a questionnaire.

5.3.3 Respondents

The total number of respondents was 291 from the 1000 questionnaires sent out. Sixteen responses were considered invalid because the questionnaire had been completed for vehicles other than the Land Rover Discovery. Therefore the response rate was counted from a total of 984 questionnaires, and calculated to be 30%. The response rate was much higher than expected, because the time scale necessitated mailing the questionnaires during the Christmas holiday period and Land Rover North America had previously experienced poor response rates to studies conducted at this time. Therefore an even higher response rate could be expected if this period was avoided.

The sample contained 92 women and 177 men (6 people did not respond to this question). Respondents fell in the age categories 18-24 to 70+, with a modal age group of 35-49 years for both men and women.

5.3.4 Questionnaire format

The questionnaire contained 47 questions covering a range of topics concerned with driving and using a vehicle. The questionnaire was developed from the discussions with the potential users of the Toolset data, Market Researchers and ergonomics experts, from the literature and pilot testing (see section 5.3.6). The questionnaire was divided into five sections labelled: *Your vehicle and others you drive; How you use your vehicle; Maintaining your vehicle; About you and your family;* and *Other information.* The contents of the questionnaire are described briefly in the following sections.

Your vehicle and others you drive

This section of the questionnaire contained 11 questions, some with sub-sections, and aimed to establish the pattern of vehicle ownership amongst the participants. Details were asked about drivers of the vehicle, access to other vehicles, reasons for purchase / non-purchase and vehicle features (present, desired and unwanted).

How you use your vehicle

The second section containing 18 questions, some with sub-questions, was designed to measure vehicle usage in a variety of activities. It also gathered information about driver behaviour and emotions in a range of situations, as well as details of problems encountered carrying out tasks using the vehicle.

Maintaining your vehicle

The six questions and sub-questions in this section covered vehicle cleaning, maintenance and servicing of the vehicle. The frequency with which maintenance tasks are conducted and problems encountered were included.

You and your family

These questions were designed to collect demographic information from respondents. Drivers were asked to indicate their age, gender, height, weight and build. Questions about family composition and employment were also included in this section.

Other information

The questionnaire ended with a section allowing participants the opportunity to offer any other information they felt was relevant to the study, and which had not been covered elsewhere.

5.3.5 Questionnaire materials

The questionnaire survey package (see Appendix B) contained a covering letter, a copy of the questionnaire, a pre-paid reply envelope and a voucher to

receive the free Land Rover baseball cap used as an incentive for questionnaire completion.

5.3.6 Survey Procedure

Pilot study

The questionnaire was piloted through the Australian NSC. Letters were sent to the two Land Rover Owners Clubs in New South Wales prior to visiting the Australian NSC, asking for people to take part in the interviews. The group members are all Land Rover owners with either a Land Rover Discovery, Land Rover Defender and/or Range Rover. There were 790 members in the two groups, however only a small number of these people attend each club meeting, and recruitment was conducted at one of the monthly meetings. Sixteen people responded to the request and a postal questionnaire was sent to the respondents. Pre-paid reply envelopes to the Australian NSC were included, and the responses were forwarded to the UK after the end of the visit. All 16 people returned the questionnaires.

The questionnaire was revised after the pilot study. The final version is included in Appendix B and was described in section 5.3.4. The original questionnaire consisted entirely of open ended questions and some of these were changed to pre-coded responses after the pilot study. Questions which were misinterpreted or misleading were clarified, some questions were removed and others added to produce consistency in the questionnaire. The revised questionnaire was discussed with the Ergonomists and Designers to ensure it still gathered appropriate data.

Main study

The main survey was carried out through the North American NSC, Land Rover North America (LRNA), and was conducted remotely with the assistance of the head of Market Research in LRNA. Questionnaire packs, containing a cover letter and questionnaire, were prepared in the UK and shipped to America for the addition of US pre-paid reply envelopes and gift certificates. The covering

letter provided a free phone US contact number together with UK addresses, in case of questions or difficulties concerning the questionnaire. The questionnaires and completed gift certificates were returned to LRNA, where the certificates were removed before the questionnaires were shipped to the UK. LRNA co-ordinated the fulfilment of the respondent incentives. A reminder postcard had been printed and sent to the US for use in the questionnaire study. However, after three weeks the number of questionnaire returns was high enough that it was considered unnecessary, and not cost effective, to send out the reminder postcard. The majority of questionnaires were returned in the US within four weeks of being sent out.

The data from the questionnaires was coded and a coding booklet produced. The open ended questions were coded as different responses were encountered. Although this led to a large number of coding categories for some questions no data was lost, and since the questionnaire aimed to provide detailed information about customers this was considered to be important. The data were entered into a spreadsheet program and descriptive analyses of the results were conducted. An overview of some of the key results is presented in the following section.

5.3.7 Results

This section describes some of the key results obtained using this tool in the US Discovery market. For a discussion of the suitability of the tool for inclusion in the Toolset see section 7.3.1.

Demographics

Sixty four percent of the questionnaire respondents were male and 34% were female, 6 people did not answer this question (N=275). The median age group for both males and females was 35-49 years (53% of men and 52% of women) and the age groups ranged from 17-24 years to 70+ years.

Figure 5.3 shows the height distribution amongst the Discovery drivers. Forty three percent of male respondents were in the 1.81-1.90m (5'11"-6'2") and

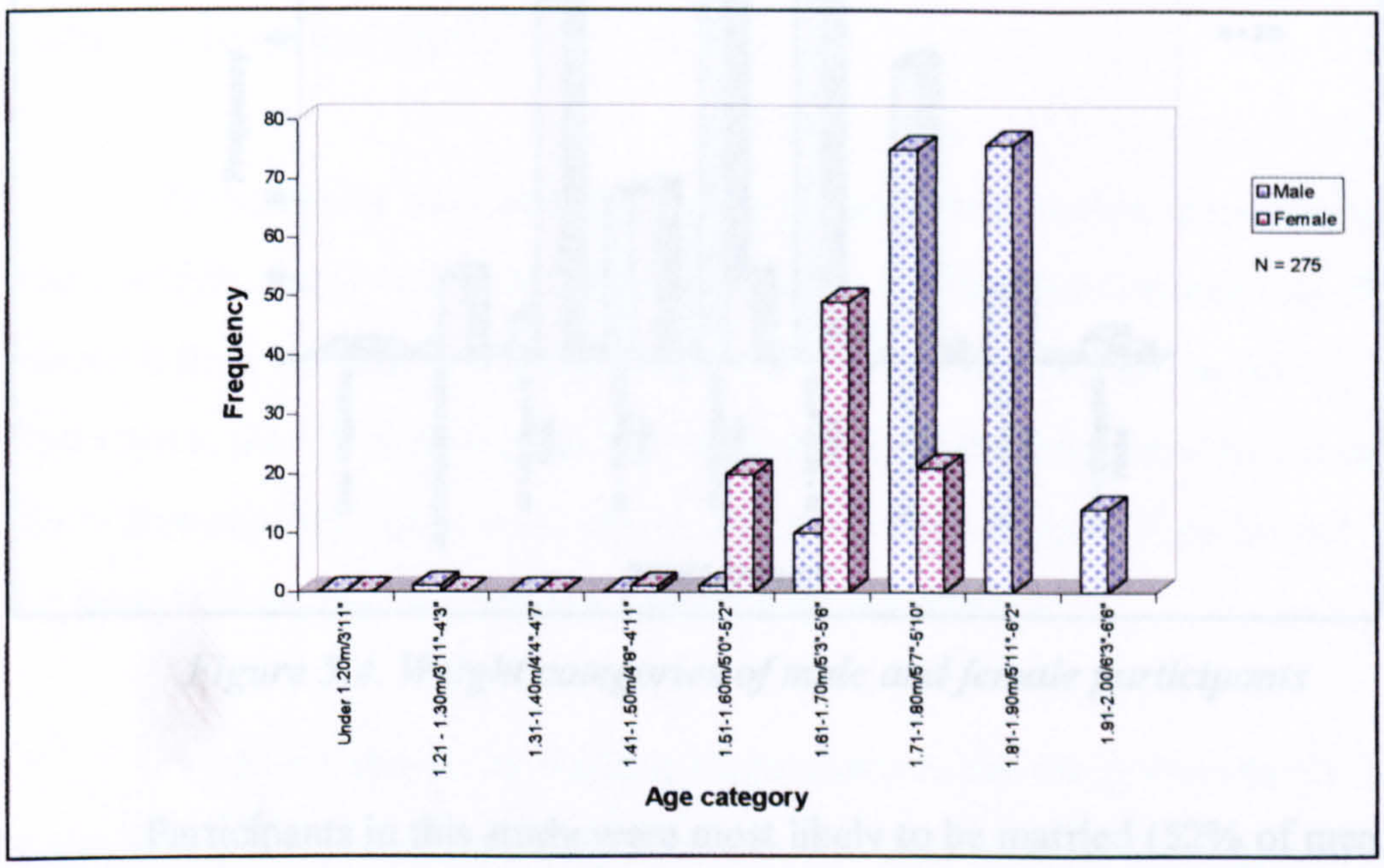


Figure 5.3. Height categories of male and female participants

42% in the 1.71-1.80m (5'7"-5'10") category. Male height categories ranged from 1.21-1.30m (3'11"-4'3") to 1.91-2.00m (6'3"-6'6"). The most common height category of the women respondents was the 1.61-1.70m (5'3"-5'6")group. Female height categories ranged from 1.41-1.50m (4'8"-4'11") to 1.71-1.80m (5'7"-5'10").

Figure 5.4 shows the weight range of the respondents. The median weight categories for males and females were 80.1-90.0kgs (177-198lbs), 30% of males, and 50.1-60.0kgs (111-132lbs), 49% of females, respectively. Both male and female weight categories ranged from under 40kgs (88lbs) to 110.1-120.0kgs (243-264lbs). The respondents were also asked to give an indication of their build type from a range of pictograms. Most people (49% of males, and 60% of females) said they were of medium build.

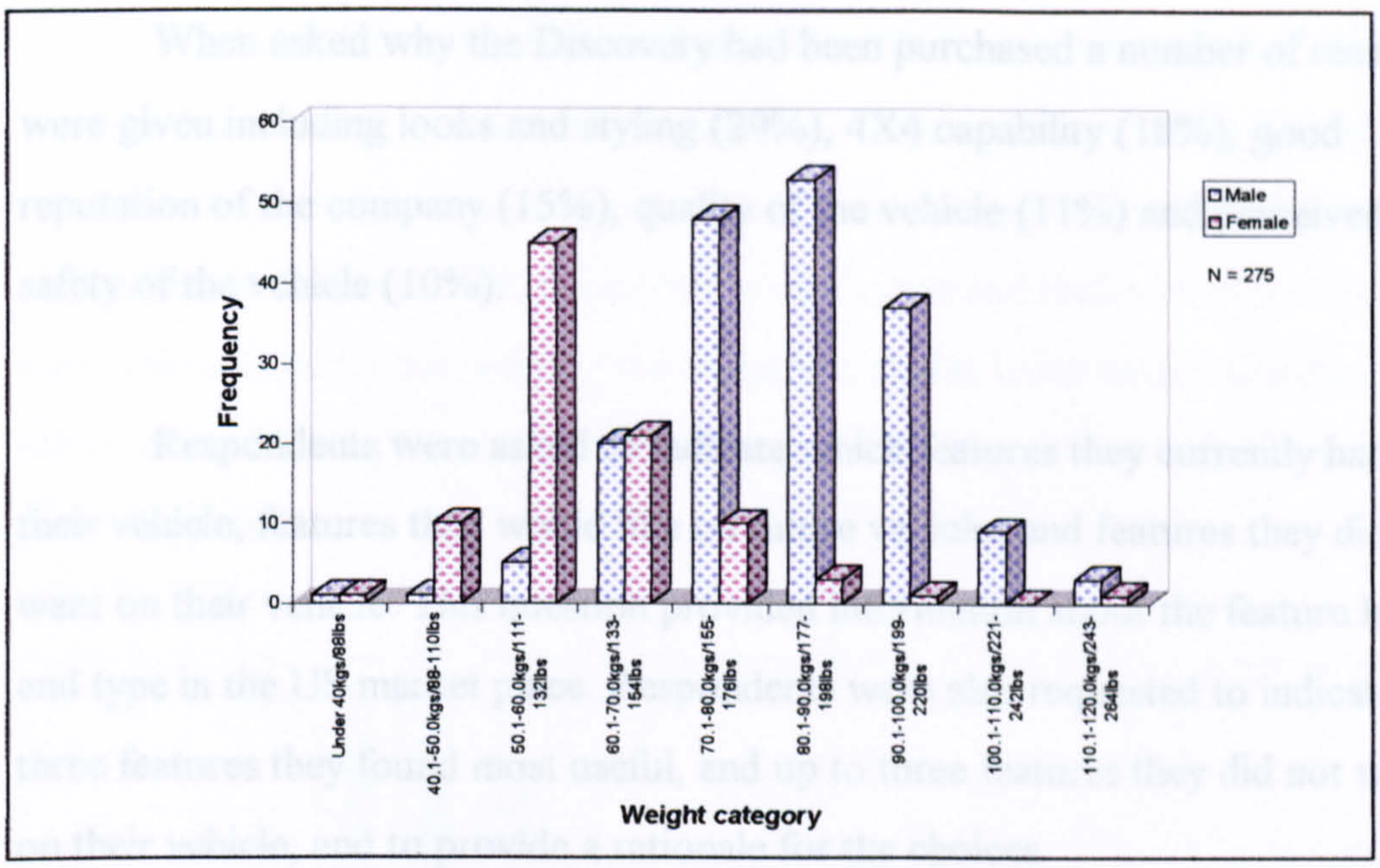


Figure 5.4. Weight categories of male and female participants

Participants in this study were most likely to be married (52% of men and 83% of women), and 56% had children. Twenty seven percent of the respondents had two children and 18% had one child, these children were most likely to be 5-8 years (26% of all respondents), 9-12 years (22% of all respondents) or over 16 years old (22% all of respondents). The most common occupation of the male respondents was either executive or professional (each 19% of men) and that of the women was either a housewife (28% of women) or professional (26% of women).

Vehicles driven by participants

As expected from the sample, all the participants in this study owned a Land Rover Discovery which was between 2 months and 2 years old. Sixty five percent of the vehicles were driven by the owner and their spouse or partner, but 30% were driven solely by the respondent. Eighty one percent of participants reported that they had access to at least one other vehicle, most often a one year old (24%) Mercedes or Lincoln (each 11%) sedan (44%), although for 19% of participants the Discovery was their only vehicle.

When asked why the Discovery had been purchased a number of reasons were given including looks and styling (29%), 4X4 capability (18%), good reputation of the company (15%), quality of the vehicle (11%) and perceived safety of the vehicle (10%).

Respondents were asked to indicate which features they currently had on their vehicle, features they would like on future vehicles and features they did not want on their vehicle. This question provided information about the feature level and type in the US market place. Respondents were also requested to indicate three features they found most useful, and up to three features they did not want on their vehicle, and to provide a rationale for the choices.

Figure 5.5 shows the features respondents in this study considered to be most useful. The most commonly cited features were air-conditioning, power seats (electric seat adjustment), cruise control, compact disc player, automatic transmission, 4X4 capability and cup holders. Reasons for these choices included ease and convenience provided by the feature, increased comfort, improved safety, frequency of use and enjoyment provided by the feature.

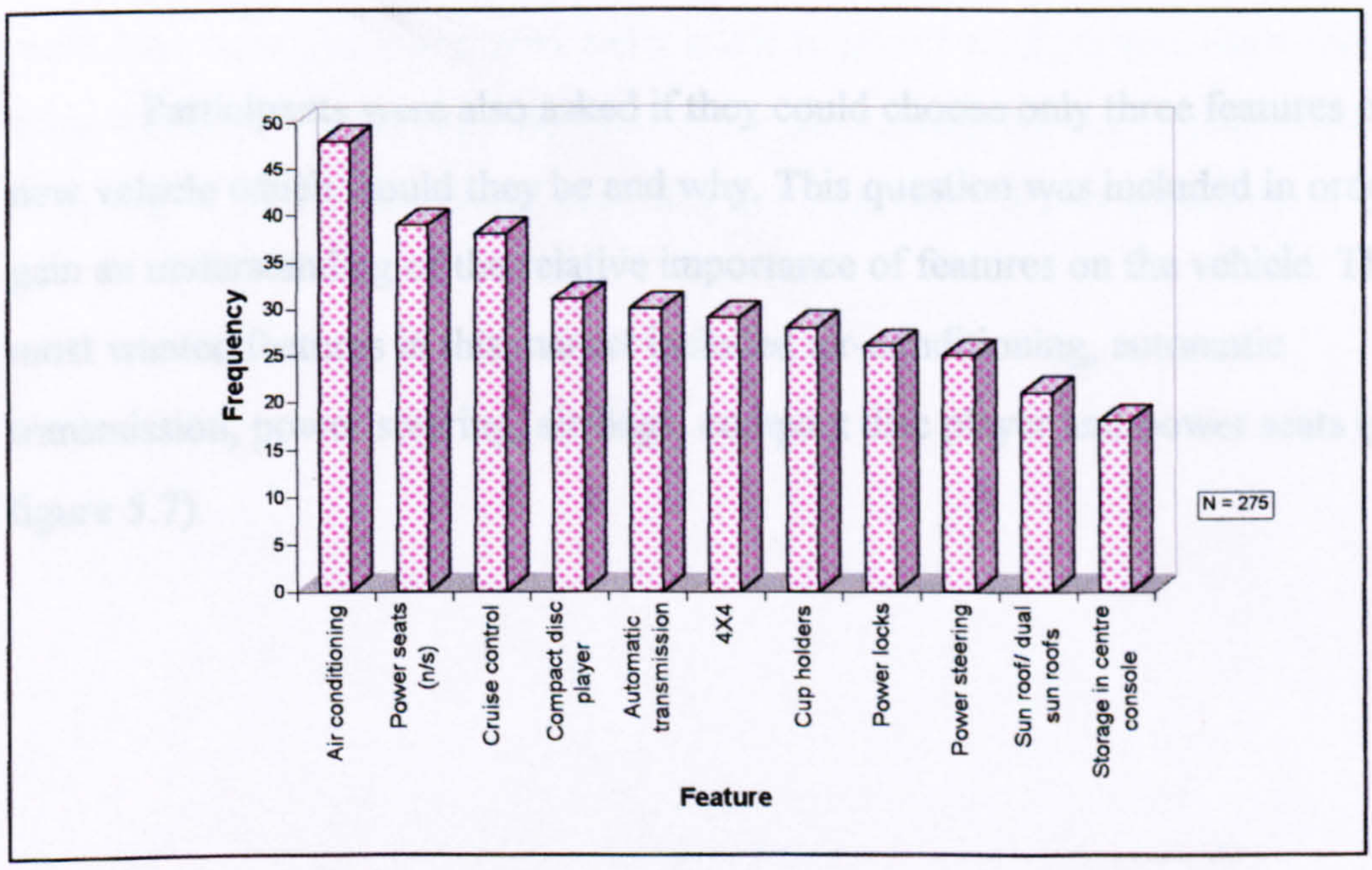


Figure 5.5. Features of the vehicle considered most useful

A small number of people indicated that there were features they did not want on their vehicle, see figure 5.6. The most frequently cited unwanted features were the air-bags, audio system controls on the steering wheel / dashboard, the adjustable steering wheel tilt, automatic transmission and cruise control. The most common reasons for not wanting the features included uncertainty regarding the safety of the feature, lack of use, poor design of the feature and lack of enjoyment from the feature.

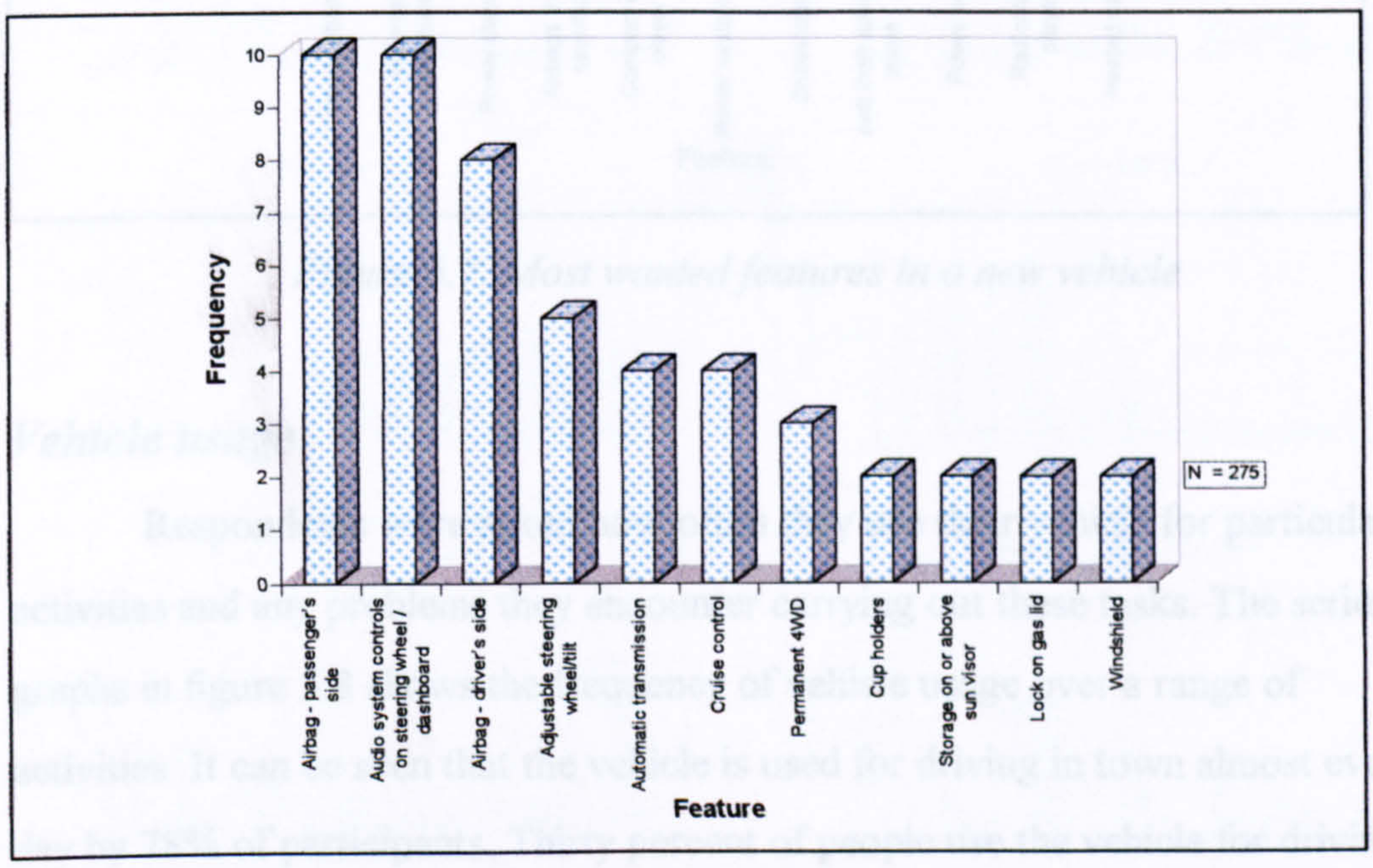


Figure 5.6. Unwanted vehicle features

Participants were also asked if they could choose only three features on a new vehicle which would they be and why. This question was included in order to gain an understanding of the relative importance of features on the vehicle. The most wanted features in this market included air-conditioning, automatic transmission, power steering, air-bags, compact disc player and power seats (see figure 5.7).

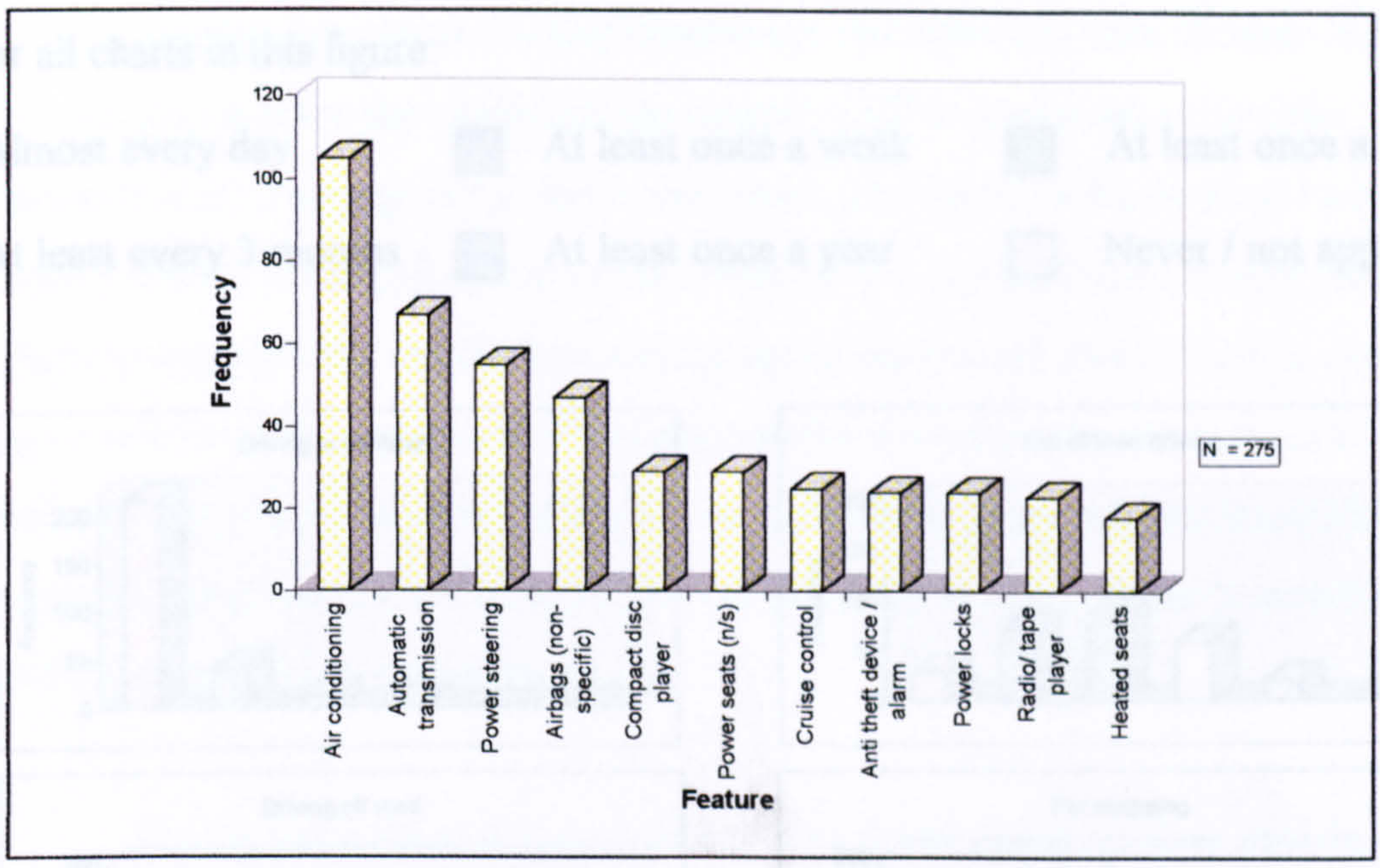


Figure 5.7. Most wanted features in a new vehicle

Vehicle usage

Respondents were asked how often they use their vehicle for particular activities and any problems they encounter carrying out these tasks. The series of graphs in figure 5.8 shows the frequency of vehicle usage over a range of activities. It can be seen that the vehicle is used for driving in town almost every day by 78% of participants. Thirty percent of people use the vehicle for driving out of town at least once a month, however few people go off road in their vehicle more than once a year and 26% never use it to go off-road, despite the vehicle being designed for this purpose. Half of the participants use the vehicle to go shopping at least once a week, and 38% use it for this purpose almost every day.

Key for all charts in this figure:

Almost every day | At least once a week | At least once a month

At least every 3 months | At least once a year | Never / not applicable

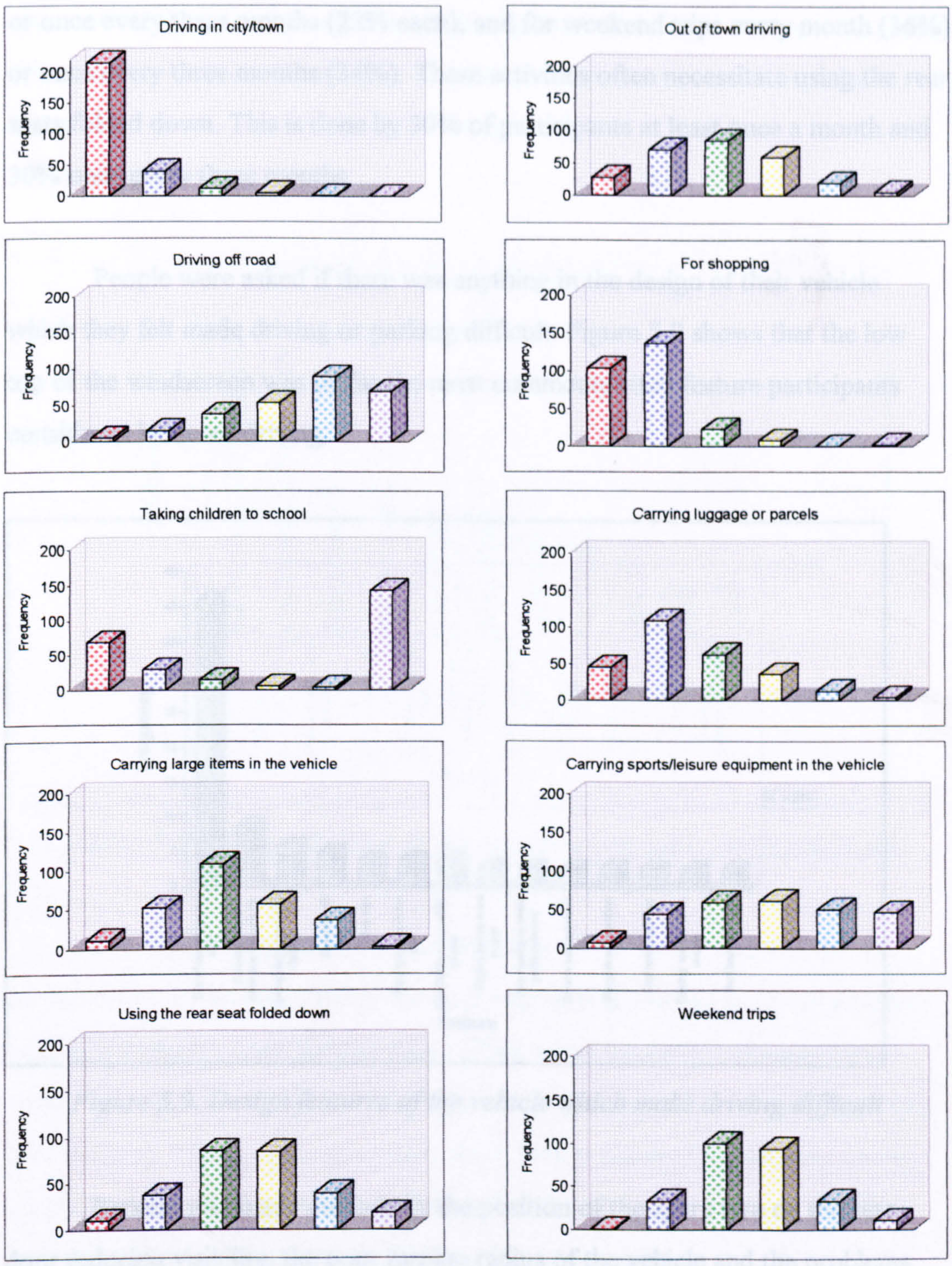


Figure 5.8. Vehicle usage over a variety of activities

Twenty five percent of participants use the vehicle to take children to school almost every day, although the majority (52%) do not use it for this purpose at all. Luggage is carried in the vehicle frequently, 40% do so at least once a week, and large items are most often carried at least once a month (40%). Participants use their vehicle for carrying sports equipment usually once a month or once every three months (22% each), and for weekend trips every month (36%) or once every three months (34%). These activities often necessitate using the rear seats folded down. This is done by 30% of participants at least once a month and 30% once every three months.

People were asked if there was anything in the design of their vehicle which they felt made driving or parking difficult. Figure 5.9 shows that the low top of the windscreen was by far the most commonly cited feature participants considered hindered driving.

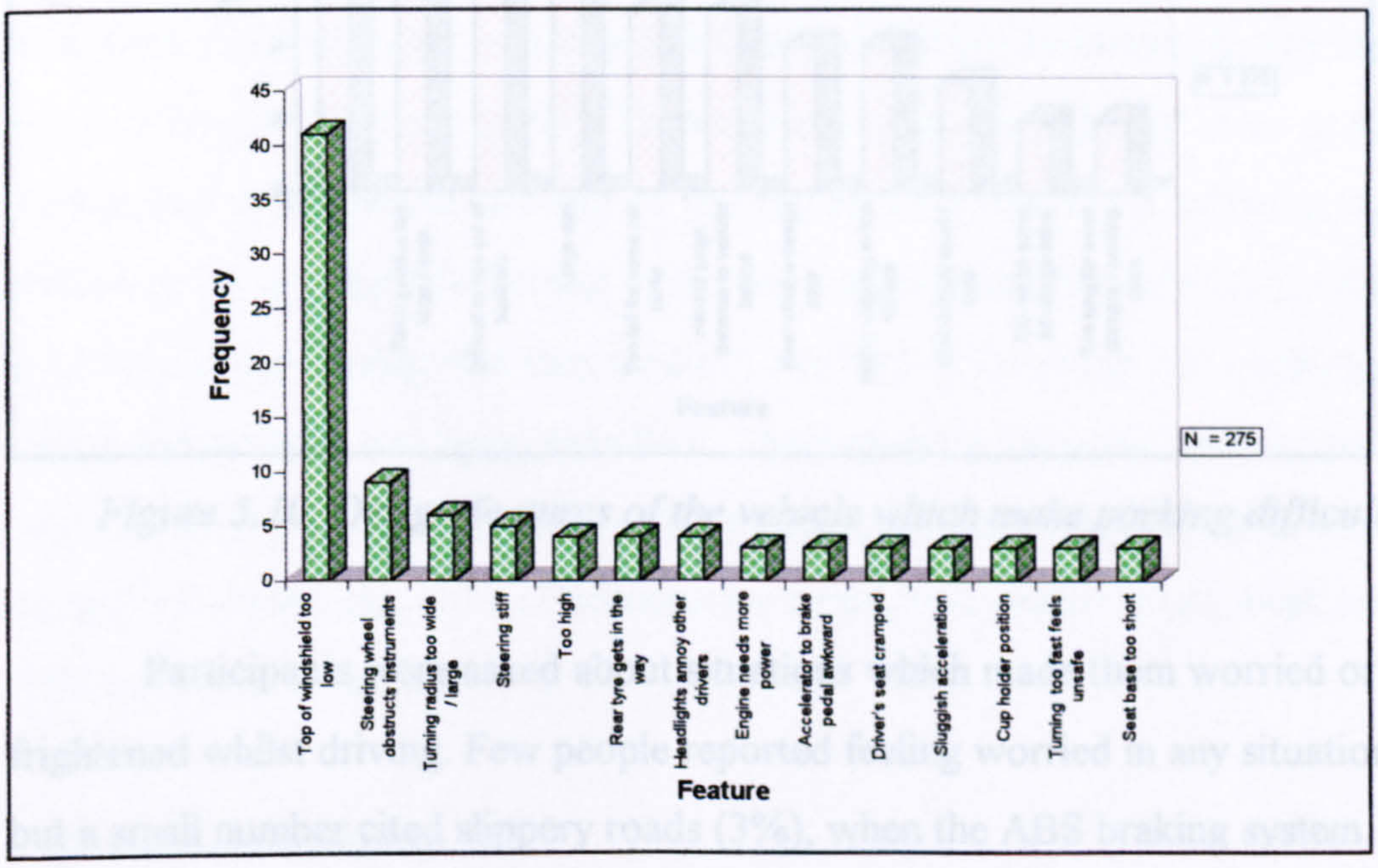


Figure 5.9. Design features of the vehicle which make driving difficult

Parking was made difficult by the position of the spare tyre on the rear door reducing visibility, the poor turning radius of the vehicle and the problems with access to many car parks due to the height of the vehicle (figure 5.10)

Questions regarding weather and animals encountered on journeys showed that 22% of respondents have to travel through snow and 18% in icy conditions. Deer and antelope are the most often encountered wild animals (23%). In both poor weather conditions and when there was a likelihood of encountering hazardous animals the most common reaction is to slow down and become more aware of the surrounding conditions, although a small number of people said they did nothing but would have had to slow down if they were not driving a Land Rover.

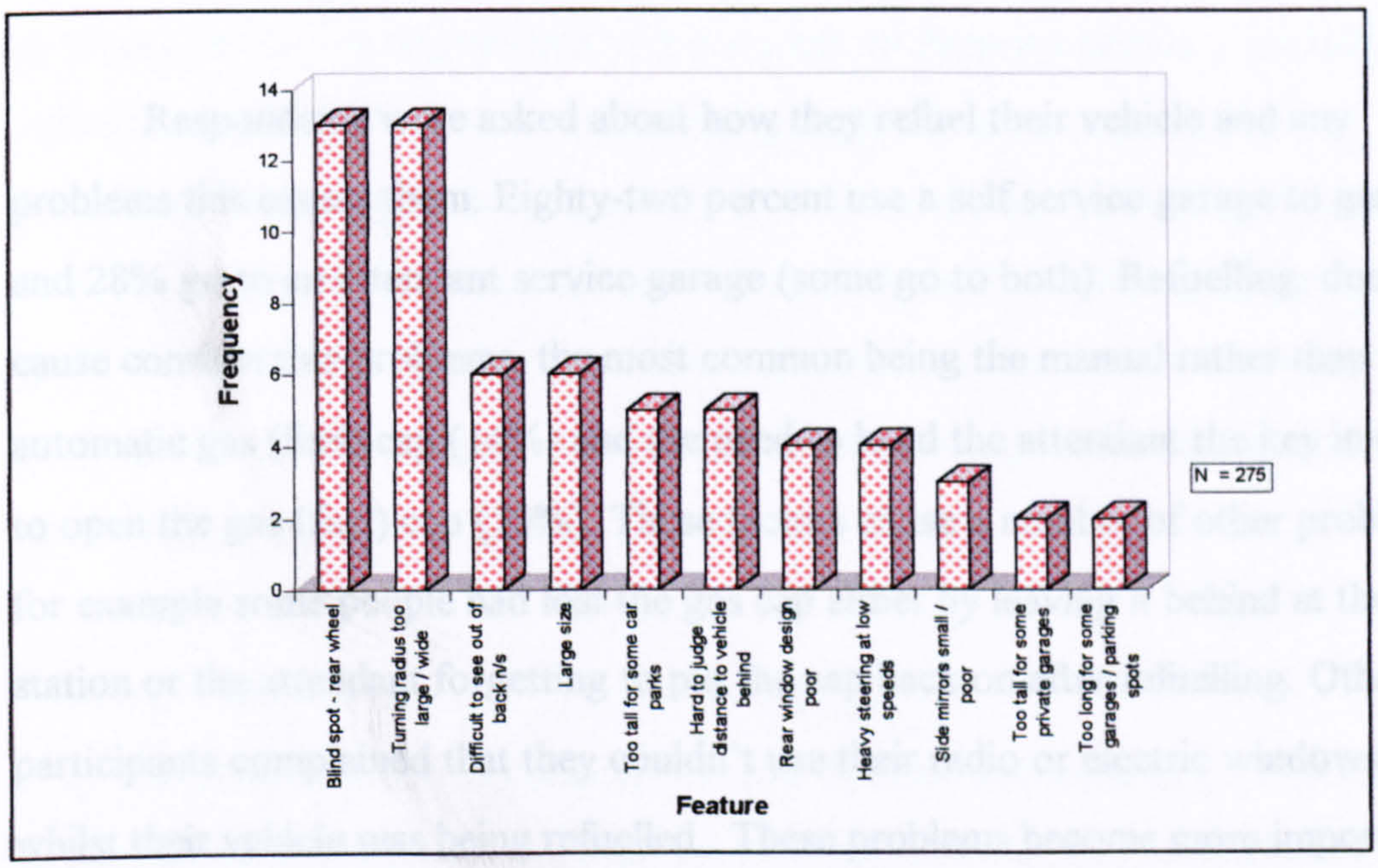


Figure 5.10. Design features of the vehicle which make parking difficult

Participants were asked about situations which made them worried or frightened whilst driving. Few people reported feeling worried in any situations but a small number cited slippery roads (3%), when the ABS braking system comes into operation (2%) and some situations when travelling or parking in city centres (2%). Participants were asked about their opinion of the security on the vehicle. Seventeen percent of respondents feel the security was good, but 9% stated that there could never be enough safety on a vehicle to stop the most determined thief. Areas where the respondents thought the security could be improved included having a lockable glove compartment (2%), a panic button on the remote alarm key system (2%) and a glass break alarm (2%).

Vehicles are used for many activities other than driving. The large majority of participants use their vehicle for eating and / or drinking (75% each). Fourteen percent put on cosmetics in the vehicle and 10% use it for changing diapers (nappies). Some participants watch television or videos, often on a regular (portable, as opposed to miniature) TV or video installed in the vehicle. By far the biggest number of complaints with regard to using the vehicle for activities other than driving centred on the cup holders. Seventeen percent want bigger, more adjustable holders, 5% want the cup holders repositioned away from the air conditioning controls and 5% want more, better cup holders in the rear of the vehicle.

Respondents were asked about how they refuel their vehicle and any problems this causes them. Eighty-two percent use a self service garage to get fuel and 28% go to an attendant service garage (some go to both). Refuelling does cause considerable problems, the most common being the manual rather than automatic gas (fuel) cap (14%) and the need to hand the attendant the key in order to open the gas (fuel) cap (10%). These factors cause a number of other problems for example some people had lost the gas cap either by leaving it behind at the station or the attendant forgetting to put the cap back on after refuelling. Other participants complained that they couldn't use their radio or electric windows whilst their vehicle was being refuelled. These problems become more important when, as in some US states, self service garages are illegal. Refuelling is a task carried out frequently, 57% of respondents refuel their vehicle every week and 25% several times a week.

Vehicle Maintenance

Details of how the vehicle is cleaned and problems this causes were asked. Fifty-six percent of people wash their vehicle in an automatic car wash, 43% wash it at home and 27% use a manual car wash at a garage. The main problems encountered are due to the height of the vehicle; people have trouble reaching the roof and centre of the bonnet, although the running boards which some people have installed on their vehicle help to reduce the problem, also the vehicle is too

tall to fit into some automatic car washes so cannot be cleaned in this way. Some respondents said they would like an automatic aerial because they sometimes forget to retract it before going through the automatic car wash. There were few problems reported with cleaning the inside of the vehicle, a task which is carried out most often every two months (34%) or once a month (32%), usually using a vacuum cleaner at a garage (54%).

Questions about how often and what type of maintenance and servicing were carried out at home were asked. The responses to these questions were disappointing because there was confusion between the terms maintenance and servicing among the respondents in this market. In America people often take their vehicle to be maintained at a local service garage and some respondents considered this to be conducting maintenance or servicing themselves, i.e. they took the vehicle to the garage themselves. A small number of participants did check the fluid levels in the engine, check tyres etc. themselves. However in future versions of the Toolset these questions could be reworded to make their meaning clearer and avoid any confusion.

Other Information

The final section of the questionnaire afforded participants the opportunity to discuss issues which had not been covered elsewhere in the questionnaire. Twenty-two percent of participants used this space to say that they love or like their vehicle. Other issues which arose in this section included mechanical problems, dealership issues and complaints about fit and finish or quality of the vehicle.

5.3.8 Discussion

For further discussion of the suitability of the questionnaire for inclusion as a Toolset tool see section 7.4.1.1.

5.4 Driving Diary

5.4.1 Aims of the Driving Diary

I. To collect in-depth qualitative information from a small number of participants.

II. To explore the temporal use of a vehicle over a period of a week.

III. To use photographs to collect pictorial data regarding the people, environment, vehicle and tasks being completed using the vehicle.

The driving diary was included in the Toolset in order to increase the range of information collected to meet the need that the Designers were provided with data on a wide range of topics. The diary provided in-depth information from a small number of people and helped to build a rich picture of customers and their lifestyle. The diary also provided information about the use of customers' vehicles over a week, which enabled a better understanding of the type and frequency of activities being carried out, and the problems encountered doing so. The photographs were included with the diary study to enable the data gatherers to meet the need of the Designers for information to be presented pictorially where possible. They also provided a rich source of information which would not have been possible to convey verbally.

5.4.2 Sampling

The participants in this study were, like those in the questionnaire described in section 5.3, drawn from the Land Rover North America database of Discovery owners. The same restrictions concerning length of ownership were applied (> 2 months and < 2 years), and those people who had been sent a questionnaire were also deleted from the sampling frame. From the resulting sampling frame 500 Discovery owners were randomly selected to receive an initial letter inviting them to take part in the diary study.

5.4.3 Respondents

It was decided for financial reasons to limit the number of participants in this study to fifty. Therefore the first 50 respondents to the initial letter were sent a diary pack. Of these 50 initial respondents who had agreed to take part in the study 20 returned completed diaries and photographs. One response was considered invalid because the diary and camera had been returned unused due to serious illness on the part of the respondent, and one diary had been filled in for the wrong model of Land Rover and was also discounted. Therefore the response rate was counted from 48 diaries and calculated to be 38%. This was a reasonable response rate considering that the diary required a considerable amount of commitment from participants. Nevertheless, the initial letter should have served to screen out most of the people who were unwilling to complete a diary, and therefore the 50 respondents who were sent diary packs should have been more committed to the study and completion of the diary.

The 18 diaries gave results for 30 drivers, 16 of whom were men and 14 women. The Discovery drivers fell into the 17-24 to 70+ age categories with a modal age group of 50-69 for men and 30-49 for women.

5.4.4 Diary format

The Driving Diary consisted of four sections: a short questionnaire, a daily diary section, an in-depth diary section and a list of photographs to be taken for the study. The diary was developed through discussions with potential users of the Toolset data, Market Researchers and ergonomics experts, from the literature and pilot testing (see section 5.4.6). The sections of the diary are discussed in more detail below.

The diary questionnaire

Questions were asked about the drivers of the vehicle, the vehicle and its features and general problems encountered using the vehicle. The results of this questionnaire were designed to provide background and context to the rest of the diary study.

The Daily Diary

The daily diary section asked participants to record details of journeys they made using their vehicle. Information about the distance travelled, duration and reason for each trip, together with details of the weather, other activities carried out in the vehicle and positive / negative issues associated with the journey, were requested. Participants were asked to fill in the daily diary section for six days, and a sample daily diary page was provided for guidance.

The In-depth Diary

The in-depth diary section recorded details of the journeys undertaken on a single day. Participants were asked to record in detail anything they had needed to do before a journey in order to make that journey, e.g. alter the seat or mirror position, get the vehicle out of the garage, what they had done during the journey, and anything they had done at the end of their journey, e.g. taken their shopping out of the vehicle. Additionally on the in-depth diary day participants were asked to take a series of photographs, using a disposable camera which was provided with the diary, before and during (whilst stationary) one of their journeys. The picture list included photographs showing details of the type of vehicle being driven, the people on the journey and the environment in which the journey was driven.

5.4.5 Diary materials

The diary survey pack included a covering letter, a copy of the diary booklet, a 24 exposure disposable camera with flash, and a pre-paid padded return envelope. The incentive, a Land Rover baseball cap or T-shirt, was obtained upon completion of a form on the back of the diary booklet.

5.4.6 Survey Procedure

Pilot study

The questionnaire was piloted twice, once in the UK without the inclusion of a camera, and once through the Australian NSC with the addition of a camera.

The pilot study in the UK was conducted through acquaintances and work colleagues. This initial pilot study was conducted to assess the suitability of the diary booklet and did not ask participants to take the photographs. Diaries were distributed in person, with a pre-paid reply envelope to enable participants to return the completed booklet. Twelve people agreed to take part in this survey, and 11 people returned completed diaries. The questionnaire was revised after this pilot study, to ensure that it was comprehensible and collected suitable data.

The second pilot study was conducted in Australia and used the revised diary booklet from the UK pilot, with the addition of the photograph list and a disposable camera. Letters were sent to the two Land Rover Owners Clubs in New South Wales asking for people to take part in the diary study (the clubs were described in more detail in section 5.3.6). Six people responded to the request and a diary pack was sent to each. Padded pre-paid reply envelopes to the Australian NSC were included, and the responses were gathered together in Australia then forwarded to the UK.

The questionnaire was revised again after the second pilot study. The final version is included in Appendix B and was described in section 5.4.4. Sections which were misinterpreted or misleading were clarified, and the revised questionnaire discussed with Ergonomists and Designers to ensure it still collected appropriate information.

Main study

The main survey was conducted through Land Rover North America. The pre-survey letters inviting people to take part in the survey, and the diary packs containing a cover letter and diary booklet, were prepared in the UK and shipped to America. Pre-paid US reply envelopes were added to the pre-survey letter and padded envelopes and disposable cameras added to the diary packs. The covering letter provided a free phone US contact number together with UK addresses, in case of questions or difficulties regarding the survey. The diaries and the cameras were returned to LRNA, where the participant names and addresses were noted

before the diaries and unprocessed cameras were shipped to the UK. LRNA co-ordinated the fulfilment of the respondent incentives.

A reminder postcard had been printed and sent to the US for use in the diary study. However, it was considered unnecessary, and not cost effective, to send out the reminder postcard as the return rate for the diary was satisfactory.

The data from the diary study was collated in three different ways. A coding booklet, based on that produced for the questionnaire study was developed to analyse the diary questionnaire. Limited time due to delays in the diary study necessitated the use of the diary data with little analysis. Booklets of the raw data showing the types of journey each participant undertook were produced giving an overview of each participant's vehicle usage. The photographs produced by participants using the diary cameras were sorted into appropriate categories which broadly corresponded to those of the questionnaire e.g. the type of vehicle and features, people who use the vehicle and weather encountered. The photographs were then stored in albums and a file box, with explanatory titles for each section. This pictorial database was then available to the Designers to be searched as required.

5.4.7 Results

Some of the key results obtained using this tool in the US Discovery market are reported. For a discussion of the suitability of the tool for inclusion in the Toolset see section 7.3.2.

Demographics

Fifty three percent of the drivers were male and 47% were female (number of drivers = 30). The median age group for males was 50-69 years (9 drivers) with a range from 17-24years to 70+ years, and 35-49 years for females (7 drivers) with a range from 25-34years to 50-69years.

Figure 5.11 shows the height distribution amongst the diary participants. Seven male drivers were in each the 1.71-1.80m (5'7"-5'10") and 1.81-1.90m (5'11"-6'2") categories. Male height categories ranged from 1.61-1.70m (5'3"-5'6") to 1.81-1.90m (5'11"-6'2"). The most common height categories of the women respondents were the 1.51-1.60 (5'0" - 5'2") and 1.61-1.70m (5'3"-5'6") groups (5 vehicle drivers in each). Female height categories ranged from 1.41-1.50m (4'8"-4'11") to 1.81-1.90m (5'11"-6'2").

The weight range of the respondents is shown in figure 5.12. The median weight category for males was 70.1-80.0kgs (155-176lbs) with 7 drivers, and male weight ranged from 60.1-70.0kgs (133-154lbs) to 100.1-110.0kgs (221-242lbs). Female drivers were most often in the weight categories 50.1-60.0kgs (111-132lbs) and 60.1-70.0kgs (133 - 154lbs) each with 4 drivers, and ranged from 40.1-50.0kgs (88-110lbs) to 90.1-100.0kgs (199-220lbs). Both male and female respondents most often reported being of medium build (14 male drivers and 7 female drivers).

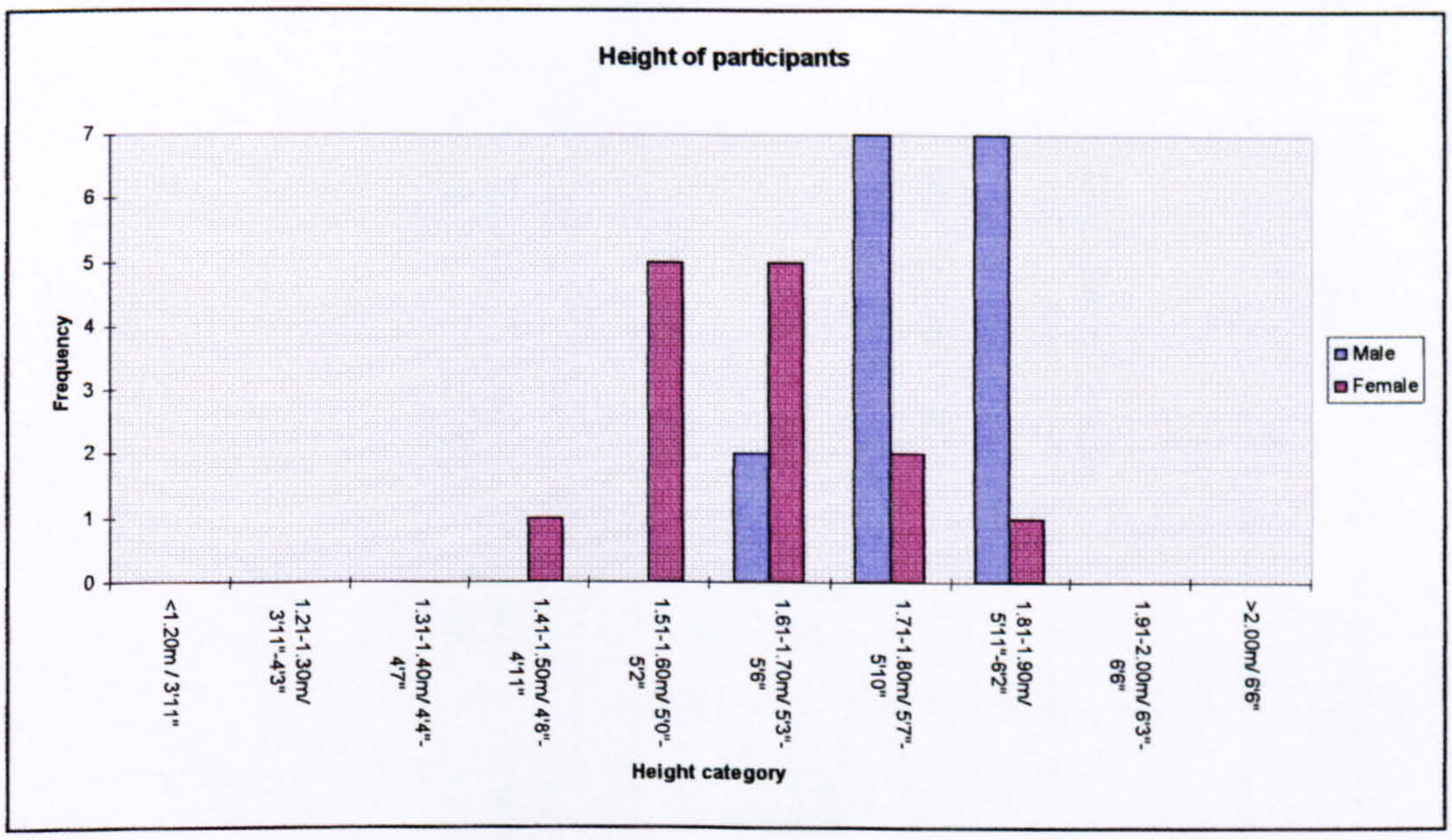


Figure 5.11. Height categories of male and female diary drivers

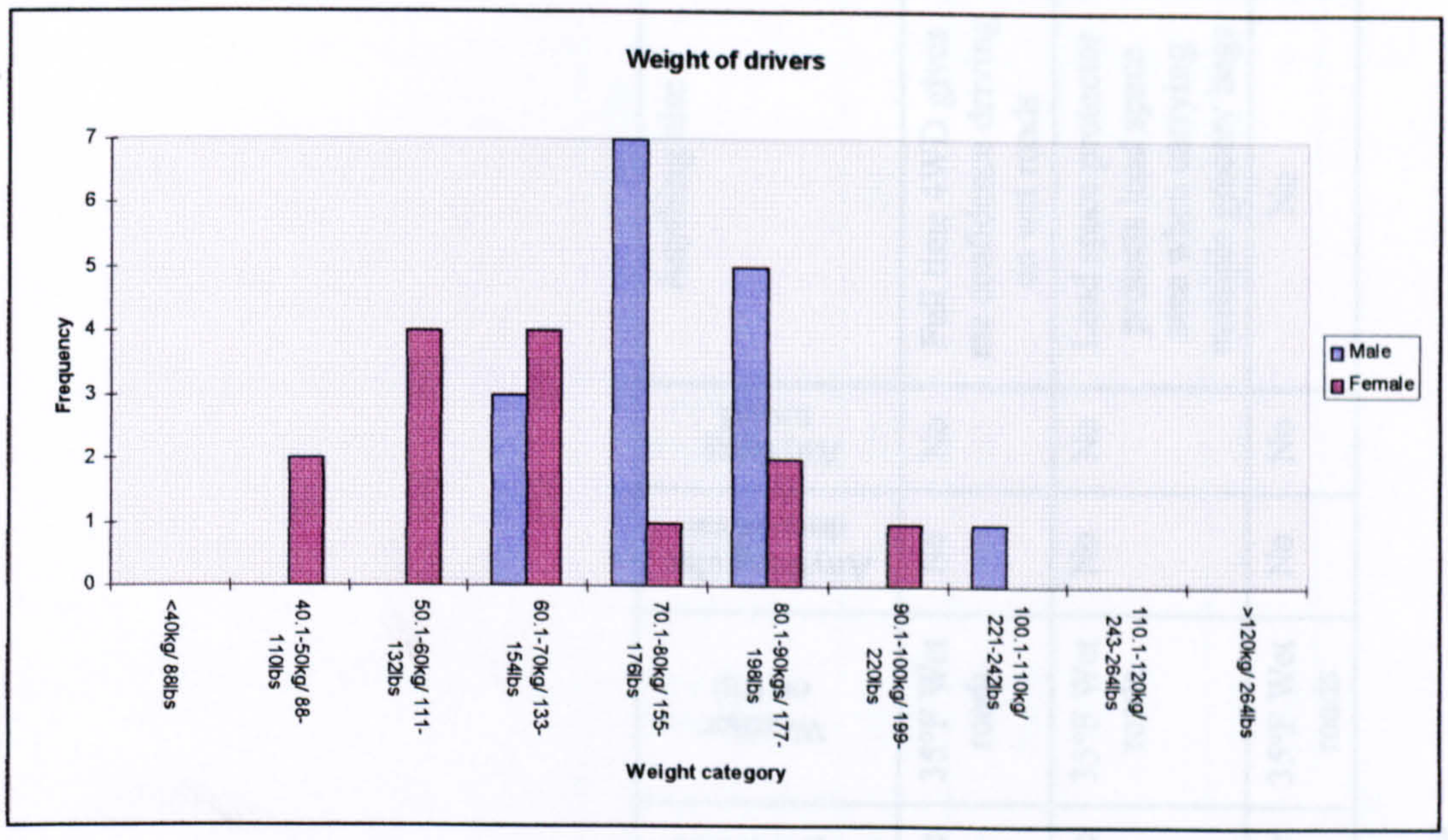


Figure 5.12. Weight categories of male and female drivers

All the diaries were completed in March which was winter for 10 respondents and spring for 7 respondents, 1 respondent did not complete this question.

Diary Number	US012

Daily Diary pages

Number	2				
Day	Number of trips made	No. of trips by driver1	No. of trips by driver2	No. of trips by driver3	No. of trips by driver4
Tuesday	3	3		-	-

Trip number	Driver number	Duration of trip (mins)	Distance of trip (miles)	Reason for trip	Roads travelled on			Passengers taken on trip	Any special requirements	Weather on trip	Anything else done in car	Anything towed	Anything else
1	1	15	6	Went to athletic club	City	High way		1 adult	None	35°F Wet roads	No	No	Full time 4WD gives me confidence driving on wet roads
2	1	20	3	Went to grocery store	City			1 adult	None	35°F Wet roads	No	No	Load space protector protects load space area when carrying multiple grocery bags
3	1	120	12	Ran multitude of errands	City			1 adult	None	35°F Wet roads	No	No	No

Figure 5.13 Examples of completed Driving Diary page

Diary Number	US002

Daily Diary pages

Number	2

Day	Number of trips made	No. of trips by driver1	No. of trips by driver2	No. of trips by driver3	No. of trips by driver4
Tuesday	4	4	0	-	-

Trip number	Driver number	Duration of trip (mins)	Distance of trip (miles)	Reason for trip	Roads travelled on			Passengers taken on trip	Any special requirements	Weather on trip	Anything else done in car	Anything towed	Anything else
1	1	999	16	To work	High way			0	None	62°F Cloudy	No	No	No
2	1	999	22	To work at sister hospital	City			0	None	75°F Sunny	No	No	No
3	1	999	3	To lunch	High way			4 adults	None	75°F Sunny	No	No	1 passenger said it was hard to get in back seat. She is 5'3" tall
4	1	999	20	Return home from work	High way			0	None	82°F Sunny	No	No	No

Figure 5.13 cont. Examples of completed Driving Diary page

Figure 5.13 shows two examples of completed daily diary pages to indicate the type of information gathered through the diary.

5.4.8 Discussion

For further discussion of the suitability of the driving diary for inclusion as a Toolset tool see section 7.4.1.2.

5.5 Ergonomics audit

5.5.1 Aims of the audit

I. To systematically identify critical ergonomics issues associated with the user interaction with vehicle features.
II. To gain an expert perspective on the ergonomics of a vehicle.
III. To explore issues which arise in data from other tools in the Toolset, in more depth.
IV. To provide information to back up data collected using the other tools in the Toolset.

The ergonomics audit was developed as a tool to provide an expert Ergonomics opinion of the vehicle features. It was included to ensure that all aspects of the vehicle had been considered, especially those which may not have been highlighted through the customer questionnaire and diary, and provide information on a wide range of issues. In addition it was designed to provide supporting information about problems reported by customers, i.e. it could be used to give a deeper understanding of issues raised by consumers.

5.5.2 The auditors

Two Ergonomists acted as the expert evaluators (auditors), one with over 20 years experience in the field and the other with 4 years.

5.5.3 Audit format

The ergonomics audit was designed as a static vehicle audit. It consisted of three main parts, general features, controls and displays, each of which is described in more depth below. A three point tick (positive) / neutral / cross (negative) rating scale was used throughout the audit for all the assessment criteria, and space was provided for explanatory comments regarding the ratings given.

Location	Are the features positioned where they could be comfortably used by all users, i.e. not too far/ near to the ground, or out of the natural reach of the user.
Accessibility	How easily accessible the features would be to all the user population from the smallest to the largest.
Suitability for purpose	Is the physical shape of the feature or space suitable for its intended use, e.g. foot room located where people would want to put their feet.
Ease of use	Is the feature or space easy to use without having to compromise posture etc.
Visibility	How easy is it to see the feature without having to move from the associated natural position.
Overall rating	This was a subjective opinion of the overall rating of the feature (not based on calculations of the ratings).

Table 5.1. Criteria used to assess vehicle features

General features

This section covered general features such as ingress and egress from the vehicle, visibility out of the vehicle and seat comfort. The assessment of the general vehicle features was carried out using the criteria shown in table 5.1.

Controls and displays

These two sections focused on the controls and displays of the vehicle whilst it was stationary. Both primary controls (those which operate the vehicle, e.g. brakes, steering) and secondary controls (those which do not directly control

the vehicle e.g. indicators, windscreen wipers) were considered, and the vehicle displays associated with the features and controls of the vehicle analysed. The criteria used to assess the controls and displays are presented in table 5.2. Some of the assessment criteria were used for controls only, some for displays only and some for both, these are indicated in the table.

Key: C = control, D = display

Location (C&D)	Are the controls within the reach envelope of the user, from their preferred seat position? The smallest user should be able to use the control without significant abdominal movement, which would make controlling the vehicle more difficult. Are important displays within the visual field of the user without the need for extensive movement of the head?
Visibility (C&D)	Are the controls and displays within view of the operator, where appropriate? The most important controls and displays should be located so that the driver need only use eye movement to see them.
Grouping (C&D)	Are the controls and displays be grouped together in a logical manner and location, where the user can easily find them? Controls should be grouped no more than 3 horizontally and 3 vertically, with no overlapping features. Controls and displays for a particular feature should be grouped together wherever possible.
Crowding (C&D)	Does the positioning of the controls and displays avoid crowding and confusing information presentation? Controls located by feel alone should be spaced to avoid interference from other controls.
Consistency (C&D)	How consistent are the controls and displays throughout the vehicle?
Clarity (C&D)	Is the display clear? The clarity depends on several factors which include: • Brightness • Glare and reflection • Symbols • Contrast • Resolution • Colour

Tactility (C)	What is the control like to use? Control tactility is affected by various attributes: • Shape • Size • Feel • Texture
Display-control relationship (D)	Is the type of display employed to show information about a control suitable for that purpose? The display should enable easy recognition and comprehension of the data it is showing. Use of an inappropriate type of display for a particular control can be dangerous and lead to unsafe driving.
Stereotypes (C&D)	Do the controls and displays conform to population stereotypes wherever possible? There are two types of stereotypes: • Natural, e.g. the right turn of a steering wheel turns the vehicle to the right • Expected or dominant, e.g. European people read from left to right whereas Japanese people read from top to bottom.
Fitness for purpose (C&D)	Is the physical shape of the feature or space suitable for its intended use, e.g. an analogue dial for fuel level?
Comprehensibility (C&D)	Is the control or display easy to understand?
Overall rating	This was a subjective opinion of the overall rating of the feature (not based on calculations of the ratings

Table 5.2. Assessment criteria for vehicle controls and displays

5.5.4 Audit form

An audit form was developed to allow assessment of the different parts of the vehicle using appropriate criteria (a copy of this form is included in Appendix B). In addition a disposable camera was used to take photographs to illustrate particular points and problems on the vehicle which arose during the audit process.

5.5.5 Audit procedure

The audit was carried out on a 1997 Discovery Tdi at a local UK Land Rover dealership. The procedure was conducted by the two expert appraisers on a

stationary vehicle and took two days to complete. The form was worked through systematically by each Ergonomist individually. The features were assessed using each criteria and when relevant there was discussion between the evaluators. Where it was considered that a feature or assessment decision needed clarification, photographs were taken to illustrate the point.

The data from the audit was felt to be useful without any analysis, however, because of the amount of data the process generated a summary of the audit was produced. This involved grouping similar features, controls and displays into categories and producing a summation of the results for each of the assessment criteria. The summary can be found in Appendix C.

5.5.6 Results

The key results obtained using this tool are reported in this section. For a discussion of the suitability of the tool for inclusion in the Toolset see section 7.3.3.

General features of the vehicle

Positive aspects of the vehicle included:

- Opening and closing of doors from outside and inside good, doors stay open when needed.
- Good amount and position of leg room for driver and front passenger.
- High roof which provided good headroom for people in the front and rear of the vehicle.
- Useful storage nets for use by rear seat passengers, on inside roof of vehicle.
- Rear seats have no central arm rest and there is no transmission tunnel on floor, so it is easy for passengers to slide along seats.

Negative aspects of the vehicle included:

- Vehicle ingress and egress poor, especially in the rear seats because of narrow space at foot level, seat impinging on door space and height of vehicle.
- Poor leg room for rear passengers due to wheel arch intrusion, cramped space when front seat pushed back and intrusion from CD player under front seat and seat electrics.
- Lack of elbow space on outboard side of vehicle.
- Poor head restraints, front restraints difficult to adjust and obstruct rearwards view, rear head restraints too low, non-adjustable and could cause hyper-extension in an accident.
- Design of boot area needs more thought; 3rd row seats difficult to operate correctly, seat belt clasp obstructs loading in boot of vehicle and luggage cover difficult to operate and store.

Vehicle controls

Positive aspects of vehicle primary controls included:

- Steering wheel nice to touch.
- Brake pedal is a good size and distance from the floor.

Negative aspects of vehicle primary controls included:

- Awkward, cramped access to ignition slot for key.
- Steering wheel thick and uncomfortable, and centre airbag is obstructive.
- Brake pedal position relative to the very small, narrow, accelerator pedal is poor.
- Hand brake and gear stick located a long way forward and can be obstructed by centre console if seat is too far back. Both feel hard and the wrong shape, and are awkward to use.

Positive aspects of vehicle secondary controls included:

- Electric sunroof controls easy to use.

Negative aspects of vehicle secondary controls included:

- Electric window switches are not laid out spatially as expected.
- Horn too big and easily leant on when exiting vehicle.
- Some of the switches round the dashboard are obscured by the steering wheel.
- Hazard warning switch not in an obvious or easy to reach position.
- Wing mirror adjustment switches confusing.
- Radio / cassette / CD player controls have too many functions on each.

Vehicle displays

Positive aspects of vehicle displays included:

- Dashboard displays. e.g. speedometer, mileage indicator, tachometer, clear and easy to read.
- Other dashboard indicators, e.g. temperature, fuel gauge clear and easy to understand.
- Vehicle lights well labelled, but fog lights labelling unclear.

Negative aspects of vehicle displays included:

- Windscreen wiper operation not clear.
- Indicator direction lights obscured by steering wheel whilst driving.
- Heater / air-conditioning control labels obscured from driver's seat.
- Front and rear electric window switches not labelled.
- In-vehicle entertainment poorly labelled.

5.5.7 Discussion

For further discussion of the suitability of the ergonomics audit for inclusion as a Toolset tool see section 7.4.1.3

5.6 Focus Group

5.6.1 Aims of the focus group

I. To provide in-depth information on issues which arise from the findings from the other tools in the Toolset.

II. To provide customer verbatims (quotes) relating to the topics discussed.

The focus group was included to meet the data gatherers' requirement for qualitative information from customers. Because the group can be tailored to meet the concerns of customers in individual markets it is a very flexible tool which provides a rich source of information on specified topics. The customer verbatims produced through these groups meet the Ergonomists' requirement that the results of the Toolset are easy to communicate to the design team, and customer language ensures the data is both easy to understand by the data users and consumer relevant.

5.6.2 Sampling

Due to financial constraints the focus group was conducted in the UK, and therefore focused on UK Discovery owners. Participants were recruited through a local Land Rover dealership and as in the other surveys they all drove Discoverys over 2 months and under 2 years old. Twenty owners were contacted by letter asking if they would like to take part in the group.

5.6.3 Respondents

The focus group was limited to eight participants in order to ensure that everyone was able to voice their opinions easily. The first 8 drivers who replied to the letter were asked to attend the discussion group, however one person who had agreed to take part did not attend the session. Therefore the focus group was conducted with seven participants.

5.6.4 Focus group schedule

A focus group schedule was devised (see Appendix B) guided by the results from the other tools in the Toolset. Important points and issues were discussed in more depth, and the schedule aimed to cover as many of the topics as possible, taking account of the need to be flexible when conducting the focus group. The following topics include some which had been identified from the information provided by the other tools as meriting further discussion.

- Participant introduction, background and reason for purchasing vehicle.
- Positive things about the vehicle / things to keep.
- Negative things about the vehicle / things to change.
- The driving position.
- Ingress / egress.
- Vehicle comfort.
- Switch / dashboard layout.
- Third row / jump seats.
- Carrying items in or on the vehicle.
- Parking the vehicle.

5.6.5. Focus group materials

The focus group schedule was provided for the facilitator and Rover observers. A video camera was set up to film the session, and an audio cassette recorder used to record the discussion. The participants were provided with light refreshments before and after the session, and each participant was given a bottle of wine and a £10 gift voucher for taking part.

5.6.6. Focus group procedure

The focus group was conducted in the showroom of the Land Rover dealership on a week day evening. An area away from the vehicles was used, and chairs were arranged around a desk ensuring that all participants could see the facilitator and could be seen on the video footage. The camera and tape recorder

were set up prior to the participants arrival to minimise intrusion on the proceedings. Three observers sat at another desk to watch the group, who were told that the observers' role was not to participate in the group at this stage. Participants were offered refreshments on their arrival before the beginning of the discussion to afford them the opportunity to introduce themselves to each other informally. The discussion lasted for approximately 1 ½ hours, after which the two observers from Rover, who were Ergonomists, joined the group for a general discussion about Land Rover products etc. The incentives and refreshments were also provided at this stage.

The data from the discussion group was transcribed from the video footage, and the verbatims organised under the headings from the focus group schedule.

5.6.7 Results

This section provides examples from some of the edited focus group transcript, for a full version of the edited transcript see Appendix C.

Why participants bought their Discovery

"Space inside is the big difference"

"It's a working vehicle"

"It looks classy as well, compared to a Shogun etc.. Some of the Japanese ones are very bulbous and dripping in chrome and don't look the part"

"Most of them aren't capable of doing what we're doing"

"I think you drive this very different vehicle.... in a very different way and I think you do relax, you do feel, you know, a bit superior really"

The command driving position

"You can't see traffic lights, if you're first in the queue you cannot see traffic lights"

"I like the driving position, I like being up high....people don't cut you up"

Ingress and egress from the front of vehicle

"I think you have to learn. You have to say left foot up, give yourself enough space in order to get your right foot in. But she [elderly arthritic mother] contends with it quite well"

"Yes I've got a running board, and clearly that does help"

"There's quite a few grab handles you can pull yourself in"

Facia and dashboard

"The keys do rattle on the steering column shroud"

"And on the facia itself, you can see where they mark it"

Back seat design

"I'd love to know the shape of the model of the person they designed the back seat for....it's a person no more than one metre high, with the head rest"

"It hasn't been designed it's just a lump in the seat, totally impractical, totally useless"

Armrest

"If you drive....and you put your arm on the door [the door pull handle], because there's nowhere else to put your elbow, there's like this razor sharp edge which goes right into the joint of your elbow"

Electric window switches

"One little irritating point, sometimes I get confused at, and other people get confused at, and that's electric windows" [General agreement from the rest of the group]

Window switches on back doors

"It's a bit disconcerting if you put your briefcase behind the driver's seat and you go round a corner and the briefcase slides.....it's the right height to press the

button on the rear window....you're going round the corner and the rear window is going wide open"

Ingress and egress from the back of the vehicle

"There's a problem getting out, because you're jumping out you can catch your foot on the door pillar"

"Or your back on the wheel arch"

"Rear wheel arch, big problem, even if you want to stand on the back to get up on the top either to wash it or get something off the roof, you've [either] got to put one foot in the car and the other on the wheel"

Comfort on long journeys

Front seats

"It's good if you're driving....but I wouldn't want to be on a long journey in the back"

Front seat head restraints

"It's not a solid plastic [front headrest] but it's not a comfortable plastic"

"It tends to push your head forward"

"Sometimes it just irritates me, because I can just feel it brushing the back of my head"

Lumbar support

"I don't know where mine [lumbar support] is!"

"It feels about the right place....we've got one or two small petite ladies who've commented on it, they're not heavy enough to get back into the seat"

Rear seats

"You have to arrange your luggage to make a head rest because there's not one in the vehicle....so you can lean back without your head falling into the back compartment"

Using the jump seats in the rear of the vehicle

"Very clever little design that [jump seats]....it takes you, oh, a couple of minutes"

"You can pull them down without the leg out. I've seen that done and it cracks the plastic"

Getting in and out of the jump seats

"You couldn't get any elderly people in, but then they're an extra little seat when required"

Features which participants felt should be kept

Space in the vehicle

"The one thing they mustn't get rid of is this space"

"If the space goes from a Discovery then it's gone [reason for buying vehicle]"

"Everybody likes getting into it, without exception...."Isn't this spacious"...."Can't you see out of it well""

Command driving position

"The position of being up high...I wouldn't want it to be altered"

Other things

"Keep the nets in the back for sweeties and maps"

"I think it's brilliant, what it'll do off road in tick over is unreal"

Loading, unloading and carrying items

"All they've got to do is stick another foot on it, make it a bit longer"

"The floor plan is not great, the volume is"

"It doesn't seem to be very well designed for carrying things....I'm also concerned if I want to fill it up I'm always feeling....what's going to happen if this starts coming forward [luggage]"

"To really use the capacity I'd have to have a dog guard....if you could have some innovation where you could actually give me something that I could, for example, hinge and drop down, and then I could really load it up in safety"

"There's no anchorage points....where can I tie this to?"

"It's difficult to tie stuff on to the roof rack on the very back bar because it's so close to the roof"

The vehicle sunroofs

"It's quite good the way they've done it because it doesn't impinge on the car headroom....but they do rattle"

Features which participants felt should be changed

"The rear seat need something doing, I don't think it corresponds with the front from a comfort point of view"

"Does anyone have any problems with that silly little can container....I like the idea, but if you've got a can in it, for one, when your can's empty it does nothing but rattle, surely you could get some plastic fingers or something to stop it"

"...or make it [cup holder] deeper"

"...and also you can rap your fingers on it when you're changing gear"

Parking the vehicle in car parks

"It's frightening sometimes, the ones you do go into, it is very close to the roof"

"Then again we've all said how we like the height"

5.6.8 Discussion

For further discussion of the suitability of the focus group for inclusion as a Toolset tool see section 7.4.1.4.

5.7 Background information

5.7.1 Aims of the background information tool

I. To provide contextual information for the results from the other tools in the Toolset, i.e. to show why particular results may have been observed

II. To provide additional non-ergonomics information about a market which may affect results from the other tools, e.g. the weather in a market may make a potential solution to a problem not feasible.

The background information tool was included in the Toolset to meet the Ergonomists' requirement for a wide range of information about customers to be collected. Including a background information tools helps to set the other data collected through the Toolset in context for each specific market. Factors such as climate or legislation which may interact with customers' lifestyles or vehicle usage can be gathered using this tool.

5.7.2 Background information format

The background information tool was developed to add contextual data to that already collected using the other tools in the Toolset. The data is not specifically ergonomics information but provides background about the market composition, environment etc. A list of headings under which useful data for the Toolset may be collected was devised, and is included in Appendix B. The tool was designed to link in with existing Rover information as much as possible. A recently initiated project within the Product Validation Department of the company aims to collect similar information to that suggested in this tool. This project was linked in with the Lifestyle Scenario Toolset and it provided the background data in this instance. However, since the project is new the amount of data collected is small but as the project continues it is expected that more information will be added to the database. The data from the Rover project was supplied as figures in a database spreadsheet and appropriate values were drawn out for use in the Lifestyle Scenario Toolset.

5.7.3 Results

This section presents results extracted from the database of information generated by the company, which were considered to be appropriate for use in the Lifestyle Scenario Toolset, see figure 5.14.

5.7.4 Discussion

For further discussion of the suitability of including data from the company database as part of the Toolset see section 7.4.1.5.

USA Data

Sales Volumes

VEHICLE DENSITY		SALES	
Vehicles per thousand population 1997	Projected vehicles per thousand population 2000	Land rover 1997	Discovery 1997
462	443	24940	15480

Market conditions

ROAD TYPES	ROAD CONDITIONS	OVERTAKE	ROAD FEATURES	DRIVING CONDITIONS	DRIVING STYLES
Divided highways	Some well maintained	Both left and right	Expansion joints	Load balance risk (idle + a/c for long periods)	Generally well disciplined
Primary roads	Some poorly maintained		Speed bumps	Off roads	Heavy police presence
Secondary roads	Salt / grit used on roads		Road flooding risk	Sand driving	
City			High ramp angles	Towing popular	
Unsealed (dirt/dust) roads			High altitude roads		

Fuels

PETROL	DIESEL	ALL GASOLINE
Leaded unavailable	Spec. 45 index	All gasoline is available as Conventional, Oxygenated and Reformulated
Leaded, 89-95, 92-96, 94-100	Sulphur content 0.05%	

Climate

RAINFALL	TEMPERATURE °C	ALTITUDE
Typical example: Miami	Lowest: Fairbanks, Jan -54 °C	Capital city (Washington D.C.): 22m above sea level
	Highest: Death Valley, July 57 °C	Some areas over 2300m above sea level
	Average: Cold Feb -32°C, Hot July 47°C	
	Capital city (Washington D.C.): min -3°C, max. 31°C	

Figure 5.14. Background data used in Lifestyle Scenario Toolset.

5.8 Toolset handbook

5.8.1 Aims of the Toolset handbook

I. To provide guidance for people using the tools of the Toolset to collect data from overseas markets.

II. To provide background and additional information on the use of the Toolset tools.

The Toolset handbook has been included in the Lifestyle Scenario Toolset to meet the expressed needs that the Toolset be usable by people with little or no experience of ergonomics or market research, and that the Toolset be suitable for use in overseas markets without the need for extensive intervention from the UK. The handbook helps to guide those with limited experience of customer requirements research by guiding them through the tools included in the Lifestyle Scenario Toolset and the stages needed to implement the Toolset. It gives examples, where possible, of the structure of each tool and the type of information it picks up. Additionally the handbook provides a best practice guide and ensures a standardised procedure in each country using the Lifestyle Scenario Toolset.

5.8.2 Handbook format

The Toolset handbook was produced to provide guidance on the use of the tools in the Toolset. It was developed as a paper based set of guidelines which can be given to overseas staff along with the Toolset data collection tools. The handbook was developed primarily for people with little or no experience of conducting customer research. The book was developed in parallel with the data collection process and describes the issues which were considered important during the use of the tools.

A general introduction providing background to the project and explaining how the tools in the Toolset fit together was included. The remainder of the book was organised into 7 sections, each covering the use of one of the tools in the Toolset, that is the Questionnaire, Driving Diary, Ergonomics Audit, Focus

Group, Video Footage and Background Information. Each of the chapters described a different tool, the information which could collected using the tool, details about how to conduct a study using the tool and where appropriate, examples of information collected using the tool. A separate chapter covering the use of video footage to capture customers using their vehicle was included. It had been intended to use video footage as part of the Toolset developed in this research, but due to time, cost and logistical difficulties it was not possible to include the use of video footage at this stage. Nevertheless, future versions of the Lifestyle Scenario Toolset may incorporate video footage taken by company personnel in overseas markets. Therefore a list of the type of footage which would be suitable for inclusion in the Lifestyle Scenario Toolset was provided in the handbook.

The handbook can be used as and when needed. In some markets most or all of the data collection may be handed over to market research agencies who will be experienced in conducting this type of research, however in other markets the data will be collected by the company personnel themselves. A full version of the Toolset Handbook is included in Appendix B.

5.9 Conclusions

The purpose of the data collection activity discussed in this chapter was to:

1. Collect data in order to validate the usability of the tools for the people who would be using them in the company.
2. Provide suitable data for communication, through part 2 of the Toolset, to the design team who would use it in their work.
3. Assess the quality and quantity of information collected using the tools and establish the appropriate analysis techniques for the data.

Although example data has been presented in this chapter the purpose was to indicate the nature of the information rather than to draw and report on the conclusions from it. A full discussion of the suitability of each of the tools for

inclusion in the Lifestyle Scenario Toolset, and the suitability of the Toolset as a whole is included in Chapter 7.

Chapter 6

Lifestyle Scenario Toolset Part 2: Integration and Communication of the Information - Study 3

6.1 Chapter Summary

This chapter addresses the integration and communication of information gathered using the tools from Part 1 of the Lifestyle Scenario Toolset, described in Chapter 5. The methods used to communicate this information to the design team who will use the it in their work, form part 2 of the Toolset. The first part of the chapter covers the integration of information from the individual tools to create a rich picture of customers' needs in the context of their lifestyle. The second part of the chapter discusses the presentation of data from the individual tools included in part 1 of the Toolset.

6.2 Introduction

Chapter 5 described the development of each of the tools included in the Lifestyle Scenario Toolset and presented examples of the results obtained using the tools. The research described in this chapter focused on the development of a set of tools for communicating the data collected with the Toolset to the data users and specifically the design teams. Figure 6.1 shows how the research presented in this chapter fits into the overall thesis structure.

The tools described in Chapter 5 produced data in a variety of formats, e.g. descriptive, quantitative, scalar, numeric, pictorial. However, much of the data was technical and used language, which although familiar to Ergonomists, was not necessarily understood by other members of the design team. As highlighted in section 2.8 of the literature review, it is vital to communicate

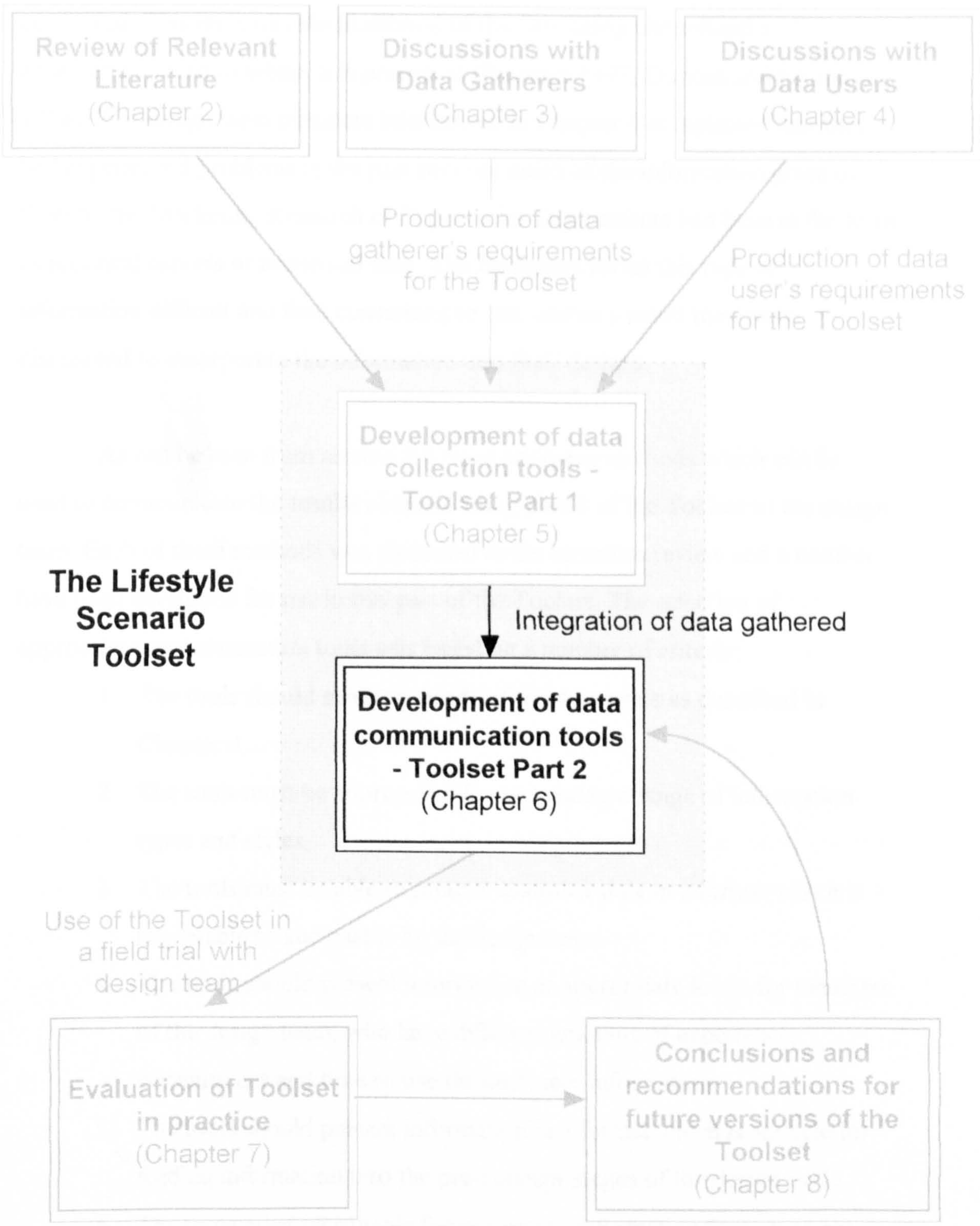


Figure 6.1 Context of research presented in Chapter 6

information between disciplines in a manner and language which is familiar to all concerned. This increases the likelihood of the data being understood and accepted by those to whom it is presented (Frascara 1997, Duncan and Moriarty 1998). The design team members interviewed in Chapter 4 complained that they had experienced problems in the past because much of the information given to them by the Marketing Research or Ergonomics Departments had been in the form of technical reports or numerical data. The Designers found this type of information difficult and time consuming to use, and as a result they were disinclined to incorporate the information into their designs.

As can be seen from section 2.8 there are many methods which can be used to communicate the results obtained using part 1 of the Toolset to the design team. Each of these methods was discussed in the literature review and a number have been developed for use in this part of the Toolset. The selection of appropriate communication tools was based on a number of criteria:

1. The tools should meet the needs of the data users as described in Chapter 4.
2. The tools must be appropriate for presenting a range of information types and styles.
3. The tools must be able to present customer data in a format which is acceptable to and usable by the design team.
4. The tools should present information at appropriate levels for members of the design team, who have different amounts of experience, commitment and time to use the customer information.
5. The tools should present information in a format which is suitable for feeding information into the pre-concept stages of the design cycle.
6. The tools must be suitable for presenting information from overseas customers.

As with part 1 of the Toolset, part 2 utilises triangulation, through the use of different communication methods which present data in a range of formats. This helps to increase the depth of the data presented and also enables cross-checking of the information to ensure greater validity of the findings. In addition, part 2 of

the Toolset aimed to communicate the information collected through part 1 at a number of different levels, e.g. raw data, high level summaries, key overall results. Presenting data at a number of levels enables the range of people who will use the data to access information at a level which is appropriate to, for example, their background, specific needs, time available or level of expertise. Thus a range of data communication methods were included in this part of the Toolset; these were raw data e.g. verbatims, high level summaries, storyboards, and an initial presentation. Figure 6.2 shows how the customer data collected was structured to provide different methods and levels of communication.

It was important to ensure that the customers' ergonomics requirements collected using part 1 of the Toolset were communicated to the design team who would use the data in a way that would maintain a user focus in the design process, i.e. to make sure the process was user-centred. However, as discussed in chapter 2, the research in this thesis aims to present user requirements to the design teams holistically, rather than as a series of requirements statements. Thus the information was approached systematically and from the perspective of the customer, the equipment they are using, the environment they are in and the tasks they carry out (or want to carry out), together with the interactions between these factors. This approach helps to focus on the fact that the customer is a person with needs and desires, living a particular lifestyle, with which the designers need to empathise.

6.2.1 Aims of the study

1. To develop a method of integrating the data produced by each of the tools in part 1 of the Toolset.
2. To develop a set of tools for presenting the data to the design team using each of the Toolset tools.
3. To develop appropriate tools for communicating the Toolset data to the data users.

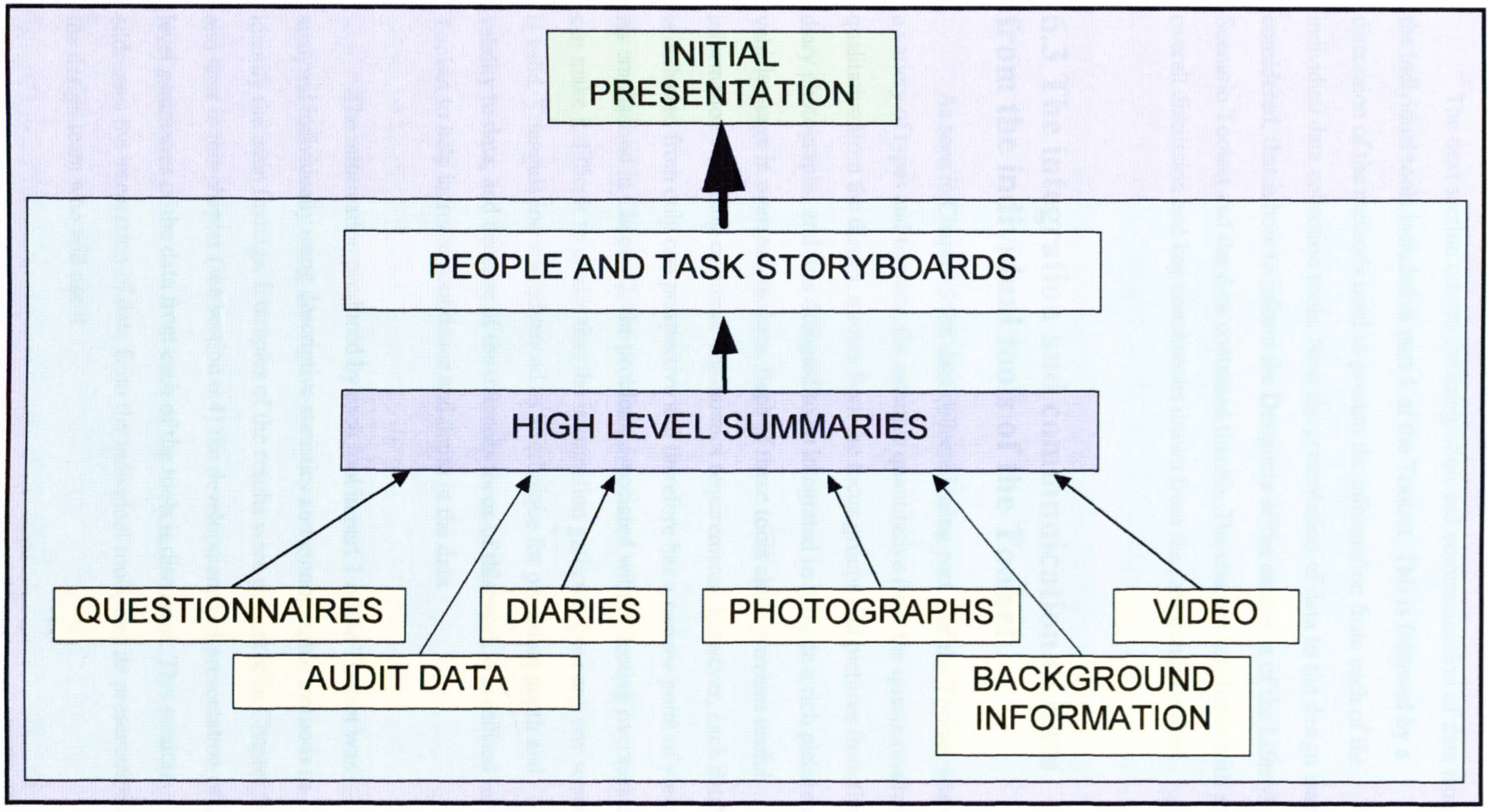


Figure 6.2. Structure of the Lifestyle Scenario Toolset Part 2

The next section covers the integration and communication of data from the individual tools included in part 1 of the Toolset. This is followed by a discussion of the methods used to present the information from each of the individual data collection tools. Next the presentation of data to the design team is considered, that is how to inform the Designers of the existence of the Lifestyle Scenario Toolset and the data contained therein. The chapter concludes with an overall discussion and key conclusions drawn from the research presented.

6.3 The integration and communication of data from the individual tools of the Toolset

As seen in Chapter 5 the data collected using part 1 of the Toolset was of a variety of types and formats, for example quantitative from the questionnaires, qualitative from the diaries, quotes from the focus groups and pictures from the diary photographs, and was designed to be integrated to provide a rich picture of vehicle usage in overseas markets. Each of these tools alone provides useful information regarding customer ergonomics requirements. However, each data set is collected from only one perspective and therefore has a narrow point of view. As emphasised in Chapter 2, the problems associated with collecting overseas data can make it difficult to ensure that the information gathered from any one source is valid. Triangulation was advanced as a technique for providing depth and validity to data, and because of the overseas focus of this work was utilised in the Toolset to help increase confidence and depth in the data.

The information produced by each tool in part 1 of the Toolset was analysed individually using descriptive statistics and ethnographic methods to identify the main findings. Examples of the results were presented in Chapter 5 and later in this chapter (see section 6.4) the development and presentation of high level summaries of the data from each of the tools is discussed. This section addresses the integration of data from the individual tools, and its presentation to the design team who will use it.

The literature review identified a number of key characteristics of Designers and design teams in general:

- They are visually oriented people.
- They work under increasingly tight time schedules.
- They do not have the time or motivation to search for ergonomics information in journals, books, etc.
- They may be mistrustful of information presented to them if they cannot see how the conclusions presented were reached.
- They tend to believe information that confirms their own beliefs, and reject that which opposes their opinions.

These issues were found to be true of the Designers and design teams from the company involved in this research, and were confirmed in the discussions with them, presented in Chapter 4. Thus it was important to establish a way of communicating information to the design team that would fit in with their way of working, and overcome any constraints on their use of the data, e.g. through misunderstandings or mistrust.

The integration of the data from the individual tools was achieved through using a task-based systems approach. The systems approach uses the person, the tasks they carry out, the equipment they use, i.e. the vehicle, and the environment in which they live, as a basis for structuring the data collected. By imposing such a structure on the data the profile of the user at the centre of the design process is enhanced. In addition, when integrating the data at a detailed level, a task-based approach was taken. Barnard (1986) in the discussion of data collection using the diary technique advocates the use of activity based diaries to focus the consumer on their activities, rather than the actual actions they perform, in order to provide context for recall of their actions. Thus in the same way, focusing on the tasks people are trying to carry out and presenting the problems etc. they experience doing this, rather than focusing on the problems themselves puts the data in context. This helps the design teams to understand how and why consumer requirements arise in their everyday usage of the vehicle.

The communication of the key findings from all the data combined was achieved through the use of scenarios presented on storyboards, and also via an initial verbal presentation to the design team (see section 6.5 for a description of the presentation given). The pros and cons of using scenarios and storyboards to communicate information were discussed in Chapter 2, and a range of uses of boards and scenarios were described. The storyboards used in this research were hierarchical, in that some were used to present an overview of the customers who used the product, their general and dislikes, and others were used to present task based scenarios of the activities people carried out, and the problems they experienced.

The decision to use scenarios to present the data to the design teams was taken for the reasons presented earlier in this section. Scenarios provide strong mental imagery and stories which are memorable, and are therefore a good way of presenting information to visually orientated people. In addition, the data was presented in language which was easily understood by people from all disciplines. The information was clear enough to be transparent, i.e. it was obvious how the data had been analysed to reach the results presented. However, as identified, Designers and design teams do not have the time or motivation to wade through a lot of information. Therefore, the presentation of long scenarios, however memorable, would not be acceptable to the design team, especially as the scenarios were intended to be their first point of contact with the Toolset data. Thus the scenarios themselves were restricted to short bullet pointed descriptions.

Key findings from the individual data collection tools were used to establish general themes and issues which were common to more than one set of results and thus more than one sub-group of Discovery owners, for example the questionnaire, focus group and audit all indicated that refuelling the vehicle was problematic. From the combined data a number of usage scenarios were developed of the tasks carried out, problems encountered and positive aspects associated with using the vehicle to carry out tasks. The tasks identified for inclusion in the Toolset were selected to represent a range of common tasks carried out by customers, which caused them difficulties, for example cleaning the

vehicle, getting in and out of the vehicle. The scenarios based around these tasks were developed to show typical information, the range of behaviours and any extreme behaviour considered to be of importance to the design of the vehicle. Numerical data was taken from the quantitative questionnaire data and integrated with more qualitative information from the diary, audit and focus group tools. These descriptions were supplemented with pictures and direct quotes from the customer, background data and graphs of the key results.

The overall combined data, in the form of scenarios was then presented on a series of storyboards. These were initially developed using Microsoft PowerPoint to design the layout and content. The pictures and graphics were then enlarged to use on foam core boards approximately 1.5m x 1m, for use by the Designers in the company's Design Studio. The decision to use storyboards was taken because the design team already used traditional theme boards showing images taken from magazines, catalogues, sketches and photographs, to display ideas and concepts around the Design Studio. They were therefore familiar with the concept of information displayed in this way. However, there were a number of important differences between the theme boards already in use and the storyboards developed for inclusion in the Lifestyle Scenario Toolset. The theme boards used by the company were developed by the Designers and based on issues they considered to be important, rather than real data. Therefore the theme boards are not representative of the user population they portray because they do not show a wide variety or range of information. They provide a snap shot of ideas and themes for the development of future products, but do not give a picture of the breadth and diversity of real consumers' lifestyles and requirements for a product. Further, because they almost exclusively use images to convey ideas, without any facts or details about the meanings of the images, the theme boards can only provide vague general indications about the lifestyle and requirements of their customers. Thus the storyboards developed in this research aimed to address the above issues by using data from real customers as the basis for the storyboards. A broad range and depth of customer information was included to create a rich picture of the customer, their requirements for the product and their lifestyle. The combined use of text and pictures ensured that the storyboards were

still essentially visual in nature, but also able to communicate additional detailed information about the customers of the product.

As stated previously two types of storyboard were developed; people based storyboards, which provided information about the consumers who participated in the study, their likes and dislikes about the vehicle, and task based storyboards which showed scenarios of activities undertaken by the consumer and the positive and negative issues associated with the use of the vehicle. When developing the storyboards consideration was given to the user, the tasks they were carrying out, the equipment and the environment they were in. Thus in effect a checklist of questions was always used to structure the boards; 'WHO is carrying out the task?', 'WHAT equipment are they using?', 'WHERE are they conducting the tasks?' and 'WHY, or what, are they doing?'. These were used as the basis for building up the core information on the storyboards.

Numerical information presented on the storyboards was obtained through descriptive statistics. The use of actual percentage figures was considered, by the Ergonomists in the company, to make the boards too confusing and possibly cause the design team to draw their own conclusions about the importance of the data, based on their own experiences and prejudices. Therefore the figures were rounded up to the nearest fraction, or omitted from the boards to keep them clear and simple. Other numerical data was presented on the storyboards visually in the form of pie charts and histograms. The type of charts displayed on the storyboards were selected according to the information being presented; data with a large number of categories was presented as histograms, and that with smaller numbers of categories displayed as pie charts.

Linking the data presented on the boards to the corresponding data collection tool from which it was taken was also considered during the development of the boards. This would enable the design team to easily identify the source of information presented on the storyboards. Two methods were considered; either including the information in the scenarios developed, or physically linking the information on the boards to the results of the data

collection tool(s) from which it came. However, both these options made the boards cluttered and difficult to read and were therefore ruled out for use in this Toolset. The scenarios and boards developed are discussed in more detail in the following sections.

6.3.1 Development of people based storyboards

Three people based boards were developed for inclusion in part 2 of the Toolset. One storyboard presented demographic information about Discovery users in the US market, another storyboard showed the aspects of the Discovery liked by the US customers and the third showed the aspects of the Discovery particularly disliked by US customers. The development of each of these boards is discussed individually below. The data on the people based boards was chosen to communicate the most common findings from the research. In addition the extreme values uncovered by the Toolset were identified, i.e. the range of data collected, and presented on the boards.

The demographic storyboard

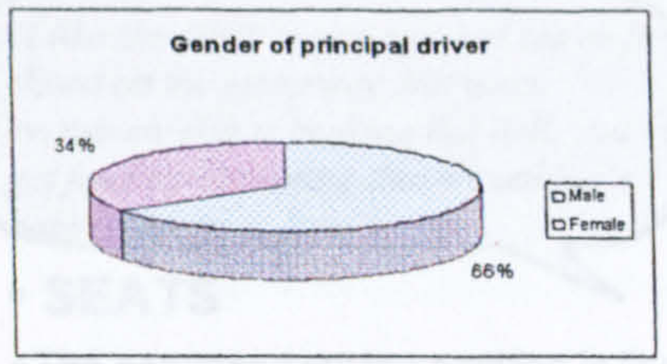
The demographic storyboard provided general data about the customer base in the US. Figure 6.3 shows the layout of this storyboard. Most of this data was taken from the US questionnaire. The information on the storyboard shows the types of people who drive a Discovery in the US market. Details about their age, gender, height, weight, build, household composition and vehicle ownership were presented, including the range of these attributes found in the data.

Graphs of some of the attributes were included on the storyboard to show graphically the range of users, both male and female, of the vehicle. Photographs of US customers were included to show some of the people who drive the vehicle in the U.S. market. The photographs were taken from those collected in the diary study, and were chosen because they showed clearly the customer, the vehicle they used and the environment in which they lived.

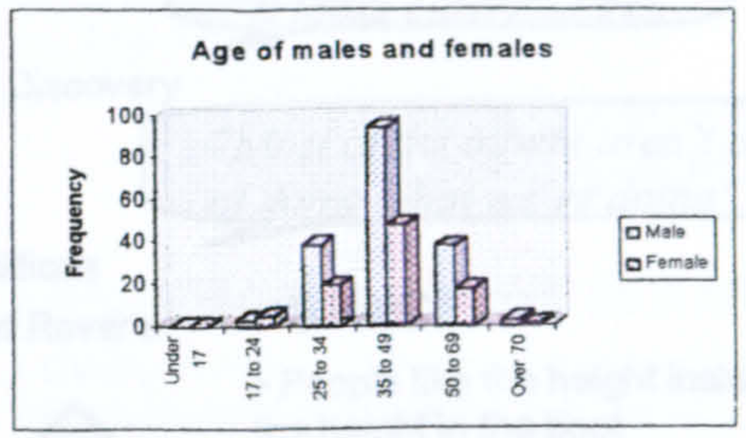
The likes and dislikes boards

These two boards were used to communicate customers' likes and dislikes about the vehicle, see figures 6.4 and 6.5. They were included to give an overview of some of the positive and negative features of the vehicle, which may not have been included in any of the task based boards. The information on these boards was taken from the questionnaire, diaries, ergonomics audit and focus group. Data from the questionnaire was used as a basis for the storyboard and was expanded and enhanced by data from the other data collection tools. Those issues which were cited most frequently were drawn from the data, together with other information which was considered important or unusual, e.g. safety issues such as poor luggage storage facilities in the rear of the vehicle. The data were then grouped into larger, more general categories and given a title, for example storage, seats, and cup holders. Relevant quotes were added from the focus group transcript to emphasise the findings of the questionnaire, diary data and audit, using customer language, and pictures of the vehicle were added to the boards so the Designers could see some of the problems.

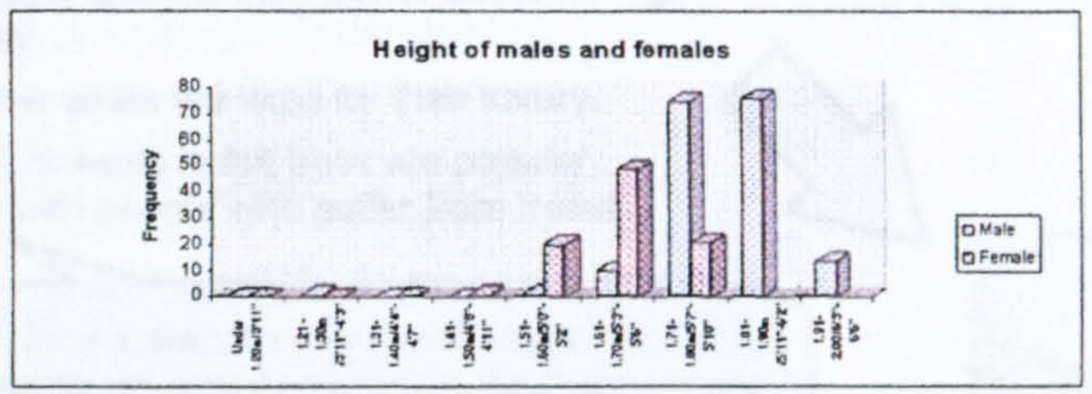
People



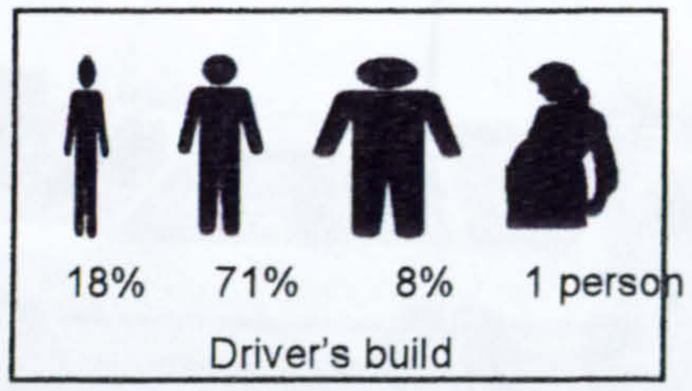
- Two thirds of Discovery drivers in this group are male.
- One third are female.

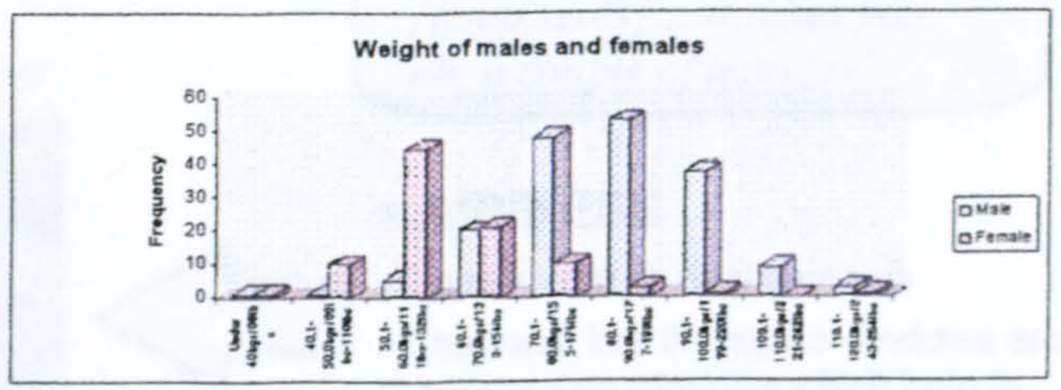


- Half of the drivers are in the 35-49 years age group.
- But drivers range in age from 17 years to over 70 years.

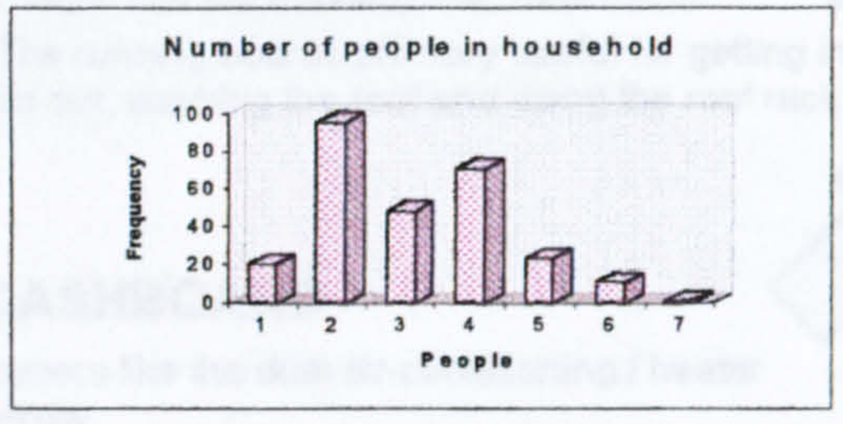


- Almost half the male drivers are in the 5'11" - 6'2" (1.81-1.90m) height category.
- Over half the female drivers are in the 5'3" - 5'6" (1.61-1.70) group (53%).
- The shortest drivers are under 4ft and the tallest over 6ft.





- Almost a third of the men weigh between 177 -198lb (80.1-90.0).
- Half of the women are in the 111 - 132lb (50.1-60.0kg) group
- There are Discovery drivers who weigh under 88lbs (40kg) and between 243-264lbs (110.1-120.0kg).



- Four fifths of the drivers are married
- Just under half have no children; just over half have one or more children.
- Households usually have 2 or 4 people in them
- A third of families have 2 children, who are most often aged between 5 and 8 years

- For a fifth of the people the Discovery is their only vehicle
- Four fifths of Discovery owners have access to at least one other vehicle
- This vehicle is most often a one year old Mercedes or Lincoln sedan

Figure 6.3. Demographic storyboard layout

What people LIKE most about their Discovery

"I like the position you can just see so far ahead on the motorway that when everybody else is braking like hell, you've got four cars warning that something's happening up in front"

• SEATS

- The command driving position is liked
- Drivers find the front seats comfortable on long journeys, and like their power seats for adjustability.
- The leather seats are liked for their luxury.
- The stadium seats in the back are popular, especially with people who suffer from travel sickness

"I have a daughter who doesn't travel very well, but she will travel very well in the Discovery and that's certainly something to do with being able to see, and that's sitting up high"

"Maybe do 350, 400 miles and you come out it without no angles and corners....quite relaxing, quite comfortable"

• DESIGN

- A quarter of the people took the time to say that they love their Discovery
- A third like the style of the vehicle
- Some love its uniqueness
- Others like the Discovery for its capabilities in all conditions
- A significant number bought it on the strength of Land Rover's reputation

"It's a working vehicle"
"It looks classy as well"

"Most of the others aren't capable of doing what we're doing"

• SPACE

- People like the height inside and the height in the boot
- They find the jump seats very good for occasional use

"Very clever little design that [jump seats]....it takes you, oh, a couple of minutes"

• OTHER THINGS

- People like the autodim rear view mirror
- The running boards are very useful for getting in and out, washing the roof and using the roof rack

• AIRINESS

- They love their dual sunroofs
- They also like the alpine windows and the large side windows which help to make is seem even more airy

"You've got a lot of air inside the car"

• DASHBOARD

- Owners like the dual air-conditioning / heater controls
- They also like the radio controls and position

"The dashboard is very good, a very pleasing one"
"You don't get stuff drop off the dash down the cassette player"

• SAFETY

- People feel safe in their Discovery
- They like its size, height and quality
- They also like the ABS and cruise control

"If I did have an accident I wanted to stand a better chance than the other guy"

• STORAGE

- People like the storage in the vehicle, especially the roof nets in the back
- The centre console storage box is also popular

"Keep the nets in the back for sweeties and maps"

Figure 6.4. Customer likes storyboard

What people DISLIKE most about their discovery

"It's [steering wheel] designed just at the right diameter so you can't see any of the dials or gauges down the two sides"
"You can see the dials in the middle, but all the switches...you have to kind of look round "

• VISION OUT OF THE VEHICLE

• A significant number of Discovery drivers dislike the poor upward vision on the front windscreen
  • The wide A pillars also reduce the view
• A small number of drivers have difficulties seeing out of the rear of the vehicle:
  • The spare wheel obstructs the view because it's too high and on the wrong side
  • The front seat head rests obstruct the view
  • The rear view mirror is too low
  • The side mirrors are too small

"If you're at the traffic lights you've really got to crane your neck"

• DRIVING PACKAGE

• The steering wheel obscures the buttons behind it
• Some people feel there's too little elbow room between the driver's seat and the door, and some find the arm rest uncomfortable.
• The electric window switches can be confusing
• Almost a quarter dislike having to open the gas cap with the key
• Drivers would like an automatic radio aerial
• For some people the pedals are awkward to use
• Discovery owners like the airbags but some are worried about safety, especially with younger and smaller people
• The power steering is not powerful enough for some people

• REAR SEATS & JUMP SEATS

• Getting in and out of the rear seats can be difficult because of the narrow door opening
• People would like better headrests in the rear
• The back seats can be uncomfortable because of the limited leg room, and wheel arch intrusion
• People like the jump seats but some are worried about their safety

"It's not very comfortable if you've got three largish adults in the back, you tend to sit a bit on the wheel arch"

• BOOT / TRUNK SPACE

• People like the height in the boot, but several said they would like it to be longer
• Some would like the luggage cover to be easier to use and remove
• People would like to be able to load luggage beyond the height of the back seat, but feel it's unsafe
• There are no anchor points for luggage in the boot

"If you hit something solid all that's [luggage] going to come forward"

• CUP HOLDERS

• Almost a fifth of people want bigger cup holders
• Some people think the cup holders should be repositioned
• Some people want more cupholders

"If you've got a can in it, for one, when your can's empty it does nothing but rattle"
"...and also you can rap your fingers on it when you're changing gear"

• STORAGE

• The door bins are difficult to use
• The dip in the dashboards is popular but people would like it to be deeper
• People would like to be able to lock the glovebox

"They've changed the door bins"
"....yeah, they've made them unusable"
"...they've now got a decent bit at the front but it goes down to nothing at the back, for no good reason as far as I can see"

Figure 6.5. Customer dislikes storyboard

6.3.2 Development of task based storyboards

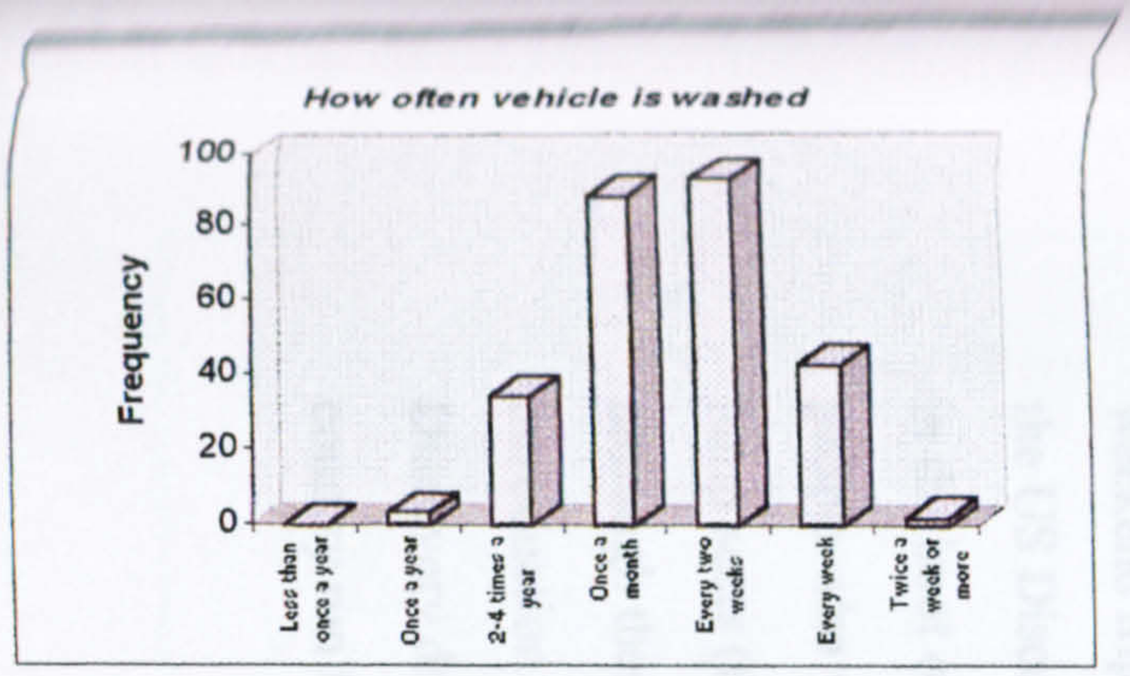
A series of seven boards was created to present a range of tasks which US Discovery owners wanted to carry out with their vehicle, identified from the data collected. The tasks and information chosen for presentation via the storyboards:

- Aimed to provide a wide spectrum of vehicle usage.
- Were typical tasks carried out by a large number of Discovery users (as identified by the questionnaire).
- Showed general aspects of carrying out the tasks in the US market.
- Detailed problems and benefits which were encountered by a large number of Discovery owners.
- Showed extremes of the data where appropriate, i.e. problematic issues identified by small numbers of respondents, but which had a large impact on the ergonomics of the vehicle.

Each of the boards developed is discussed in detail below.

Vehicle Cleaning

This storyboard was developed to show how people cleaned their vehicle and the problems they encountered doing so, see figure 6.6. The information on this storyboard was based mainly on the questionnaire and focus group data. The questionnaire results were used to present a graph of how often the vehicle is washed, to show how many times people are likely to encounter the problems identified in a typical year. The data was enhanced by the use of photographs from the diaries and ergonomics audit, and direct quotes from the focus group transcript. The information showed the most common ways of cleaning the vehicle, both inside and outside, together with the frequency of cleaning. It highlighted problems encountered by shorter people when washing the vehicle, and also difficulties with using an automatic car wash to clean the vehicle.



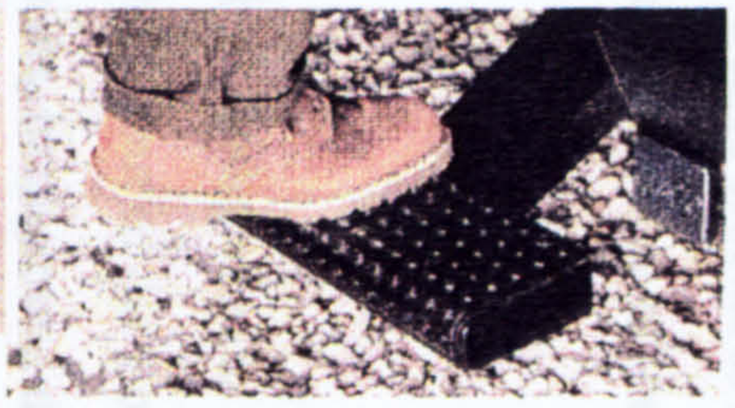
Vehicle Cleaning

•Most people clean the outside of their Discovery either every two weeks or once a month. Over half of them use an automatic car wash and just under half wash the vehicle by hand at home. The inside of the vehicle is most often cleaned 2-4 times a year using a vacuum cleaner at a garage.

"You have to open the driver's door and stand on the seat"

• Ed cleans the outside of his vehicle at home – he finds it difficult to reach the centre of the roof and bonnet on his Discovery. He opens the door and stands on the sill to wax the roof, but finds it difficult in the rear door because the sill is so narrow.

When his wife, Fran, helps him to clean the car she has to use a step ladder in order to reach and she also as difficulty cleaning behind the spare tyre. They have considered installing running boards and a vehicle adder to help them reach the roof, but they feel that running boards should come as standard on such a tall ehicle.



• Al takes his Discovery to an automatic car wash. Unfortunately he can't take it to the nearest garage because the Discovery is too tall for the car wash there. He is about to use the car wash when he remembers that he must fold the wing mirrors flat in order to fit in the space, and put the aerial down so it doesn't get knocked off. He would really like a power antenna which is linked to his radio on/off button.

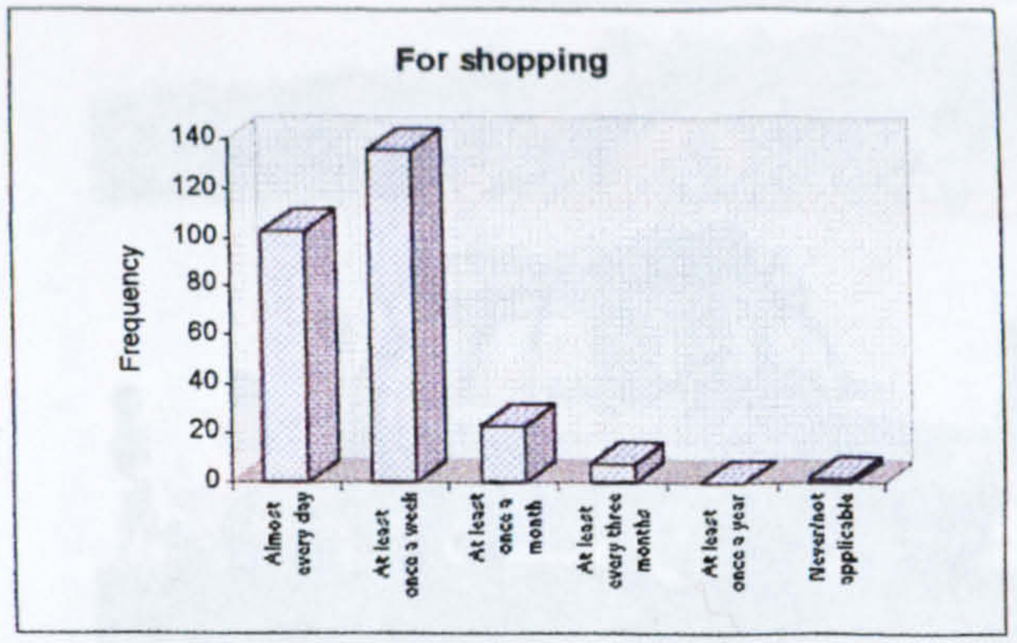
Figure 6.6. Vehicle Cleaning

Shopping

The storyboard displaying the scenarios of problems encountered when shopping is based on information from the questionnaire, driving diary, ergonomics audit and focus group, see figure 6.7. Data regarding how often the vehicle was used to go shopping was supplemented by a graph, produced from the questionnaire results, showing the frequency of shopping trips in the vehicle. Problems concerning the use of multi-storey car parks, and parking the vehicle were indicated, and the feelings of insecurity experienced, especially amongst women, highlighted in information about the alarm and locking system on the vehicle. The lack of adequate storage for shopping bags and the frustrations experienced using the luggage cover, despite its usefulness and popularity, were identified. Direct customer quotes were added to the storyboard to highlight problems in consumers' own language. Pictures from the driving diary and audit were supplemented with pictures from the company's sales brochures (until a full library of pictures is built up in the future) to communicate some of the issues raised.

Weekend Family Trips

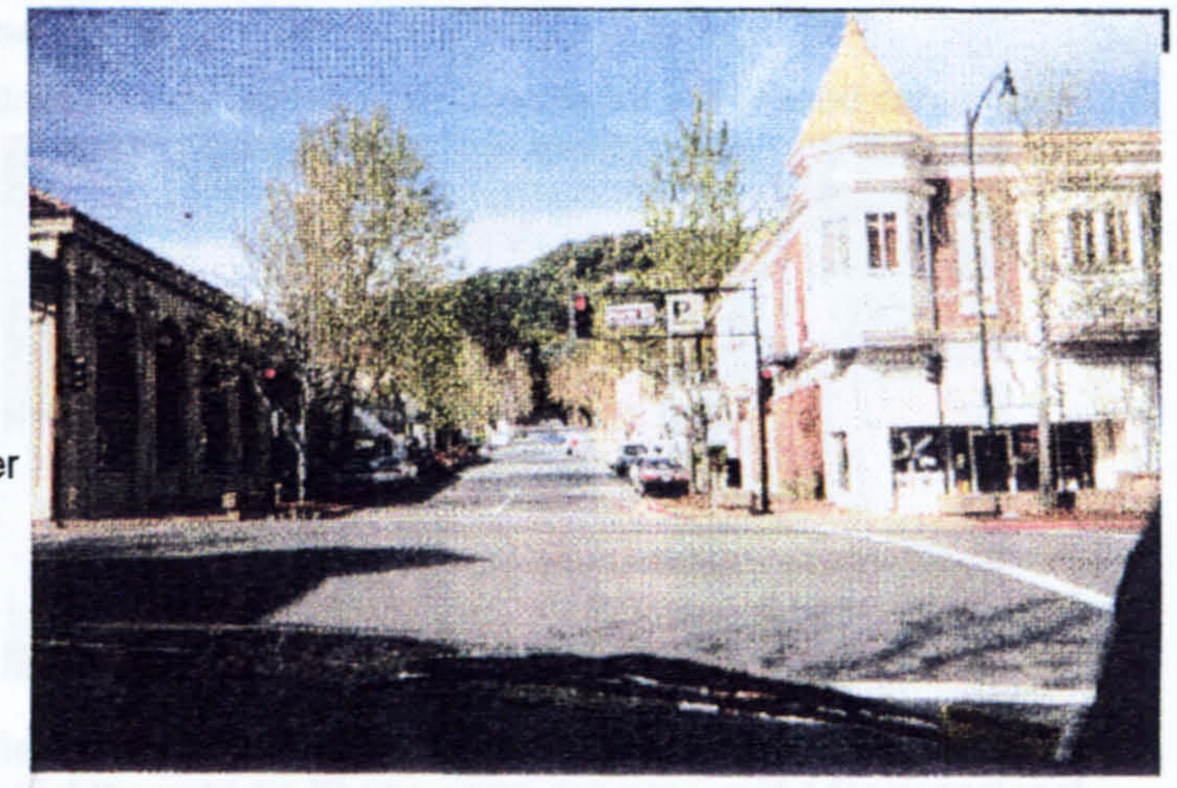
This storyboard was created to show the vehicle being used as a family vehicle on a weekend trip away, see figure 6.8 for the layout of the storyboard. The basic data was taken from the questionnaire results, background data and the focus group transcript. The frequency with which the vehicle is taken away on weekend trips was shown, and the family chosen were of typical composition for the US Discovery market. Issues raised by the amount and safety of luggage space in the boot of the vehicle were described, together with problems encountered by people who wanted to use their vehicle to tow a trailer, etc. The popularity of the jump seats (fold down 3rd row seats), especially with children was described, although there were some safety and usage issues identified. Concerns about the introduction of air-bags into the vehicle were emphasised. The fact that some US Discovery drivers would like a compass in their vehicle because most roads in the country run from north to south or east to west was highlighted, as was the use of



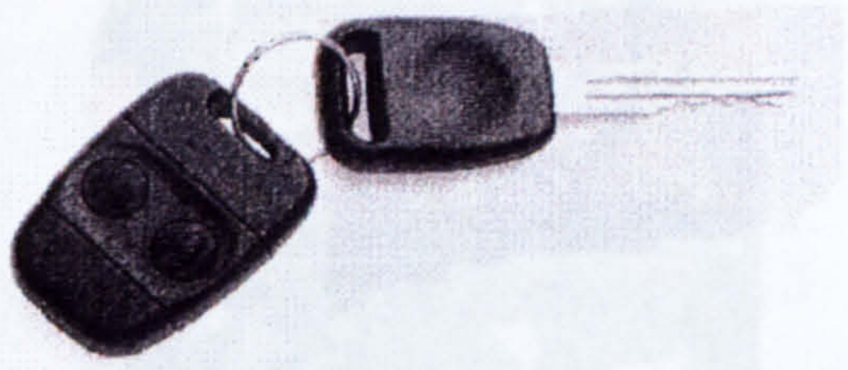
Shopping

• Half the people use their Discovery to go shopping at least once a week and over a third use it almost every day.

"It's frightening sometimes, the [car parks] you do go into, it is very close to the roof"



• Maria drives her Discovery to the Mall where she has to use the only car park entrance tall enough for her vehicle. Even this entrance has a low ceiling which is close to the roof of her vehicle. Maria finds a parking space but has difficulty parking because her Discovery has a large turning circle and she feels the power steering is not as effective as she would like it to be.



• Maria gets her shopping and returns to the vehicle. She likes the remote lock/unlock key ring but sometimes feels a little vulnerable in the car park, she wishes her key fob alarm signal was stronger and had a panic button on it so she could get help if she needed it. She also wishes she could unlock just the driver's door in some situations, where she doesn't want all the doors to unlock at once.

• Maria puts most of her shopping bags on the floor behind the driver's seat which helps to keep them upright. She also has a box of groceries which won't fit in the confined floor space so she has to put it in the back. She finds the luggage cover in the back very useful to hide her groceries, although she has trouble trying to store it away properly when she's finished with it.

• Maria drives home but she can hear her shopping sliding from side to side as she drives because there are no convenient anchor points. When she arrives home some of her shopping bags have tipped over and her groceries are loose on the floor. Maria would like a grocery net as standard to keep her shopping in place.

"There's no anchorage points....where can I tie this to?"

Figure 6.7. Shopping

Weekend Family Trips

•A third of people take their Discovery on weekend trips at least once a month, and a third use it at least once every 3 months for this purpose.

•Don and Cissy take their two children, Brad (7) and Jennifer (9), upstate for a weekend camping trip.

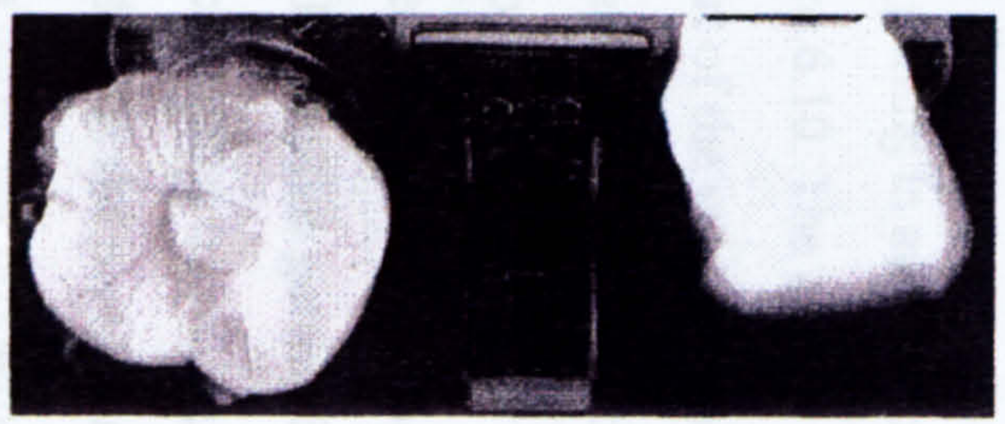
• They put their luggage in the back of the vehicle, but they can't load it any higher than the height of the back seat because there's nothing to stop it falling forwards. They have too much luggage to fit in the back (which is smaller than it looks because of the rear seat back angle) so they tow a trailer behind the vehicle. Unfortunately the towing package they bought for the vehicle doesn't fit easily because the socket for the lights is not of standard American design.

• Whilst away they meet up with some friends and decide to go to the amusement park. Jenny and her friend sit in the jump seats at the back of the vehicle. These seats are very useful for occasional use, and they like the design, although they have to make sure people know how to operate the support leg properly.

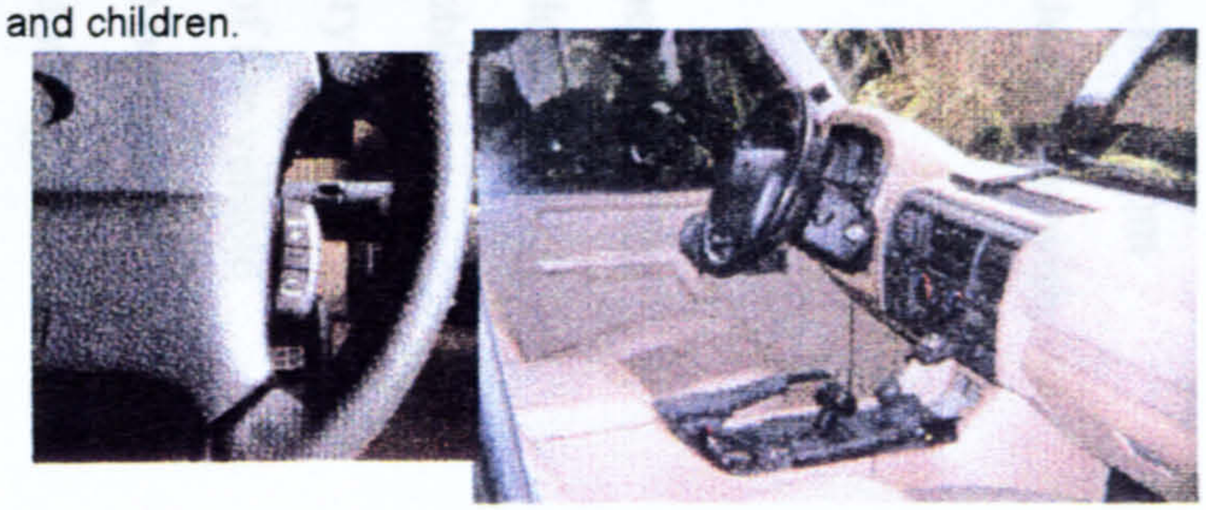
"That's the only problem with the side facing rear seats [they are close to the back window]...children love them....all kids do"

"You can pull them down without the leg out. I've seen that done and it cracks the plastic"

• Don has some reservations about the seats being so close to the rear doors, but the kids love them because they're "something different".



• Brad wants to sit in the front to talk to his Dad, but because he's not very tall his parents are worried about the safety of the passenger air bag, and won't let him sit in the front. Cissy doesn't really feel safe with the airbag herself as she is short. She would like an airbag on/off switch or an adjustable airbag for smaller people and children.



• Don would like a compass to help him navigate on the journey (most US roads run North/South or East/West) or if he could afford it a GPS/In-Vehicle Navigator. On long trips like this one, Don likes his cruise control and finds it very helpful to keep his speed in check as "traffic police presence" is very high in the US.

Figure 6.8. Weekend Family trips

the cruise control as a speed limiter because of the strong traffic police presence. These issues were emphasised because they are not common practices in the UK and would therefore be unfamiliar to members of the design team. Pictures from the diary study, company literature and ergonomics audit were included along with quotes from the focus group.

Carrying Large Items

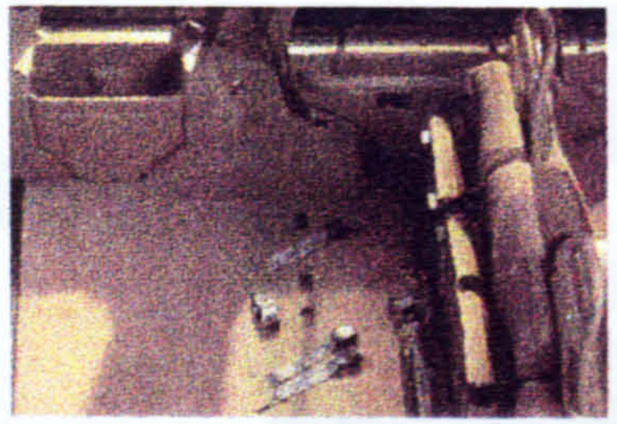
This storyboard identified issues associated with the use of the vehicle for carrying large items, see figure 6.9. The frequency of using the vehicle for this purpose was shown to identify how often people experienced the problems encountered. The basic data was collated from the questionnaire, diary and focus group. Issues arising from the lack of length, and height in the boot of the vehicle were presented, as was the fact that the roof rack was difficult to use because it was so close to the roof of the vehicle. Mud and water brushing on clothing due to the height of the rear bumper, and the weight and hinge position of the rear door, were also considered problematic. Finally on this storyboard issues associated with the field of vision out of the vehicle, some of which were caused by the left hand driving position of the vehicle, were presented. Quotes from the focus group and pictures from the diary study, ergonomics audit and company brochures were added to highlight some of the issues shown on the storyboard.

Getting In and Out of the Vehicle

There were a number of problems associated with getting in and out of the vehicle which were presented on this storyboard, see figure 6.10. The most commonly reported problems when trying to get in and out of the vehicle, taken from the results of the questionnaire, were shown on a graph. Other data on the boards was drawn out from the questionnaire, diary and focus group data. Problems experienced by a range of people, such as shorter people, taller people, the elderly and women were identified on the storyboard. Difficulties getting into the back seats of the vehicle, and the discomfort experienced whilst travelling were highlighted, as were some of the solutions used to alleviate the problems. The poor upward vision out of the front windscreen was a particular problem in

Carrying Large Items

- Almost half carry large items in their Discovery at least once a month.
- A fifth of people carry large items at least once a week
- A small number of people use their Discovery to carry heavy loads almost every day



• As Josie is using her vehicle to pick up some planks of wood from a wood yard, she folds down the rear seats and struggles to remove the luggage cover which she finds awkward. When she gets to the yard she finds the planks are too long to fit, even with the seats down. She would like an opening back window, or a rear tailgate to carry long items. Eventually Josie decides to put the wood on the roof rack. The wood fits but it's difficult to tie it on at the back.

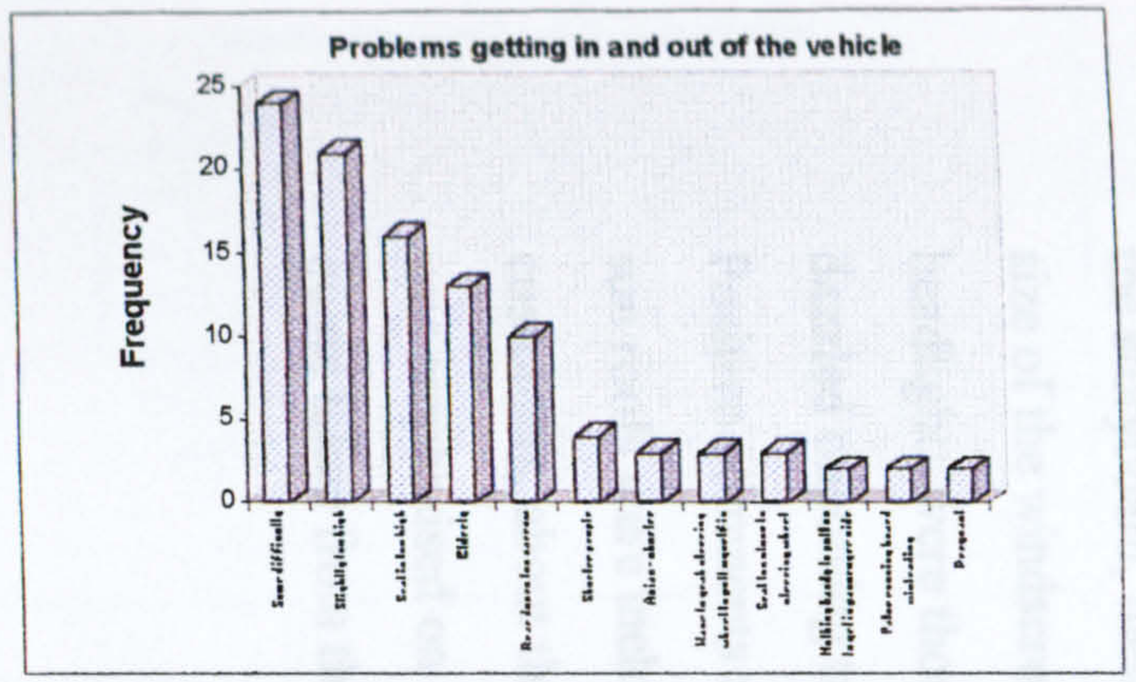
"It's difficult to tie stuff on to the roof rack on the very back bar because it's so close to the roof"

• Josie buys some furniture which she loads into the boot. The back is high and as Josie leans in to put the furniture into the vehicle she brushes against the rear bumper which is wet and dirty.

• Josie is parked at the side of the road and the boot door opens into the path of the traffic so Josie doesn't like to open it too far. The door is heavy and sometimes falls back against her if it is not clicked in place properly.

• As Josie reverses out of the parking space, she finds the spare tyre obstructs her rearwards view; the wing mirrors are small and the front seat head restraints also obstruct. Josie feels the spare tyre should be on the opposite side of the door, and the wing mirrors need to be larger.

Figure 6.9. Carrying Large Items

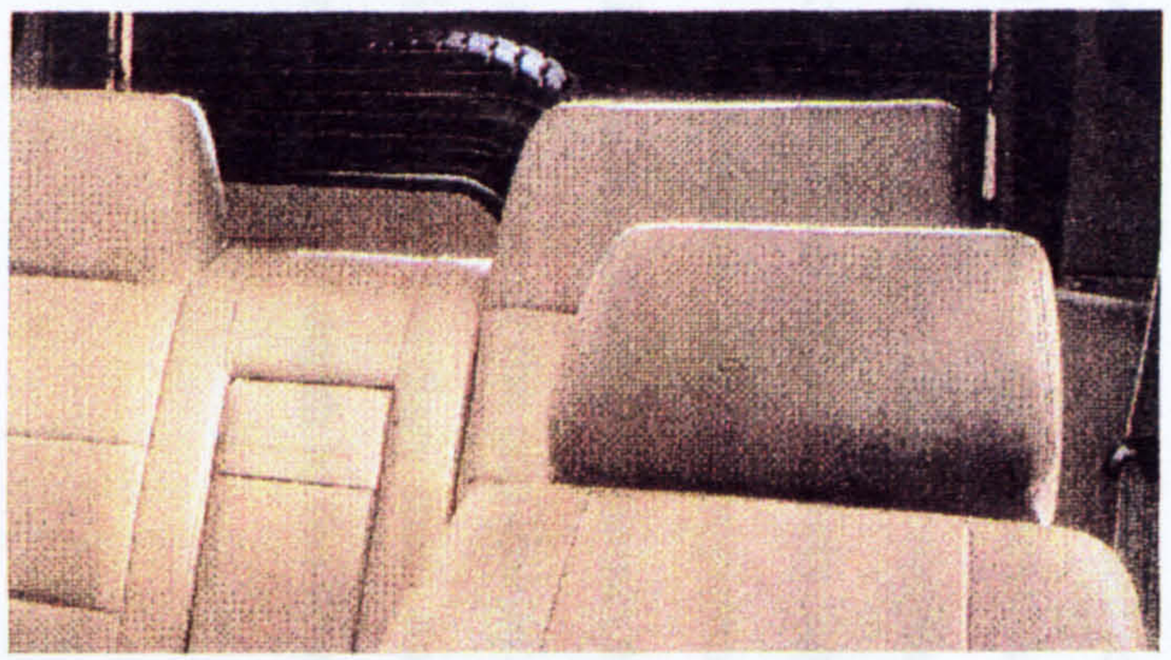


Getting in and out

• Jim and Barbara are going to the theatre with Jim's elderly mother who has arthritis. Barbara finds it difficult to get into the Discovery because she is wearing a skirt. On the way to pick up Jim's mother, Barbara reapplies her make-up but the vanity light on the mirror isn't bright enough, which makes this more difficult.

"If I didn't have side steps, with my mum, then I think I would be in trouble"

• When they reach Jim's mother's house, Barbara gets into the back and Jim helps his mother into the front. The running boards are a help with access, but Jim's mother still finds it too difficult to get in the back because the door opening at floor level is so narrow. Barbara finds it uncomfortable travelling in the back because there is not very much leg room and the moulded headrests on the back of the seat are not high enough to support her head.

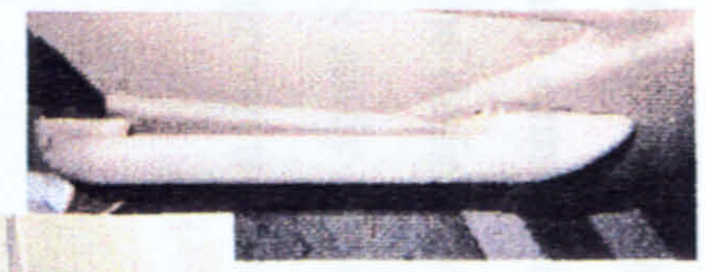


"[The headrest] hasn't been designed it's just a lump in the seat, totally impractical, totally useless"

"If you drive....and you put your arm on the door [the door pull handle], because there's no where else to put your elbow, there's like this razor sharp edge which goes right into the joint of your elbow"

• Jim is large and finds there is not much elbow room in the driver's seat. He rests his arm on the door handle but a sharp edge cuts into his elbow (on long journeys he takes a pillow with him to make it more comfortable). He also finds it very difficult to see overhead mounted traffic lights because he is tall and the windscreen header rail is very low.

"There's a problem getting out, because you're jumping out you can catch your foot on the door pillar" "Or your back on the wheel arch"



• When they reach the theatre, Jim parks in a side street. Although he feels the security on the Discovery is okay, he would like a window-glass break alarm, a fuel cut off to the engine and a lockable glove box.

• Jim parks next to the kerb to make getting out easier for his mother. Barbara finds it difficult to get out of the rear and catches her foot on the door pillar, getting mud on her skirt from the running boards.

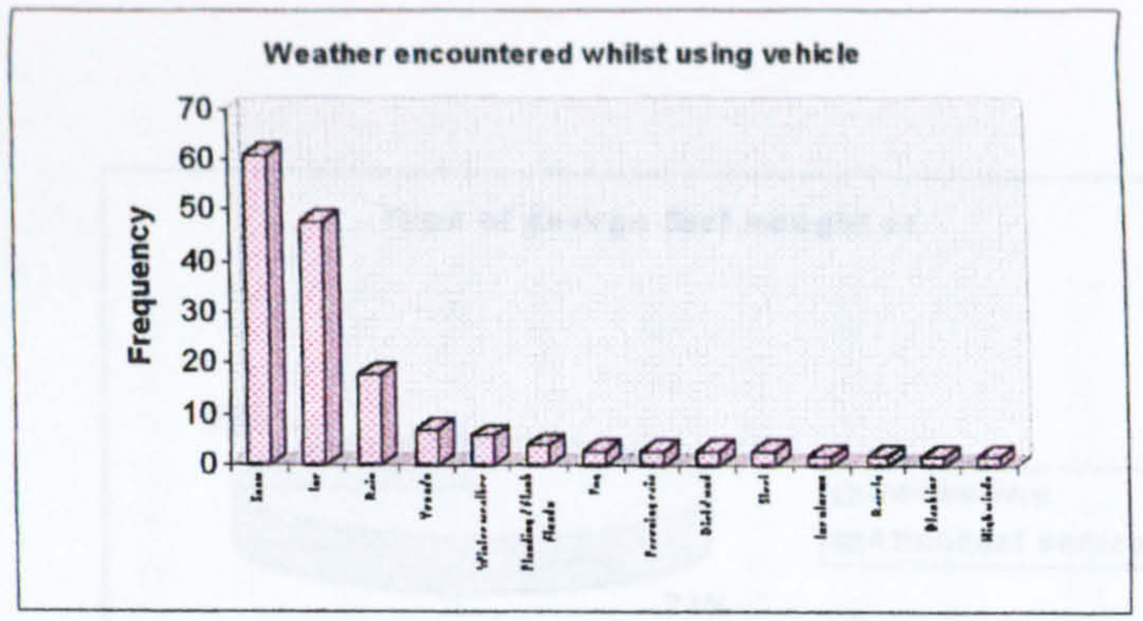
Figure 6.10. Getting in and out of the vehicle

the US market because of the prevalence of overhead mounted traffic lights and street signs, and was therefore included in the scenario. Finally some of the security issues raised by participants in the studies, such as the desire for a locking glove box, were included. Pictures were taken from the diary study and audit photographs, and appropriate quotes drawn from the focus group transcript.

Driving in Various Weather

This storyboard was developed to show the range of weather conditions in which US Discovery drivers used their vehicle, see figure 6.11, and data was collated from the questionnaire, diary and focus group. The questionnaire results were used to draw a chart of the frequency with which customers encountered a variety of different weather conditions, e.g. heavy rain, snow, sleet, high temperatures. Customers' were generally satisfied with the capabilities of the vehicle in all weather conditions, however there were some situations which caused them problems. Scenarios were developed to show the problems experienced with the vehicle in a number of different weather conditions, i.e. those reported most often by participants in the questionnaire study. There was a lack of confidence in the automatic braking system (ABS) in slippery conditions, and a desire for better cold weather features on the vehicle, although those customers who had heated seats installed were happy with them. There were a number of problems reported during heavy rain which were considered important to show on the storyboard, these included poor windscreen wipers compounded by the small size of the windscreen and the limited visibility out of the vehicle. Additionally the headlights were thought to be too weak by some, yet others complained they dazzled oncoming traffic both of which have considerable safety implications. Positive comments about the airiness of the vehicle and the popularity of the dual sun roofs were included, and one of the most common complaints made by the US customers, about the lack, small size and position of the cup holders in the vehicle, was emphasised on the storyboard. Pictures from the diary study and a relevant quote taken from the focus group transcript added depth to the data presented.

Driving in various weather



• People encounter a wide variety of poor weather conditions whilst driving their Discovery; these are mainly snow, ice and heavy rain.

• When the weather warms up the snow and ice turn to rain. The windscreen wipers on Terry's Discovery do not work as well as he would like - they leave some areas of screen uncleared, and this, combined with the small windscreen area, can make visibility difficult. It can be made worse by the screen misting up (cleared only by using the heater on full power). Sometimes the headlights are not powerful enough, although oncoming drivers complain about the brightness and position of the beam.

• Terry lives in New York State, which has very harsh winters. He feels safer in his Discovery than he does in his other car, as he feels the Discovery can cope well in most conditions. He is a little unsure of the ABS in slippery conditions – feeling it acts too quickly and causes the vehicle to "snake" downhill.

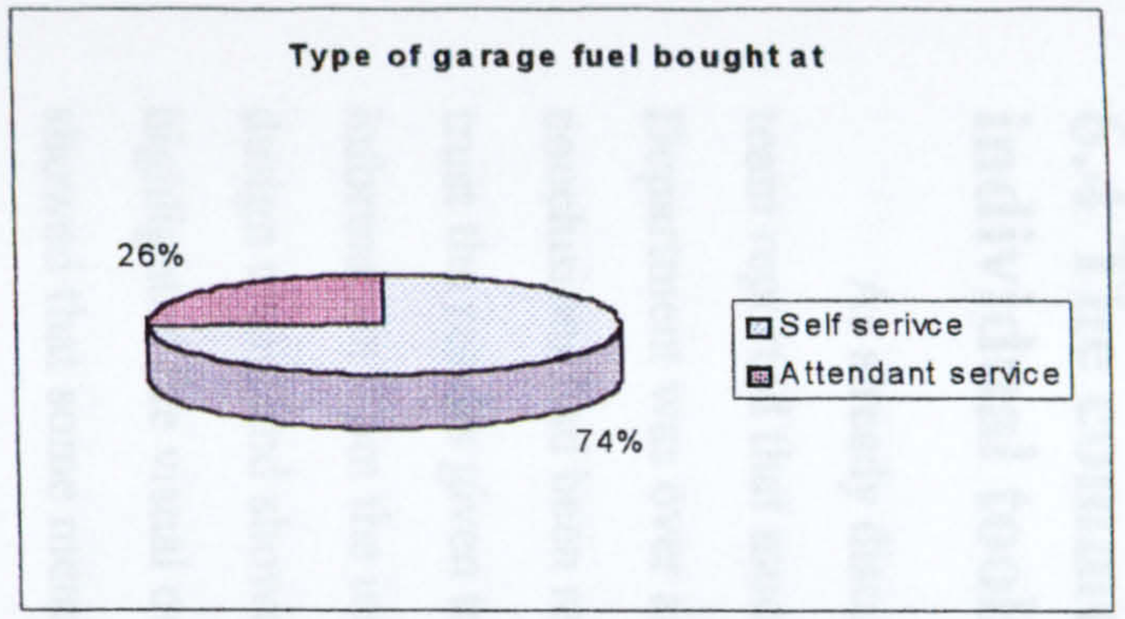
• Terry would like a heated front windscreen and a more powerful heated rear screen as it takes a long time to clear in the morning. He appreciates the heated seats. Terry also he had an exterior temperature indicator, so he could tell when the temperature drops below freezing, and he has to drive more carefully.

• Jake lives in California so most of his driving is done in hot, dry conditions. He loves the dual sunroofs for letting in light and air. He uses the air-conditioning a lot (most wanted feature by over a third of people), but feels it should be much more powerful so that people in the back can feel the benefit.

"The airiness is a good point to pick up on, I have the dual sunroofs in mine and with the alpine lights the glass area is quite deep and it's a nice sort of airy feel"

• Jake occasionally has problems with glare on his windscreen due to its position and angle. He often has a soft drink whilst driving, and although he likes the cup holders, their design annoys him as they are too small for some large cans and cups, too shallow to hold bottles properly and their location obstructs the air-conditioning and radio controls . Jake's friends also complain because there aren't enough drinks holders in the back.

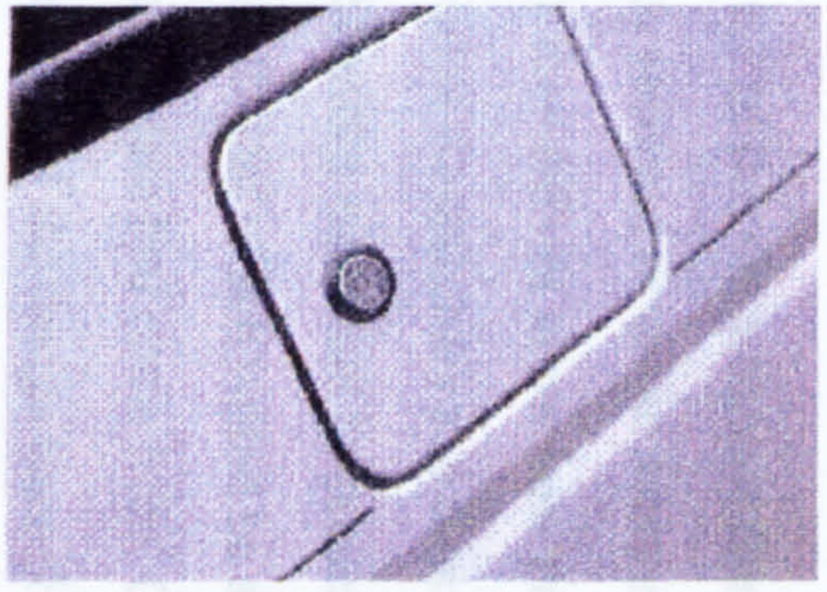
Figure 6.11. Driving in various weather



Refuelling

- Over three quarters of people go to a self service garage to get fuel
- About a third go to an attendant service garage (in some states self service garages are illegal)
- A small number use both self and attendant service garages
- Most people buy fuel at least once a week

• John goes to an attendant service garage - it is a cold, snowy day and he has to switch off his engine and open his window to give the attendant the key to unlock the petrol cap. He can't close the window now because the attendant has the key, so he's getting cold and wet, and he can't even listen to his radio because the engine is switched off. John would like an inside gas cap release.



• John pays the pump attendant and drives off. It's only when he gets home that he discovers the attendant has forgotten to put the petrol cap back on, because there is no where convenient to put it whilst filling the vehicle. This is the second time John has had to buy a new petrol cap.

• Doug buys his fuel from a self service garage. The gas cap on his Discovery is on the opposite side to the one on his other vehicle (which is American built). He sometimes finds it difficult to fill his Discovery because of the awkward angle of the gas tank filler, which makes the fuel pump cut out often. He has to fill the tank very slowly, and it takes him longer than he likes.

Figure 6.12. Refuelling the vehicle

Refuelling

The final storyboard focused on refuelling of the vehicle and the problems this caused customers, see figure 6.12 for the layout of this storyboard. This storyboard was based on data from the questionnaire, diary study, focus group and ergonomics audit. The number of people refuelling their vehicle at self service and attendant service garages was extracted from the questionnaire data and used to show how many people experienced the different problems associated with refuelling their vehicle. The frequency with which people get fuel for their vehicle was included to show how often the problems would be encountered. Issues relating to the use of attendant and self service garages were presented to show the range of problems encountered. One of the most frequently cited of these issues was having to open the window to give an attendant the petrol cap key, because there was no inside gas cap release. Other issues included the fact that the petrol cap was often lost or left behind because it was not attached to the vehicle, and the awkward filling angle of the fuel tank, making refuelling slow and difficult, which was a particular problem for those who filled the vehicle with fuel themselves. Pictures from the diary study and ergonomics audit were used to make the storyboard more visually appealing, and highlight some of the issues on the storyboard.

6.4 The communication of information from individual tools in the Toolset

As already discussed in section 6.3 of this chapter, members of the design team reported that much of the data they received from the Marketing Research Department was over analysed, and that they did not know how particular conclusions had been reached by the Market Researchers and thus did not always trust the results given to them. It was therefore important to present the information from the individual tools in a format which would be accessible to the design teams and showed overtly where the data had come from. Chapter 4 highlighted the visual orientation of members of the design team. However, it also showed that some members of the team, e.g. the Concept Engineers, wanted the

visual representation of the data to be backed up by more detailed facts about the information. Nevertheless, they still did not have the time, or desire, to search through tables of facts and figures about the data collected. The raw data, presented in Chapter 5, was very detailed and the Ergonomists within the company considered that it would need to be interpreted by an Ergonomist to enable the design team to use it effectively. Conversely, the storyboards, presented in section 6.3 of this chapter, were easy to use for all members of the design team but the scenarios presented on the boards did not show a lot of the data used to develop them, i.e. the facts and figures behind the scenarios. Therefore there was a need for an intermediate level of data presentation between the raw data and the scenarios on the storyboards, which would provide some details of the data but in a format which was as concise and visually orientated as possible. This would enable people to obtain more details about the information presented on the storyboards, or to search for information they required without having to wade through the raw data. Thus a high level summary was developed to communicate the results of the data collection tools from part 1 of the Toolset. The high level summaries varied in their content and the amount of analysis conducted on them according to the type of data collected by the relevant tool. The following sections discuss the development of high level summaries for each of the tools described in Chapter 5.

6.4.1 International questionnaire

The raw data from the questionnaire study was extensive and detailed. However, as identified in Chapter 4 the design team had little time or motivation to look through pages of numerical data. Thus it was important to present this information in a way which was acceptable to the design team, who preferred visual material where possible. Therefore the questionnaire data was presented as a book of graphs, some of which were presented in Chapter 5 section 5.3.7. Each question or part of a question was shown on a separate graph, and the charts bound together to form a book. The charts were plotted using the frequency of response for each category and shown in descending order of occurrence. Where there were a lot of data categories only the top 10, 15 or 20 categories were

charted to ensure that the graphs did not become over complicated. Each graph was marked with its corresponding question number from the questionnaire and a descriptive title for identification. The book of graphs was considered to be clear enough for use by the design team without the need for interpretation by an Ergonomist. The book was therefore placed in the design area to allow direct access by the design team without the need to go through the Ergonomics Department.

6.4.2 Driving Diary and Photographs

The Driving Diaries were analysed to create a book of results. Due to the relatively small number of diary returns each was treated as a type of case study, and the results book showed each person's driving activity over a week. The case studies were kept in the format they were entered into the diary because they read as a 'story' of each day's activities carried out by the participant. The questionnaire at the front of each diary was used to provide background information to the participant's diary records. A summary of each person's driving related activities over the seven day diary study was included after each case study. This showed the averages of the number of trips taken and the duration of the trips, and the range of activities, weather encountered, roads used and problems which arose during the week. An additional summary of all the diary participants' information, showing the averages of the number of trips taken and the duration of trips together with information about the range of activities, weather, roads used and problems encountered for all participants in the first batch of returns, was produced. Results from subsequent batches of diaries were not included in the overall summary due to the short time scales being worked to, but were included in the individual results section of the book. Selected diary entries were shown in section 5.4.7.

Some of the photographs from the diary study were used on the storyboards, and all the photographs from the diary study were collated. Each of the pictures was identified on the reverse side with its corresponding diary code and the category of picture it fell into, i.e. pictures of people who use the

Discovery, the environment, traffic lights. The categories were devised with the checklist identified in section 6.3 in mind, that is WHO uses the vehicle, WHAT vehicle do they use, WHERE do they use the vehicle and WHY or what do they use the vehicle to do. The pictures were then sorted into the appropriate categories and put in order of the diary code, to enable quick and easy access to specific pictures. The first batch of returns were sorted into photograph albums for easy viewing. Later batches of pictures were stored in a card index box under the relevant headings. The photographs could be used on their own or in conjunction with the diary book to provide further information about the each of the participants and their driving environment. The results book and photographs were placed in the design area for ease of access.

6.4.3 Ergonomics audit

The information produced by the ergonomics audit was detailed giving information about the suitability, positioning, usage, etc. of different vehicle features and including verbatim comments made by the ergonomics experts, see section 5.5. However, this type of data would be difficult and time consuming for the design team to use. Therefore a summary of the data was developed to show the main findings of the tool in a visually orientated manner. The information generated through the audit was summarised by collapsing the data into a smaller number of categories, for example, the sections auditing the headroom for the driver, front passenger, rear passengers and third row seats were combined into a general category for headroom. The new categories were given a rating based on the 'Overall Rating' from the individual features in the raw data. Each of the symbols used in the 'Overall Rating' was converted to a score as follows, ✓ = 1, **o.k.** = 0 and ✗ = -1, and the individual section scores were summed to give a overall category score. This category score was then presented as another rating scale using the symbols  . Each symbol was coloured according to an established 'traffic light' system already used by the company to indicate good and bad points. This system was familiar to the people in the design team and thus the audit summary fitted in with the company's established methods of working.

The number of faces indicated how well or badly a feature category had been rated and the colour made it easy to identify positive and negative scores. Symbolic rating scales were used throughout the audit to ensure that the results produced were not used in calculations, etc. to produce spurious data, as they were not intended to be ratio scales. An example of part of the audit summary is shown in figure 6.13 and the full summary is included in Appendix C.

The photographs from the audit were given a number and a title which described the aspect of the vehicle they were showing. The pictures were then sorted into a photograph album in the order of the audit points they referred to. The high level summary of the audit was linked into the pictorial database with relevant photograph numbers indicated at the appropriate points on the summary sheet. The audit summary and photograph album were placed in the design area so they were readily available to the design team at all times.

6.4.4 Focus group

The transcript from the focus group was already in a format which was easily understood by the design team, because it used the verbatim comments straight from the customer. Therefore the comments were edited to bring out the important points and then arranged under the headings used to guide the focus group discussion. Direct quotes from participants were used in the summary because of the strong evidence of customer needs and problems which they provide. The edited transcript of the focus group was placed in the design area to ensure it was near the design team. Examples of the focus group discussion were presented in Chapter 5, section 5.6.7, and the edited transcript is included in Appendix C.

The video and audio tapes from the focus group were also provided to the design teams in their full format. Although editing of the video footage was considered most of the film contained useful information and it would have been

Ergonomics Audit - LandRover Discovery

Point score: ✓ = 1, O.K.= 0, ✗ = -1

Summation of each section columns: ☺ = good 😐 = neutral ☹ = poor

GENERAL

Task/ feature	Assessment	Location	Accessibility	Suitability for purpose	Ease of use	Overall subjective rating
DOORS OPENING AND CLOSING						
Outside *Photo. no: 1*	✓	3	2	1	1	1
	o.k	0	1	3	1	3
	✗	1	1	0	2	0
	SUM	☺☺	☺	☺	☹	☺
Inside *Photo. no: 5*	✓	1	1	2	1	2
	o.k	0	0	0	1	0
	✗	0	0	1	1	1
	SUM	☺	☺	☺	😐	☺
INGRESS/ EGRESS						
Front *Photo. no: 2*	✓	0	0	0	0	0
	o.k	0	0	0	1	0
	✗	2	2	2	1	2
	SUM	☹☹	☹☹	☹☹	☹	☹☹
Rear *Photo. no: 3*	✓	0	0	0	0	0
	o.k	0	0	0	0	0
	✗	2	2	2	2	2
	SUM	☹☹	☹☹	☹☹	☹☹	☹☹
3rd row *Photo. no: 10, 11*	✓	0	0	0	0	0
	o.k	0	0	0	0	0
	✗	2	2	2	2	2
	SUM	☹☹	☹☹	☹☹	☹☹	☹☹
INSIDE						
Leg room *Photo. no: 5, 21, 27*	✓	2	1	2	2	2
	o.k	1	1	0	0	0
	✗	0	1	1	1	1
	SUM	☺☺	😐	☺	☺	☺

Figure 6.13 Example of the Ergonomics audit summary layout

difficult to know which data would have been most useful to the team at this stage. Therefore the tape was left uncut, although it is possible in the future to cut sections of the tape for specific purposes if required.

6.4.5 Background Information

The background data presented in section 5.7.3. was extracted from the Product Validation database and was already a summary of the information in the database. Therefore the table shown in section 5.7.3. was placed with the design team in its entirety. In the future as more background information is added to the database, this summary will need to show the most common information together with the extreme values of the data to give a detailed picture of the market for which a product is being developed. The Background information was placed in the design area to ensure it was easily available to the design team.

The next section in this chapter addresses the presentation of data, both from the individual tools and the integrated data from the Lifestyle Scenario Toolset to the design team who are developing the new product.

6.5 Presentation of the Toolset data

The storyboards used to communicate the combined data from all the data collection tools, presented this information at a high level. However, is was not sufficient to place the boards and high level summaries of individual tools in the design area and expect the design team to use the data. As discussed in Chapter 4 members of the design team felt there should be some way of alerting them to the presence of new data. They were in favour of an initial presentation at the outset of the design process to explain the Lifestyle Scenario Toolset to them and the information it could provide for the designers. Thus a presentation of the data was used to champion its existence and use and the design team, the Ergonomists and a representative from the US Market Research Department at LRNA were invited to attend. The presentation took place in the design studio of the company and approximately 20 people in total attended. The speaker was a member of the

ergonomics team responsible for the future maintenance and upgrading of the Toolset, and one of the people likely to present information from this source in the future. Hence this was also part of the evaluation of the use of the Toolset. The author was also present to answer any questions which arose or provide more information where necessary.

The speaker first described the purpose of the research being presented and explained that the Lifestyle Scenario Toolset data was hierarchical. The levels of data were outlined, i.e. that the storyboards were the top level of data in the Toolset, and that high level summaries and the raw data were also available for use. The whereabouts and how to obtain the different information was explained, that is that the storyboards and high level summaries were to be placed in the design studio, and the raw data was to be kept in the Ergonomics Department. The presentation then moved on to show each of the storyboards in turn and discuss the information on them. Each storyboard was presented as a short scenario, or story, of typical customer behaviour and the range of issues encountered in the US market. The attendees, the design team, were able to discuss the boards during the presentation and clarify any misunderstandings as they arose.

Once all the boards had been displayed a discussion of the data on the boards took place. The more in-depth data from the individual tools was introduced at this stage and the design team had a chance to explore the information. The Designers discussed how the Toolset data might be used in their future designs for overseas markets and also some of the problems experienced in the past trying to design vehicles for markets where they had little or no customer information available to them.

The plan to evaluate the Lifestyle Scenario Toolset data and presentation methods was explained. That was to leave the storyboards and high level summaries in the design area. The design team were asked to explore the data more fully and evaluate the content and presentation of the Toolset by filling in a series of evaluation logs, or feedback sheets, each time they used the data. The

team were also asked to take part in a meeting one month after the Toolset data had been placed in the design area, to discuss the suitability of the data and presentation methods for meeting their requirements from the Lifestyle Scenario Toolset. The evaluation procedure is discussed in more detail in Chapter 7 of this thesis.

6.6 Discussion and conclusions

A number of methods for communicating the customer ergonomics information collected using part 1 of the Lifestyle Scenario Toolset were selected from those discussed in the literature review (see Chapter 2). Methods were selected according to a number of criteria which were presented, and which incorporated the needs of the Designers as identified in Chapter 4. The development and usage of the data communication tools, which form part 2 of the Lifestyle Scenario Toolset, were discussed in detail in this chapter.

The tools used to present the information collected using part 1 of the Toolset were hierarchical in structure. This meant that people with different backgrounds and approaches to work were able to use the Toolset data at a level which was appropriate to their needs. Communication of the data was achieved via the use of scenarios presented on storyboards, high level summaries of the results from individual tools, raw data from the individual tools and an initial verbal and visual presentation of the Toolset findings to the design team. Thus each level of data provided a different amount of detail and information about the data collected, and more in-depth information could be accessed if needed.

The storyboards were developed using a systems approach to structuring the data in terms of the user, the vehicle they drive, the environment in which they live and the tasks they carry out with their vehicle. People based boards were used to provide an overview of the market, and task based boards showed a series of activities which people carried out using their vehicle. The information on these latter boards was chosen to be representative of the US Discovery owners, but

also showed the extremes in the sample and data which were considered to impact on the ergonomics of the vehicle, e.g. safety issues. The storyboards were developed to include a variety of information types including facts and figures about the customers, pictures, graphs, and customer quotes. These storyboards were placed in the design area in a prominent position so that they were always visible to the design team as they worked.

The high level summaries of data from the individual tools were presented graphically or pictorially where possible, and showed the main results from each of the tools. These summaries were developed to be placed in the design area, for use by the design team without the need for interpretation by an Ergonomist. However, this meant that the Ergonomists had little control over the interpretation of the information made by the Designers, and would need to ensure that no misinterpretations occurred during the design process.

The raw data was kept in the Ergonomics Department and when the Designers needed to use the data the Ergonomists could help them to interpret the information in a way which would be useful to them. Nevertheless, this meant that the design team must always come to ask the Ergonomist for details of the raw data, and thus was not as convenient for them in their everyday design activities. However, the data was considered to be too specialised to be placed in the design team, and needed interpretation to make it meaningful in the context of the Designers' work.

The initial presentation of the data was given to the design team to familiarise them with the Toolset and the data it produced. The structure of the Toolset was presented and the various tools available to the design team were introduced. Each of the storyboards was presented and a general discussion about the Toolset and the data it contained took place. At the end of this discussion the design team were asked to take part in the evaluation of the Toolset, the plan of the evaluation was explained and the importance of their feedback in developing a Toolset which matched their needs was emphasised. The design team agreed to

evaluate the Toolset and the data it contained with respect to their needs for customer information.

The next chapter presents the evaluation process and its outcome, both in terms of the suitability of the data collection tools which form part 1 of the Toolset for collecting overseas customers' ergonomics requirements, and the data communication tools which form part 2 of the Lifestyle Scenario Toolset, for communicating customer requirements to Designers.

Chapter 7

Evaluation of the Lifestyle Scenario Toolset - Study 4

7.1 Chapter summary

This chapter reports on the research carried out to evaluate the suitability of the Lifestyle Scenario Toolset for the collection and communication of customer requirements from overseas markets. The first part of the chapter addresses the suitability of the individual tools included in part 1 of the Toolset, for collecting ergonomics requirements from overseas customers. The second part of the chapter covers the suitability of the data presentation methods included in part 2 of the Toolset, for communicating the data collected to the design team. This second part begins with a discussion of the applicability of the individual tools for communicating data and then covers the effectiveness of the combined data for conveying information to the design team. The chapter concludes by discussing some of the organisational issues which impact on the use of the Lifestyle Scenario Toolset within the company involved in the research.

7.2 Introduction

The research presented in Chapters 5 and 6 covered the development of data collection and presentation tools for inclusion in the Lifestyle Scenario Toolset. Study 4 which is presented in this chapter addresses the evaluation of parts 1 and 2 of the Toolset with respect to the aims and objectives as outlined in Chapter 1. The overall aim of the research is to develop methods for gathering customer requirements in overseas markets, and for presenting the information collected to design teams, taking a user-centred design approach. The specific objectives in order to achieve this aim are the development of a Toolset of methods for collecting customer ergonomics requirements in global markets, and the provision of appropriate methods for

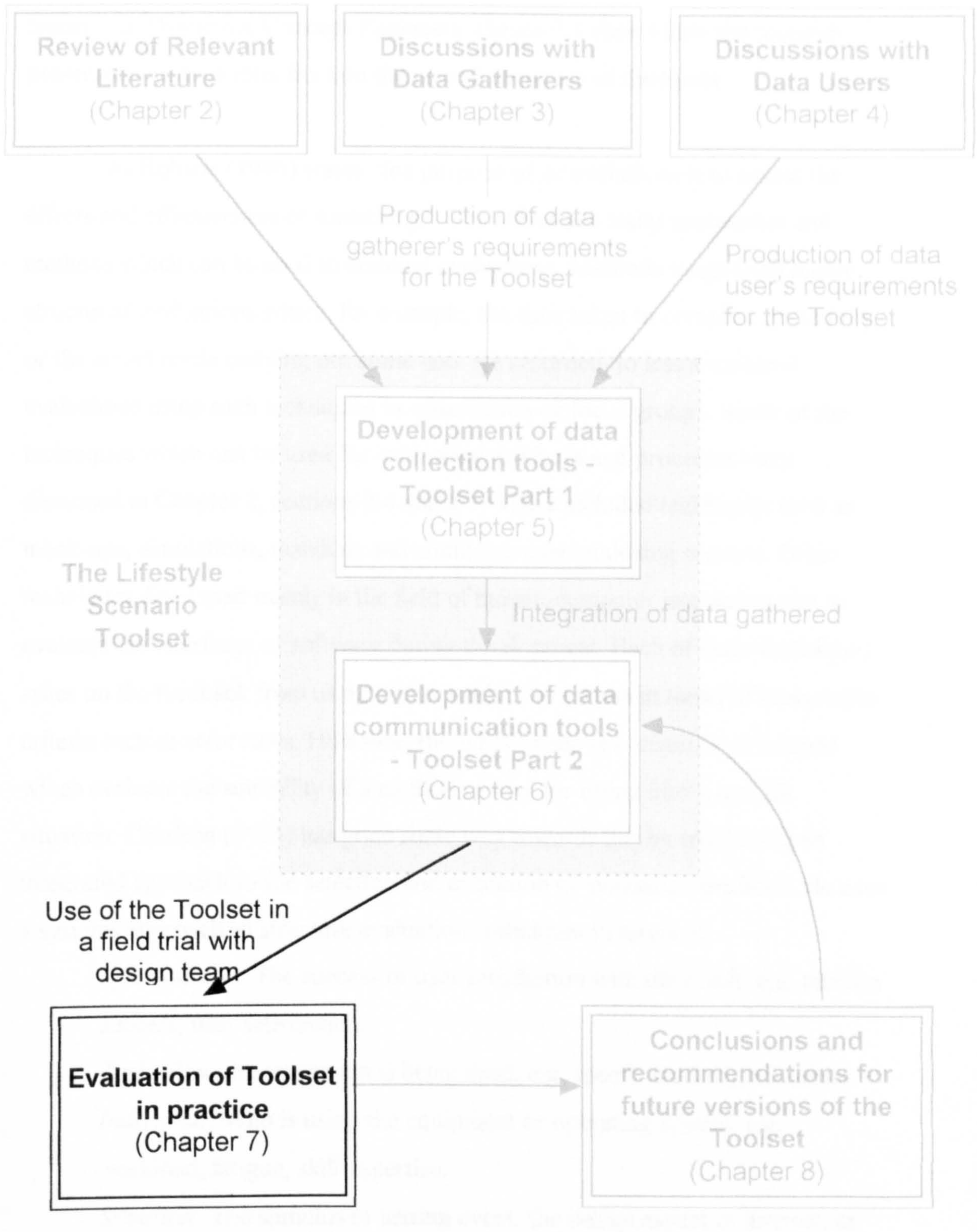


Figure 7.1 Context of the research presented in Chapter 7

communicating the information collected using the Toolset to members of design teams, e.g. Designers, Concept Engineers. Figure 7.1 shows how the research presented in this chapter fits into the overall structure of the thesis.

As Robson (1996) states "the purpose of an evaluation is to assess the effects and effectiveness of something". Thus there are many approaches and methods which can be used to conduct evaluations. Methods range from highly structured evaluations where, for example, the time taken to complete an activity, or the errors made carrying out some task are recorded, to less structured evaluations using such techniques as observation or focus groups. Some of the techniques which can be used for evaluating products and processes were discussed in Chapter 2, sections 2.4 and 2.7. These included techniques such as mock-ups, simulations, manikins and computer man modelling systems. Other techniques developed mainly in the field of human-computer interaction aim to evaluate the interfaces of software during development. Each of these techniques relies on the feedback from users of the product or system in terms of measurable criteria such as error rates. However, there have been few methods developed which evaluate the suitability of a method or tool for fitting into a real life situation. Charlton (1996) has gone some way towards this by advocating an integrated approach to the selection and execution of evaluation methods. He uses a systems approach to structure evaluation techniques in terms of:

Effectiveness: The success or user satisfaction with the result, e.g. mission success, user satisfaction.

Task: How the equipment is being used, e.g. speed, accuracy, sequence.

Individual: Who is using the equipment or operating system, e.g. workload, fatigue, skill/expertise.

Situation: The stimulus or setting event, the design aspect of interest, or the system function involved, e.g. testing of displays, controls, training.

This method still evaluates the effectiveness and task criteria with objective measures, such as the number of errors made, or the time taken to complete a task. These are then analysed in relation to the individual and situation measures, for example workload and documentation, using multivariate statistics to

determine which objective criteria relate to which human measures. Although this type of evaluation goes some way to considering the introduction of a method or tool in terms of the impact it will have on the people who use it and their working practices, it still uses objective measures to achieve this goal. However, it is not always possible to use measurable criteria when assessing the impact or effectiveness of a new system, method or tool, as was the case with the Lifestyle Scenario Toolset.

The Toolset developed in this research was used in a real life setting within the company both in the UK and overseas. It was developed to fit in to the time scale and structure of the development of a specific new product, the next generation Discovery, and therefore a number of restrictions impinged on the evaluation of the Lifestyle Scenario Toolset.

1. The time scale involved in the development of automobiles is long, it takes several years before a design is actually produced. Thus it would be impossible to evaluate the effect of the information provided by the Toolset on the final vehicle developed, within the time scale of this research.
2. Because the design process takes place over an extended period it would have been difficult to get the design team to keep a record of their use of the Toolset over the entire period of developing a new vehicle. This is especially true because, as discussed in Chapter 4, they are not used to keeping records of their design decisions.
3. Instances where the data was used in a design may become clouded by the mass of other data which affects the design, e.g. costs, ease of manufacture. Thus it would be difficult to single out the contributions which were entirely due to data provided by the Lifestyle Scenario Toolset.
4. The design team worked under tight time schedules, and were not able to take part in any evaluation exercise which would disrupt their work in a significant way.

Therefore the Toolset was evaluated as it was being developed and also once it had been used to collect and present data. The data collcction tools which formed part 1 of the Toolset were evaluated formatively during the development of the Lifestyle Scenario Toolset, and iterative design was used to incorporate the recommendations into the next version of the tools. These types of changes are difficult to identify and evaluate in the final Toolset but help to ensure that the development of the Toolset meets the users requirements, as identified in Chapter 3. In addition the data collection tools were evaluated by the Ergonomists and Market Researchers from the company, as they were used to collect data, to establish their usability and suitability for collecting data, and their ability to meet the relevant user requirements established in Chapter 3.

The data communication tools which form part 2 of the Toolset were evaluated with the design team in a field trial. This was considered to be the most suitable method for testing the Toolset data and communication tools because the context of use heavily influences the utilisation of the Toolset in practice. The design team was that identified in Chapter 4, who were working on the next generation Land Rover Discovery. One of the major markets for this vehicle was the US market and therefore the overseas customer data used in the field trial of the Toolset was gathered in the US. The design team were asked to evaluate the data communication tools in terms of their usability and the suitability of the information they provided, for meeting their needs as identified in Chapter 4.

Some authors have argued that ergonomics evaluations should take more account of the cultural impact of the system, method or tool being introduced (Martin et al. 1991) and measurement issues identified include:

- *Viability* - are the benefits of system / tool use sufficiently greater than its costs?
- *Acceptance* - do organisations / individuals use the system / tool?
- *Validation* - does the system solve the problem?
- *Evaluation* - does the system / tool meet requirements?
- *Demonstration* - how do observers react to the system / tool?

- *Verification* - is the system / tool put together as planned?
- *Testing* - does the system / tool do what it is designed to do?

In line with this opinion the evaluation of the Lifestyle Scenario Toolset aimed to address the above factors, i.e. the socio-technical issues when considering the introduction of the Toolset into the company.

7.3 Method

7.3.1 Aims of the study

1. To evaluate the suitability of each of the individual data collection tools in the Toolset with respect to the procedure used, the respondents who took part, the data produced and the cost-benefit associated with the use of the tool.
2. To evaluate the usability of the Toolset as a whole in terms of how well the tools fit together, the data collected, how well the Toolset fits into the company structure, and how well it meets the requirements of the data gatherers for collecting data in overseas markets.
3. To evaluate the usefulness of the communication methods used to present the Toolset data, in terms of meeting the data users requirements for overseas customer ergonomics information.

7.3.2 Sampling

7.3.2.1 Toolset Part 1 - Data Collection Tools

The evaluation of the Toolset data collection tools was conducted with members of the Marketing Research Department at LRNA and Ergonomists based in the UK. The participants were chosen because of their relevant experience of using data collection tools and in particular the data collection tools from the Lifestyle Scenario Toolset.

7.3.2.2 Toolset Part 2 - Data Communication Tools

The evaluation of the data communication tools was conducted with the design team working on the second generation Land Rover Discovery (mainly the Designers and Concept Engineers), senior Ergonomists within the company, and an ergonomics expert from outside the company. The participants, most of whom also took part in the research presented in Chapter 4, were selected because they were working on a new product and had relevant experience of using the Toolset data in their work.

7.3.3 Participants

7.3.3.1 Toolset Part 1 - Data Collection Tools

Five people took part in this evaluation; two participants worked in the Marketing Research Department of LRNA, two participants were Ergonomists within the company and one was an Ergonomist from outside the company.

7.3.3.2 Toolset Part 2 - Data Communication Tools

Seven people took part in this evaluation, four were Designers or Concept Engineers from the design team, two were Ergonomists working in the same design team and one was an Ergonomist from outside the company.

7.3.4 Evaluation Methods and Procedure

7.3.4.1 Toolset Part 1 - Data Collection Tools

The Toolset data collection tools were evaluated against a number of criteria, some of which were identified in the introduction to this chapter (see section 7.2). The Toolset data collection tools were evaluated individually with respect to the procedure used, the respondents who took part, the data produced and the cost-benefit associated with the use of each tool. In addition the data collection tools as a whole were assessed in terms of how well the tools fitted together, the quality and type of data collected, how well the Toolset fits into the company structure, and how well it meets the requirements of the data gatherers as established in Chapter 3. Thus consideration of the socio-technical issues which

accompany the introduction of the data collection tools were included in the evaluation of part 1 of the Lifestyle Scenario Toolset.

Evaluation of the data collection tools took place in two main ways. Firstly iterative evaluation was conducted throughout the development of the Toolset via discussions with the Marketing Researchers, Ergonomists, Brand Managers and Designers to ensure that the Toolset was focusing in the right direction. The findings from this evaluation program were used to shape the development of subsequent versions of the Toolset. Secondly, at the conclusion of the data collection study the suitability of the tools for collecting data in overseas markets was evaluated through interviews with the data gatherers identified in Chapter 3, that is the Market Researchers, Ergonomists, Brand Managers and Designers. The interview discussions focused on the issues identified above, e.g. the procedure used with each tool, the cost-benefit, in addition the participants were free to discuss any aspect of using the tools to collect data, that they wished to talk about.

7.3.4.2 Toolset Part 2 - Data Communication Tools

Three methods of evaluation were used to assess the suitability of the Toolset data and communication methods for use by the design team: an activity log, a group interview and an expert appraisal.

Activity Logs

A series of activity logs was devised to collect data on the use of the data communication tools within real life design activities. Figure 7.2 shows an example of one of the activity logs, which were in essentially the same format for each tool. Logs were provided for use with the Questionnaire graph book, the Driving Diary book, the Driving Diary photographs, the Ergonomics Audit summary, the Focus Group selected transcript, the Focus Group video footage, the Background Data booklet and the Storyboards.

DATE	WHO ARE YOU?	DEPT	WHAT INFORMATION WERE YOU LOOKING FOR?	DID YOU FIND IT? please circle	WAS THE INFORMATION USEFUL? please explain	DID YOU LOOK ANYWHERE ELSE FOR THE INFORMATION YOU WANTED	DID THE INFORMATION FROM **THIS** TOOL INFLUENCE YOUR DESIGN ACTIVITY IN ANY WAY? please explain
/ /				Yes No		No ☐ LST Audit ☐ LST Diary photos ☐ LST Diary data ☐ LST Focus group transcript ☐ LST Video footage ☐ LST Background data ☐ Went to Ergonomists for further data from LST ☐ Went to other people for additional information ☐ Other _____	
/ /				Yes No		No ☐ LST Audit ☐ LST Diary photos ☐ LST Diary data ☐ LST Focus group transcript ☐ LST Video footage ☐ LST Background data ☐ Went to Ergonomists for further data from LST ☐ Went to other people for additional information ☐ Other_____	

Figure 7.2 Example of an activity log sheet used in the evaluation of the Lifestyle Scenario Toolset.

Instructions about what to record and when, were included at the beginning of each of the log books to guide the participants. Each log sheet then asked for the following details:

- Date and author of log entry.
- What information was being sought from the Toolset tool?
- Was the information found and if so was it useful?
- Details of other sources of data used to find the required or additional information.
- How the information gleaned from the tool had affected their design activity.

The Group Interviews

A flexible group interview schedule was drawn up for the discussions with the design team. Some of the issues addressed included:

- Which tools were perceived to be most useful to the design team?
- Which types of information were considered to be most useful?
- Which information was most easily understood by the design team?
- Whether there was any other ergonomics information which would have been useful to the design team which the Toolset did not collect?
- Whether any of the information already collected was not considered to be useful to the design team?
- Individual tools - data content, level of information provided, method of presentation.
- If the tools weren't used, why was that and what could be done to make them easier to use?

The Expert Appraisal

The expert appraisal used the same basic interview schedule as the group interview, to assess the impact of the Toolset on the company procedures and methods used to gather customer data and to supplement the data gathered using the other evaluation methods. This ensured that the socio-technical aspects of introducing the Toolset into the company were addressed.

After the initial presentation of the Toolset data had taken place it was agreed amongst the design team to leave the high level summaries and storyboards in the design area for an initial period of 4 weeks. The design team agreed to fill in the activity logs each time they used a tool from the Toolset.

Group interviews were arranged to take place at the end of this period to discuss the Toolset and its use with the members of the design team. One interview was conducted with the Designers / Concept Engineers and another with the Ergonomists. The expert appraisal was also completed at this time. The Toolset data was then left permanently with the company for future use. By leaving the data communication tools in the design area the design team were able to spend time exploring the data.

The following sections of this chapter present the results and discussion of the evaluation of part 1 and part 2 of the Lifestyle Scenario Toolset. The final section covers the key overall conclusions established through the evaluation of the Lifestyle Scenario Toolset within the Rover Group.

7.4 Toolset Part 1 - Results and discussion

Each of the tools has been analysed, where applicable, in terms of the procedure used, participants involved, data collected and cost-benefit. The effectiveness of each tool for collecting data, and its suitability for use in the company involved in this research are considered. For further details about the

development of each tool and selected results see Chapter 5, for full results from each tool see Appendix C.

7.4.1 Individual data collection tools

7.4.1.1. International questionnaire

Survey procedure

1. Use of the instructions provided. The questionnaire survey was successfully conducted by Land Rover North America employees from the instructions given. The survey did not require any specialist knowledge to implement because it was a pre-printed postal self completion questionnaire. The questionnaire was 'Americanised' by the head of LRNA marketing research, and the US version gathered similar types of information to that collected during the pilot study. However, there are a number of changes to the procedure which LRNA felt may improve the tool for future use. The study was run entirely by LRNA employees and although they found it easy to conduct it was found to be labour intensive because they had to complete each questionnaire pack with a stamped addressed envelope and gift certificate. In the future it is probable that the questionnaire data collection will be contracted out to a market research company who would deal with the assembly of the packs and the questionnaire returns together with the fulfilment of the incentive. This would increase the cost of conducting the research, but most of the NSCs have too few staff to complete the survey procedure themselves, and it is standard practice to contract out large scale surveys.

2. Provision of incentives. It was decided that the incentive which was originally intended to be a dollar bill should be changed to a Land Rover baseball cap, because Land Rover is considered a prestigious company in the American market. It was thought that a dollar bill may have a detrimental impact on the company image in this market. Nevertheless, this incentive may need to be varied between markets depending on the company image and position in the marketplace.

3. Telephone help line. Land Rover North America provided a US free phone number for questions relating to the research and questionnaire. This was considered necessary as most Americans would expect to be able to call a help line toll free. However, no calls regarding the questionnaire were received which would indicate there were no problems associated with the completion of the questionnaire. The provision and cost of this number may vary between markets depending on the structure of the company in a particular country, however it is recommended that a phone or postal contact always be made available to participants.

4. Market criteria for using questionnaire. The questionnaire survey procedure would work well in countries where the postal system is good and therefore the non-response rate due to non-delivery of the questionnaire is low. There may however, be a need to collect similar data in different ways in markets where the postal service is not reliable or where the social structure of the society does not respond well to direct questioning, for example in Japan. These issues would need to be addressed prior to introducing the questionnaire into the new market.

5. Response rate. The high response rate indicates that the questionnaire was well received, and this could be due to a number of reasons. Firstly people may have genuine issues relating to the ergonomics of using their vehicle which they wish to express. Secondly, there are few questionnaires sent to the general public which cover aspects of vehicle usage in the same way as this questionnaire, therefore the level of interest in the subject is high. Further it was clear from the questionnaire that the research was being conducted through an English university which together with the other factors may have influenced participants who were keen to respond to something a little out of the ordinary. Another factor which may have influenced the response rate was the incentive, a Land Rover baseball cap, which was of some monetary value and status. This may have encouraged people who would not have otherwise replied to the study.

Respondents and data produced

1. Demographic information. The results from the demographic section of the questionnaire indicate that the respondents came from a wide range of backgrounds, and that the tool is not only picking up responses from one narrow section of the population. Further the diversity of responses to the survey questions would indicate that the tool is picking up information from people with a variety of experiences of using their vehicle over a wide range of activities.

2. Data collected. The tool produced information over a broad range of topics, many of which had not been addressed before by the company. Therefore, the questionnaire is gathering new, additional information which was previously unknown.

3. Validity of the tool. In order to assess the validity of the questionnaire data triangulation was used to compare it to data already collected by the company, through the Customer Quality Tracking Study discussed in Chapter 3. The CQTS survey collects a small amount of information about customer requirements at a very high level, for example levels of satisfaction about different aspects of the vehicle, and customer complaints about vehicle features. This data was compared to that from the Lifestyle Scenario Toolset questionnaire to see if the data produced by the Toolset agreed with that already collected. By comparing the data collected through the Toolset questionnaire with that already collected by the company, confidence in the Toolset data was increased, and the company were more certain about the results produced by this research. The Toolset data closely followed the themes arising in the company data, which would indicate that this tool picked up valid and reliable information.

Cost-benefit analysis

1. Questionnaire costs. The questionnaire cost approximately £2840 to conduct. The major part of this, approximately $3000 (£1800), was spent on the incentive offered to each participant on return of their completed

questionnaire. This incentive, and therefore the associated cost, will vary from country to country, depending on the market position of the company, the vehicle being surveyed, i.e. whether it is considered to be a prestigious make and the sample size and response rate. However, the amount of data produced by this survey is considered to fully justify the cost of conducting the work, since the data is new and informative to the design team and able to provide Ergonomists and Designers with reliable figures from a large number of respondents.

Key Conclusions

- The questionnaire survey can be completed successfully.
- The questionnaire collects new and useful information.
- The survey is relatively easy to conduct, but takes a lot of resource to set up initially.
- The data collection may be contracted out to a market research agency to reduce the resources needed within the company.
- The cost of implementing the questionnaires is justified by the returns.

7.4.1.2 Driving Diary and photographs

Survey procedure

1. Use of an external agency. The diary study was completed through LRNA in conjunction with an external US market research agency. LRNA felt it would require too many resources for them to co-ordinate the diary study themselves. Therefore an external agency was contracted to organise the survey procedure, that is complete the envelope packs, add cameras, send out and collect returned diaries and complete the fulfilment of the incentive. Using an external agency increased the cost of this study considerably however it significantly reduced the length of time taken to conduct the work. It is most likely that a similar procedure, using the services of an external market research agency, would be employed in the future since the process worked effectively.

2. Translation of the diary. The Driving Diary was Americanised by the head of Market Research at LRNA and there were no problems caused by the language. However, there was a little confusion over what was meant by a journey, some people took this to mean each time they drove the vehicle, and others considered a journey to be the outward travel, time at destination and return travel (this was especially the case if a number of small stops on a round trip were made). This should be clarified in future versions of the Driving Diary, although it is difficult to establish exactly what constitutes a journey.

3. Use of disposable cameras. The use of cameras was well accepted by the participants. All those people who returned their diary also sent a used camera back. Each of them had photographed the piece of paper with their diary code printed on it, and taken all or most of the pictures requested.

4. Data collection process. There were some delays in the collection of data using the Driving Diary which meant that the results were late coming back in. Because of the tight time schedule of this project, due to the need to fit in with the design cycle of the new vehicle being developed, the results from the other tools were analysed before the diaries were returned from the US. Thus the diary data was not analysed as fully as would have been liked. The delays in the diary study also created some problems with the photographs which were linked to the Driving Diary. The pictures were intended for use with the storyboards to present information to the design teams. On this occasion most of the cameras arrived in the UK in time for the pictures to be processed and used on the storyboards, however if delays occurred in the diary survey in the future the situation could arise where there are no photographs for use on the storyboards. It may therefore be necessary to break the link between the diaries and photographs in subsequent versions of the Toolset, and find an alternative method for obtaining the photographs.

5. Response rate. The response rate for the diary study was good amongst those who had agreed to take part in the study, but this is tempered by the fact that the sample had been recruited from a larger sample of people through an initial

letter requesting participants. The number of people in the diary study was limited to fifty people and the initial letter explained the level of commitment required from participants. Therefore those people who agreed to take part should have been more likely to complete the diary than the general US Land Rover Discovery owner population. Nevertheless the response rate of 38% indicates that this may not have been the case.

Participants and data produced

1. Participants. The results from the demographic section of the Driving Diary questionnaire indicate that participants came from a range of backgrounds, although as previously stated these people may have been more committed to completing the diary than other Discovery owners. The participants carried out a range of activities using their vehicle as can be seen from the diary entries (see Appendix C for full results).

2. Data collected. The tool produced information about activities carried out using the vehicle over a period of a week and was useful in building up an in-depth picture of vehicle usage. The photographs taken by participants showed varied environments and provided pictorial data on a wide range of topics. However, there was a certain amount of repetition amongst the pictures because all the participants were asked to take the same list of photographs. In future use of the Toolset more data may be collected by asking groups of participants to take different sets of photographs, thus increasing the variety of pictures produced.

Cost-benefit analysis

1. Diary costs. The Driving Diary study cost approximately £1540 to conduct. The work was carried out through an agency which increased the cost considerably. The study was expensive in part due to the fact that initial letters had to be sent to recruit participants. The diary packs themselves were also costly because of the inclusion of the disposable camera, nevertheless a relatively small number of packs were sent out. The use of cameras by participants to take photographs produced valuable pictorial data, however the

use of 24 exposure cameras left each of the films with some blank frames. This could be made more cost effective by asking participants to take more pictures of a wider range of activities to do with the vehicle. Thus although the Driving Diary and photographs produced useful data the study needs to be modified, for example by breaking the link between the photographs and the diary or including a wider range of photographs to be taken by different participants, in order to make it more cost effective.

Key Conclusions

- The Driving Diary and photograph study can be conducted successfully through an external market research agency.
- The diary and photographs collect new and useful information.
- The link between the Driving Diary and photographs may need to be broken in future versions of the Toolset.
- The diary survey is costly and the returns may not always justify the expense if there is a limited budget.

7.4.1.3 Ergonomics audit

Audit procedure

1. Completion of the audit. The audit was easy to conduct for an ergonomics expert and the structured approach taken ensured the process was systematic. However, it was labour intensive and took the ergonomics experts two full days to complete the audit. The work necessitates the use of experts because ergonomics knowledge is needed to conduct the audit effectively. Since the beginning of this research project a program of ergonomics audits on vehicles has been introduced into the company and follows a similar schedule to that used here. Thus the audit developed for use in the Toolset could be combined with that already used in the company and will not require extra resources. Additionally in future applications of the audit a smaller number of assessment criteria may be used to evaluate the features to reduce the time taken to complete the work.

2. Use of the data on future projects. Conducting the ergonomics audit on a series of vehicles will, over time, produce a database of information which can be accessed without the need for additional work. So although the audit is labour intensive in the first instance the data it produces can be used on numerous projects.

Participants and data produced

1. Requirements for auditors. The audit is the only tool in the Toolset which requires ergonomics expertise for completion. As such the data produced should highlight any features which are not picked up through the use of the other tools in the Toolset. The data also backs up that collected from the customer and is able to provide more information about why problems are occurring, i.e. the customer may complain that the seat is uncomfortable but not state why, the audit results may then indicate that the seat squab is too short, thus clarifying the situation.

2. Limitations of the audit. The audit produces a lot of in-depth information, although this doesn't come directly from the customer. As a static audit, i.e. the vehicle was stationary, this tool is not able to pick up issues which arise from the interaction of vehicles and their environment. It would be possible to augment the audit so as to include vehicle usage for carrying out a range of tasks, however, this would increase the amount of time needed to complete the appraisal. A limited number of tasks would need to be chosen and these may not reflect the full range of activities for which the vehicle is used. Further to this the interaction of the vehicle and environment would vary considerably in different markets and an audit would have to be conducted on the vehicle in each overseas market. It was not financially viable within the scope of this research to send an Ergonomist to the US market to carry out the ergonomics evaluation. However, considering the quality and depth of information produced using this tool it may be cost effective in the future to recruit or send an ergonomics expert to each country to conduct the audit.

3. Audit photographs. The photographs taken as part of the audit study were found to be very useful for illustrating issues arising from the audit. The photographs were captioned and linked to the audit results, and provided a good focus for discussion of the findings.

Cost-benefit analysis

1. Audit costs. The cost of the audit conducted for this research was negligible (≈£10), however in the future Rover Ergonomists would have to conduct the work. This would cost the company in terms of man hours, but as previously discussed the company now has its own program of vehicle audits into which the Toolset audit could be linked. Therefore the additional costs of conducting this audit are minimal, a lot of useful data can be produced using the tool, and it is recommended for inclusion in the Lifestyle Scenario Toolset.

Key Conclusions

- The audit is feasible to conduct.
- Expert knowledge is needed to conduct the work.
- The audit can be combined with other work now being carried out within the company.
- The cost of conducting the audit is minimal.
- The audit is an essential Toolset tool and its inclusion provides additional helpful information.

7.4.1.4 Focus Group

Focus Group procedure

1. Completion of the focus group. The focus group was conducted successfully in the UK. The original aim of conducting the focus group in the US using American Discovery owners could not be achieved within the time and monetary constraints of this project. Therefore the focus group was run in the UK in order to assess its suitability for inclusion in the Toolset.

2. Suitability for use overseas. The themes discussed by the group in the UK were selected after initial analysis of the US questionnaire data and audit information. There should be few problems translating the focus group schedule for use in other countries because firstly the schedule would be based on information from the relevant local market, and secondly being a verbal discussion it allows problems or misunderstandings to be probed and clarified immediately. The schedule may need to be expanded with more detail and instructions if the focus group is to be run through an agency in the future. The facilitator for the UK focus group had ergonomics experience and was able to work from a minimal schedule, however, ergonomics expertise is not necessary in order to conduct the focus group.

3. Use of video to record the focus group. The video and sound recordings taken of the focus group were used to transcribe the discussion and the tapes were provided to the design teams so that they could see and hear the participants' conversation. The video recording was of sufficient quality to be able to hear the conversation, however it is suggested that the audio recordings still be made as a backup to the video footage.

Participants and data produced

1. Participants in the focus group. The participants who took part in the focus group were drawn from a small sample of people who were considered by the local Land Rover dealership to be people who would want to talk about their vehicle. Therefore they may not be entirely representative of the population as a whole. Nevertheless a wide range of problems and experiences were discussed amongst the group which would indicate that the group was diverse in nature and had a variety of experiences to draw on.

The participants in future groups should be drawn from a larger sampling frame to ensure that there are enough people willing to take part and that there is diversity amongst the groups.

2. Suitability for use in overseas markets. The focus group is a very flexible tool for collecting data from customers and each group can be tailored to gather information about a different range of topics. This makes it very useful for application in a wide variety of markets and to cover the issues pertinent to each in depth.

3. Data produced. The focus group produced in-depth data on a range of topics which had been identified through the results of the other tools, and which complemented the data gathered through these tools. The focus groups generated a series of customer quotes (verbatims) which helped to illustrate problems and issues in the customers' own language, and which proved to be very powerful in communicating information to the design team.

Cost-benefit analysis

1. Cost of conducting the focus group. The focus group cost approximately £170 to conduct. Most of this was spent on the gifts given to participants. The cost of setting up a US focus group through an agency was approximately $4000 and therefore not feasible within the scope of this research. However, since the focus group has been determined to provide valuable information for the Toolset it is probable that it will be conducted through an agency in the future, and it is suggested that it continue to be included as a tool in the Toolset.

Key Conclusions

- The focus group can be completed successfully.
- The information collected adds to that gathered using the other tools in the Toolset.
- The focus group collects helpful information and provides direct customer quotes.
- Although the cost of the focus group would rise when conducted through an agency the depth of data collected, the flexibility of the tool and the effectiveness of communication to the design team via verbatims justifies its continued inclusion in the Toolset.

7.4.1.5 Background information

Procedure, data produced and cost-benefit analysis

1. Data produced by the tool. The database of background data is already in place and gathering information about markets continually. The department which is collating the data has been willing to share the information as part of this project and since this tool links in with current company work it is effective in maximising the communication of information between departments and disciplines. At present the database is relatively limited in terms of relevant data for the Lifestyle Scenario Toolset, but will become increasingly useful in providing background information as it grows in size. It may also be able to pick up a wider range of issues such as population composition and cultural aspects of a country in the future which would further increase its usefulness as a Lifestyle Scenario Toolset tool.

2. Presentation of the background data. As the database expands it may be necessary to develop a way of presenting the information produced in a more user friendly way. The design teams expressed a dislike of purely numerical data and at present the background information is a list of figures which may not be utilised fully by the designers if the amount of information presented grows too large.

3. Links within the company. One benefit of using this database is that there is no additional cost to the project associated with the use of the data. It is already available within the company and therefore can be accessed as and when required. Additionally the use of this data strengthens links between departments in the company and provides the opportunity for closer collaboration in the future.

Key conclusions

- The background database will become more useful in providing information as its depth and content increase.

- The data is suitable for backing up that gathered using the other tools in the Toolset.
- There is no additional cost involved in using this data and it creates a link between departments within the company.
- The continued inclusion of the background database as a tool for the Toolset is recommended.

7.4.1.6 Toolset Handbook

The Toolset Handbook was developed throughout the data collection process to ensure that it was pertinent to the use of the Toolset for collecting real data. However, this means that the Handbook has not yet been evaluated independently in a real life situation, because the Toolset has only been used for an initial data collection exercise. The Toolset Handbook was evaluated by the Ergonomists and head of LRNA Market Research, as it was being developed with the aim of making it as relevant as possible. Nevertheless, it will not be until the Toolset has been used in the future with people who have not been involved in its development, that a true evaluation of the Handbook can take place. It is important however, to provide a handbook to guide non-specialists through the use of the Lifestyle Scenario Toolset, and to ensure that their needs for clear instructions in easy to understand language, have been addressed.

7.4.2 Suitability of the Lifestyle Scenario Toolset as a Toolset for collecting data.

Data collection using the individual tools chosen for inclusion in part 1 of the Lifestyle Scenario Toolset has been discussed in the previous sections. The next sections cover the suitability of part 1 of the Toolset as a whole for collecting customer data. The Toolset is discussed in terms of how well the tools integrate with each other and also the issues surrounding the use of the Toolset to collect data.

7.4.2.1 Integration of the tools in the Toolset

Procedure, data produced and cost-benefit analysis

Each of the tools chosen for inclusion in part 1 of the Toolset was successfully used to collect data from customers. These tools can be used as stand alone tools, however as discussed in Chapter 2, it is the use of a variety of different tools and techniques through triangulation, which produces the rich picture of customer lifestyle information and requirements, and therefore the integration of the tools in the Toolset is very important.

In order to integrate the data from each of the data collection tools which form part 1 of the Lifestyle Scenario Toolset, in a way which provided depth and confidence in the data it was important that each of the data collection tools produced a different type or depth of information.

The questionnaire aimed to produce high level, quantitative information from a large number of people. The data collected through this tool was used to establish the presence and magnitude of particular behaviour and problems associated with the user of the vehicle.

The driving diary was developed to collect in-depth, qualitative information from a small number of people. The temporal nature of the information gathered aimed to show how people used their vehicle over a period of a week, and thus illustrate the range of ways in which the vehicle was used in this market. The photographs collected as part of the diary study were intended to show the range and variety of situations in which the vehicle was being used. These photographs provided a wealth of information about the subject of the picture, and also additional background information which had been picked up in the pictures.

The ergonomics audit produced in-depth expert information about the ergonomics of the vehicle. This data picked up information which may not have been identified by customers themselves. The data provided an assessment of the

whole vehicle and was able to give more information about the possible reasons behind customers' ergonomics requirements and problems.

The focus group was used to explore particular issues in considerable depth with a small number of vehicle drivers. The discussion produced verbatim comments from customers, which could be used to emphasise the findings from the other tools. Since this information came straight from the customer it was difficult to refute, and therefore provided very powerful information but from a small group of possibly unrepresentative customers.

The background data was included to provide a context for the data collected using the other tools. The data was quantitative and established some of the facts and figures which backed up the data collected through the other tools in part 1 of the Toolset.

As can be seen, each of the tools collected a different type of data, e.g. quantitative, qualitative, verbal or pictorial, or a different level of information, e.g. high level general information or in-depth customer quotes. Chapter 6 discussed the methods used to integrate information from the various data collection tools in a systematic fashion. Most of the data from the tools was found to integrate well, the only data which proved difficult to integrate was that collected using the Driving Diary. As stated in Chapter 5 due to delays in the data collection schedule the Diary data had to be collected and analysed in a short time. Therefore it was not analysed in any depth, and proved to be difficult to integrate with the rest of the data. In future uses of the Lifestyle Scenario Toolset, now that the appropriate time scale for conducting the diary study is known, it should be possible to analyse the data more fully, thus facilitating its incorporation into the combined data more easily. Nevertheless the photographs taken by the Diary participants proved to be easy to integrate with the rest of the information and were very useful for illustrating points on the storyboards.

The total cost of using the Toolset to collect data from the US market was approximately £4500. This was considered to be very cost effective when

compared to the outlay associated with other research conducted by the company. Although the cost may be greater when the Toolset is used in the future, due to the company's need to conduct most of the research through market research agencies, it is still expected to be cost effective and relatively low cost. Further to this each of the tools can be used alone which means that the cost can be reduced if needed by using only a limited number of the tools at any one time.

7.4.2.2 Organisational issues associated with using the Toolset to collect data

There are two main organisational issues associated with using the Toolset to collect data from overseas markets. First is the need to co-ordinate a large number of people from different disciplines and backgrounds, and second the difficulty of getting people to adopt the use of the Toolset to collect data.

Co-ordinating the data collection process

The Lifestyle Scenario Toolset is made up of a number of individual tools and this can have implications for its use in collecting data. The tools were designed as far as possible to be usable by non-specialists in data collection, although the Ergonomics Audit tool necessitated the involvement of an ergonomics expert. The other tools are suitable for use by non-experts and could be used solely by Rover personnel in overseas markets.

However, it is likely that in the future data collection with most of the tools would be done through a market research agency, to reduce the time and effort commitment from Rover personnel. This would result in people with different levels of expertise being involved in the data collection process. These people would need to be co-ordinated so that they all followed the same agenda to reach the same goals. The most effective way of co-ordinating all the people involved in the Toolset data collection activities would be to have champions of the Toolset. These would be people who had an overview of the project and who could ensure that the data collection process was organised effectively. It would be preferable to have a champion in the UK to co-ordinate all the Toolset data

collection activities, and also a champion in each of the markets where data was to be collected. The UK champion would probably be a member of the Ergonomics or, further in the future, Market Research Departments. The overseas champions may be a member of the Market Research Department in that market if appropriate, otherwise someone in a position of responsibility in the overseas market may take on the role.

Another aspect associated with using a number of individual tools to collect data is that of co-ordinating the planning and data collection time scales. Each of the tools takes a different amount of time to use for data collection, and varying time needed to analyse the data produced. This presents little difficulty if the tools are being used individually to provide additional data to the Toolset database, but if the tools are being used together a time schedule will need to be established so that all the data can be co-ordinated effectively. The schedule must allow time for delays in any one of the tools, because there may be unforeseen problems or necessary changes to the data collection schedule.

The Toolset will need someone to co-ordinate and update the information database developed from the data, and the UK champion would be a strong choice for this role because they will have an overall perspective of the Toolset data. The database co-ordinator would need to ensure that the data is analysed and entered into the database in a standard way, and that any gaps in the information available are addressed.

Adoption of the Toolset

As with the development of any new project at the early stages, there was some difficulty securing commitment from relevant people to help with the data collection process. Until the results of a project have been proved to be useful to a company it can be difficult to get people to buy in to the research. The UK Market Research Department were quite busy at the time this research was being conducted and therefore were not able to provide much practical input into the project. However, the head of marketing research at LRNA was very helpful in conducting this work, and championed the Toolset in his company. This assistance

enabled the Toolset to be used to collect data in the US market, where it would otherwise have been very difficult.

Now that the Toolset has been shown to collect useful data for the company, the UK Market Research Department have shown some considerable interest in taking a more active role in the Toolset data collection process in the future, and widening the role of the Toolset within the company.

7.5 Toolset Part 2 - Results and discussion

The data collection tools were evaluated using the activity log, group interview and expert appraisal. The activity log provided the structure for the interview and expert appraisal. Thus the activity log is discussed separately and the results from the interviews and expert appraisal are presented in a combined format in this chapter. For further details about the development of the data collection tools and selected results see Chapter 6.

7.5.1 Activity logs

The activity logs were checked each week during the initial period of the evaluation. However, none of the design team filled in the logs of their use of the Toolset data. The team were regularly reminded about the importance of the activity log entries to the evaluation, and each time they agreed that they would record their Toolset usage. Nevertheless, this did not happen and no data was recorded in the logs.

There are a number of issues in evaluation which the lack of activity log data served to highlight. Firstly there are issues caused by the differences in perspective on the research activity undertaken. The most important aspect of this research to the company was understandably the introduction of the Toolset into the workplace as soon as possible. Once this had been done, from the company's perspective the project goal had been achieved. A workable prototype Toolset and a substantial amount of data was available to feed into the design process. The

a substantial amount of data was available to feed into the design process. The company employees were then able to evaluate the Toolset in use, and draw their own conclusions as to its success or failure in achieving the intended aims. This takes away the incentive to complete the log books, as the design team know whether they want to use the Toolset, and how useful the data is to them. They achieve nothing more by filling in the log books, and hence doing so has a low priority in a busy work schedule.

It is difficult to find a satisfactory way around this problem. One solution would be to encourage the design team to fill in the log book each time they use the data by having a data custodian who is in charge of the data, rather like a library lending system. However, this may serve to deter the use of the Toolset by the design team. Knowing that they could not use the data unless the log was completed would be likely to push them into using another data source or none at all.

Another problem with the use of logs to record activity is that the act of 'verbalising' and recording the activity can actually change the activity itself. By taking the time and effort to fill in the log the design team are changing the way they work, each interaction with the Toolset data is longer than it would have otherwise been, and the design team may be deterred from using the data because it is seen to be time consuming.

7.5.2 The Group Interviews and Expert Appraisal

Information gathered through the evaluation interviews and expert appraisal is organised under relevant headings according to the tool being discussed. The section begins with the evaluation of the individual communication tools included in part 2 of the Toolset. Then the suitability of the integrated communication tools and the Lifestyle Scenario Toolset as a whole are discussed in terms of the data produced and the communication of this information to the design team.

7.5.2.1 Questionnaire graph book

The questionnaire graph book was generally well received after initial apprehension. The questionnaire graphs were considered at first glance by the Designers / Concept Engineers to be too cumbersome to use. However, as they began to look through the data in more detail and actually use the data they became more interested in the information it could provide. Nevertheless, they did have some concerns over the number and format of the graphs provided. One of the team commented *"There's a lot of charts to wade through"*, but since it is not known which information will be most useful to the team at any one time it can be difficult to be selective about which graphs to present.

There were problems with the font size being too small on some of the graphs, *"Yeah, yeah [I'd use the graphs] I couldn't read them on the sheets that was the only problem"* which was caused by the descriptive titles of the chart categories. It was considered more usable to label the graphs with the descriptive titles rather than a category code, but this meant that some of the titles were very small and it may be necessary to limit the length of the title in future versions of the graph book.

The Designers / Concept Engineers asked for the data in the book to be presented as percentages rather than numbers of respondents. This was something which was also discussed at the interview with the Ergonomists. They had expressed worries about the Designers / Concept Engineers interpreting data from the Toolset in inappropriate ways, and were concerned that they would use the percentage figures as a reason for ignoring or misinterpreting some of the findings. This was a point which provided some disagreement amongst the Designers / Concept Engineers. At present some of the categories on the graphs contain small numbers of responses and some of the Designers expressed the opinion that if there were only small numbers they would not take much notice of the data. However, others claimed *"But it's still useful even if it is small numbers"* because it showed that a problem existed. It was felt by the external Ergonomist that it was important to maintain the narrow response categories, i.e. a greater number of

smaller categories, in the questionnaire to ensure that the level of detail required by the design team was provided.

Respondents could also provide more than one answer for some of the questions so the percentages did not always add up to 100%. Therefore it may be difficult for the Designers / Concept Engineers to know how much overlap there was between categories, and would make interpretation of the data difficult. Additionally some of the information which did not come out of the questionnaire data strongly was given more weight from the findings of the other tools in the Toolset. Therefore the percentage figures alone do not tell the whole story, but need to be used in conjunction with other information.

Further to this, due to the wide range of questions asked on the questionnaire some of the data sections were based on a small number of participants, for example the section on problems encountered cleaning the vehicle was based on the results from the participants who cleaned their own vehicle and who answered the questions in this section. If such data had been presented as a percentage of the overall number of respondents it would have shown a very small figure, and not have given a convincing argument of the importance of some of the issues, e.g. the fact that in some states it is illegal to use a self service garage. If the data had been presented as a percentage of the number of people who had answered the question the Designers / Concept Engineers would have had to remember to take this into account when considering the issue. Therefore it was considered easier to present the data in terms of participant numbers rather than percentages.

7.5.2.2 Driving Diary booklet and photographs

Communication of the Driving Diary information presented some problems mainly due to the short time scale imposed on the study. The booklet was not considered by the Designers / Concept Engineers to be particularly user friendly. This was not entirely unexpected as there had not been time to analyse the data extensively and no high level summary was developed, although a summary of the

data had been produced and included in the booklet. The Designers / Concept Engineers expressed the need for the data to be summarised further, *"This is the raw data we'd want someone else to produce a summary"* and to be presented in a more compact structure. At present the data shows each of the diary participants' activities over the seven day period in which they completed the diary, and a summary at the end of each. Although this was interesting data the amount of time it would take to read the complete booklet was considered to be unacceptably long. Bearing in mind that one of the requirements of the data users, identified in Chapter 4 was that the Toolset should provide an easy to use analysed version of the results showing the key findings, it is important to find an alternative way of presenting this data if it is included in future versions of the Toolset.

The Diary photographs however, were considered by the Designers / Concept Engineers to be very useful to them, *"They're very useful in lots of ways...apart from what the vehicle is, the environment as well"*. This highlights the Designers / Concept Engineers preference for pictorial information, *"It says more than 4 or 5 pages of hand written information to us"* and reinforces the adage that 'a picture tells a thousand words'. The Designers / Concept Engineers spent some time exploring the photographs and found many instances where their misconceptions about overseas customers were exposed, for example *"I always assumed they were right above you [the overhead mounted traffic lights] but they're not, they're a distance away"*. The photographs were therefore very good for providing irrefutable evidence of data which may help to reinforce or change the way Designers / Concept Engineers view the overseas market.

7.5.2.3 Audit summary booklet and photographs

The audit summary booklet was well liked by the Designers / Concept Engineers. It was considered to be quick and easy to use, and the presentation of the information with a pictorial scale was popular, *"You can almost just see that instantly can't you"*. The descriptive nature of the audit summary was also considered by the Designers / Concept Engineers to be appropriate to the way

they work *"We don't have time to read the details, we really don't"*, and *"This is very descriptive isn't it.....for instance you can very quickly see ingress and egress"*.

The photographs which accompanied the audit summary, like the diary photographs, provided a great deal of information to the design team, *"I think the photographs are excellent"*. The audit photographs had been numbered and were linked to the summary so that issues which came up in the summary were illustrated with the appropriate photographs. Additionally the photographs had a short description on each, explaining the reason for the picture, and this was liked by the design team, *"It's good as well with the little annotations on them...it shows what you're focusing on"*.

7.5.2.4 Focus group selected transcript and video footage

The focus group transcript was used to discuss some of the issues which had arisen from the Toolset data, in more depth. The Designers / Concept Engineers used the data as a starting block from which to discuss other issues concerning in the design of vehicles. It was the most well liked out of the written information *"Of the written stuff I think the quotes from people are the most useful, 'cos it's fact isn't it, from Joe public"*, and considered easier to use than the questionnaire data, *"It's easier to get information from than the graphs"*.

The video footage was not used by the Designers, mainly due to its running time of over 1hour. This had been considered a potential problem by the Ergonomists before the Toolset was implemented, however as discussed earlier in section 6.3.4, it was decided to leave the video uncut at this stage because all the information on it was considered to be useful. Nevertheless, the Designers / Concept Engineers did not watch the footage because it appeared to be too time consuming. However, they did say that they would watch a shorter video, *"If it was half an hour or less we'd watch it"* and in the future the video footage will need to be cut down. This would need someone with experience of editing video footage to complete and is time consuming, but if it can be shown that the

Designers / Concept Engineers gain enough information from the short film its cost in terms of man hours can be justified.

Use of video footage can be very powerful to show real customers and their opinions, and as suggested earlier in this thesis the use of video footage to show customers carrying out various tasks was something which the Ergonomists were keen to implement in the future. The experience gained through video taping the focus group indicates that the footage should be kept to a minimum, and be varied as much as possible. Again this would involve editing and cutting the footage before it is implemented in the design team.

7.5.2.5 Background information

The background data was found to be useful to the design team, and they considered it essential information, *"It's quite a high level summary, the sort of things this department should be aware of anyway"*. Despite this the Designers / Concept Engineers agreed that this information was not well documented, known or used properly. They were therefore pleased to link into the work being conducted by the Product Validation Department, and keen to use it in their future work.

7.5.2.6 Storyboards and initial presentation

The suitability of the storyboards and the level of data on them was discussed. The Designers / Concept Engineers thought the storyboards were a good way of presenting the information, *"Yeah that's good, that gets through to us"*. They also concluded that the level of information presented on the storyboards was about right, *"Either a diagram or photograph and a brief description is much more valuable and gets home...we get all this hand written stuff and you almost need to be a solicitor to understand it"*. The storyboards had provided the design team with new information *"It's already changed my ideas about some things...I thought all Americans were really tall and fat, but you can see, that's not true"*, and provided a focal point to discuss other issues.

Some of the Designers / Concept Engineers thought it would be a good idea to link the information on the storyboards to its source, *"It's a shame you can't link the bullet points to the appropriate graph"*. As discussed in section 6.3 this had been considered and tried out during the development of the storyboards, but the Ergonomists concluded that the storyboards became too cluttered and the information was unnecessary at this level of presentation.

7.5.3 Suitability of the Lifestyle Scenario Toolset as a Toolset for communicating data

The overall usefulness of the Toolset data and the effectiveness of the communication methods as a whole are discussed in this section. The design team were very positive about the data provided by the Toolset, *"I thought it was very comprehensive, could hardly suggest any more you could do"*, and *"This is very good isn't it...this is your pictures and comments"*. They felt it provided them with new and useful data about their overseas customers, *"Sometimes a person will buy one of our vehicles and then he won't buy the next one, and we don't know why....if you go and ask people about the vehicle we have designed, the good and the bad points about it, that's probably one of the best feed backs we can have.....we don't get it in this area"*. They were positive about the multiple levels of data presentation, *"The different levels of information, that's a really good way of doing it"*

There was also a lot of agreement amongst the design team that they would like the Toolset to be used to collect data in other situations. For example some of the comments included: *"What would be good is if for every car we work on you could capture information like this instead of just the odd comment we get from Marketing"*, *"It's a shame we can't get this done for competitor vehicles as well...this is exactly right"*, *"If we could do this on Jeep Cherokee, and Defender. It would be great on Defender"* and *"It would be good to find out what the Far Eastern people thought of it [Discovery]"*.

The Ergonomists also considered the Toolset to have been useful in collecting new and relevant information. They have already implemented the use of some of the tools on other projects, for example the use of photographs in Ergonomics audits and focus groups to collect ergonomics related information. In addition most of the other tools, i.e. the storyboards, questionnaires and customer photographs are to be implemented on other projects in the near future.

The Toolset is now being incorporated into the company's range of data collection techniques. As discussed in section 7.4.2.2 it was initially difficult to get the Toolset adopted by the UK Market Research Department because it had not been proved to provide the design team with useful data. However, now the design team have expressed their desire for the Toolset to be used on other projects the Market Research Department are investigating ways of integrating the data collection tools with their own data collection activities. This would indicate greater acceptance of the Toolset within the company now that its usefulness to the design team has been established. In addition the Ergonomists are now able to sell the Toolset within the company on the basis of the results presented in this thesis.

7.5.3.1 Other issues associated with implementing the Toolset

There are a number of organisational issues which need to be addressed in order to ensure that the Toolset can be used effectively by the company in the future. Some of these factors also had implications for the evaluation of the Toolset with the design team.

Placement of the data in the company

It had been agreed at an initial evaluation meeting that the storyboards and high level summaries should be placed within the design area to ensure that they were easily accessible by the Designers and Concept Engineers from the design team. The raw data was to be retained in the Ergonomics Department, as it was considered to need expertise to interpret the information. However, it emerged after several days that the Ergonomists had not placed the information in the

design area, instead it was kept in the Ergonomics Department in a locked cabinet. There was a feeling amongst some of the Ergonomists that the data should be kept together in the Ergonomics Department where they could monitor the use of the data and control its whereabouts.

The Designers and Concept Engineers had been told by the Ergonomists where the data was being stored and that they could obtain access to it by asking the Ergonomists, but none of the Designers had actively sought out the data to use in their work. This points to two issues relating to the placement of data in the company.

Ownership of the data

Since the Ergonomics Department had funded a large part of the data collection activity using the Toolset, they were understandably keen to maintain a firm grip on the data it produced. The issue of ownership of the data can tend to obscure the reasoned arguments for placing the data directly with the potential users, mainly the Designers and Concept Engineers. The fact that the Designers had stated as one of their requirements for the Toolset that it should be easy to use and access highlighted another problem with keeping the data in the Ergonomics Department.

Access to the data

The Designers and Concept Engineers working on a particular marque of vehicle are usually grouped together in one area of the design studio. The studio itself is a large open plan building in which the various related groups each have their own section. The Designers and Concept Engineers rarely visit the Ergonomics section of the studio unless they have a specific question to ask, or meeting to attend. Therefore it is not a natural activity for the Designers / Concept Engineers to leave their section to use information based in the Ergonomics Department. Any information they need will usually be investigated and supplied to them by the Ergonomists. Further to this the Designers / Concept Engineers would not necessarily actively seek out data unless they are convinced of its worth. By leaving the full Toolset in the Ergonomics Department the likelihood of

it being used by the Designers / Concept Engineers was diminished because they had no experience of the data and therefore no inclination to use the Toolset.

Finally, the company has a clear desk policy which influenced the way in which the data was stored. The policy that all work should be stored away overnight leaving an empty desk was one that was adhered to more rigidly by some than others. The Ergonomics Department fully embraced the policy and therefore the Toolset data was always stored away at night in a locked cabinet. However, the Design Department was less strict about enforcing the policy, due in part to the number of large sketches and drawings which were less able to be stored easily and safely. Therefore when the data was moved to the design area it was possible to leave it in a designated place, where the Designers and Concept Engineers knew it would always be. This area was also within sight of the Designers / Concept Engineers as they worked and thus the Toolset data was more conspicuous.

7.6 Key overall conclusions

- The data collection tools were able to pick up new, previously uncollected information about customers and their ergonomics requirements.
- The Toolset picked up data in a range of formats and types of information.
- The data collection tools were usable, where appropriate, by people who were not ergonomics experts to gather data.
- The data collection process could be conducted through a market research agency where appropriate.
- The data collected from different tools could be combined to enhance the validity and depth of the information.
- The driving diary was the least cost effective tool, however this was due in part to unavoidable delays in this study, which can be addressed in future use of the Toolset.

- The Toolset was well received by the design team.
- The Toolset provided the design team with new and useful information.
- The photographs and the audit summary were the most popular tools amongst the Designers / Concept Engineers.
- The diary data was the least well received of the Toolset information.
- Of the written data the focus group quotes were the most well liked.

Chapter 8

Discussion and conclusions

8.1 Chapter summary

This chapter presents a summary of the project research. The aims of the thesis are re-examined in relation to the Toolset developed in this work, and recommendations for the future use of the Toolset to collect and communicate overseas customer ergonomics requirements provided. Contributions to knowledge and possible future research directions are discussed, before the presentation of some final conclusions.

8.2 Summary of the research

This thesis examined the collection and communication of overseas customer ergonomics requirements in the pre-concept stages of the design process. Emphasis was placed on the collection and incorporation of data from overseas markets because Designers have less knowledge about these users. The research aimed to investigate methods which could be used by non-Ergonomists to gather customer ergonomics information without the need for extensive training in ergonomics techniques. It also sought to develop methods for the dissemination of customer information to design teams in a way which they would find useful and usable. Finally this thesis investigated the integration of methods developed into a Toolset which could be placed with the company involved in this research, in a way which would be acceptable to them and maximise the likelihood of it being used in the development of new products.

The research comprised four studies. The first covered the collection of data gatherers' requirements for the Lifestyle Scenario Toolset. Interviews were conducted with company employees who would use the Toolset to collect data, that is people from the Marketing Research and Ergonomics Departments, as well

as personnel responsible for the collection of data from overseas markets. These discussions gathered information about the needs of the data gatherers for a Toolset of methods to collect customer ergonomics requirements. The second study investigated the needs of the users of the Lifestyle Scenario Toolset data. Discussions with Designers, Concept Engineers, Brand Managers and Ergonomists complemented those undertaken with the data gatherers. The needs of the data users for a Toolset of methods communicating overseas customer ergonomics requirements were established. The third study comprised the development of tools for collecting and communicating customer ergonomics information. This study built on the information gathered through studies 1 and 2, to develop a two part Toolset, called the Lifestyle Scenario Toolset. The first part of the Toolset consisted of a set of methods for collecting overseas customer ergonomics requirements, and the second part comprised a set of methods for communicating the customer requirements to the design teams who would use the information in the design of new products. The fourth and final study evaluated the suitability of the Lifestyle Scenario Toolset for collecting and communicating data from the perspectives of the Toolset users, that is the data gatherers and the Toolset data users, the design team working on the development of the next generation Land Rover Discovery. Figure 8.1 shows how this chapter fits into the overall structure of the thesis.

8.3 Assessment of the Research Aims and Recommendations for Future Use of the Toolset

The general aim of this project was to develop methods for gathering customer requirements in overseas markets, and for presenting the information collected to design teams, taking a user-centred design approach. Within this broad aim a number of specific research objectives were developed, see section 1.4.1. It was proposed that in order to make products usable and effective several different types and sources of data were needed to provide a rich picture of users and their activities. This was considered to be even more important in markets

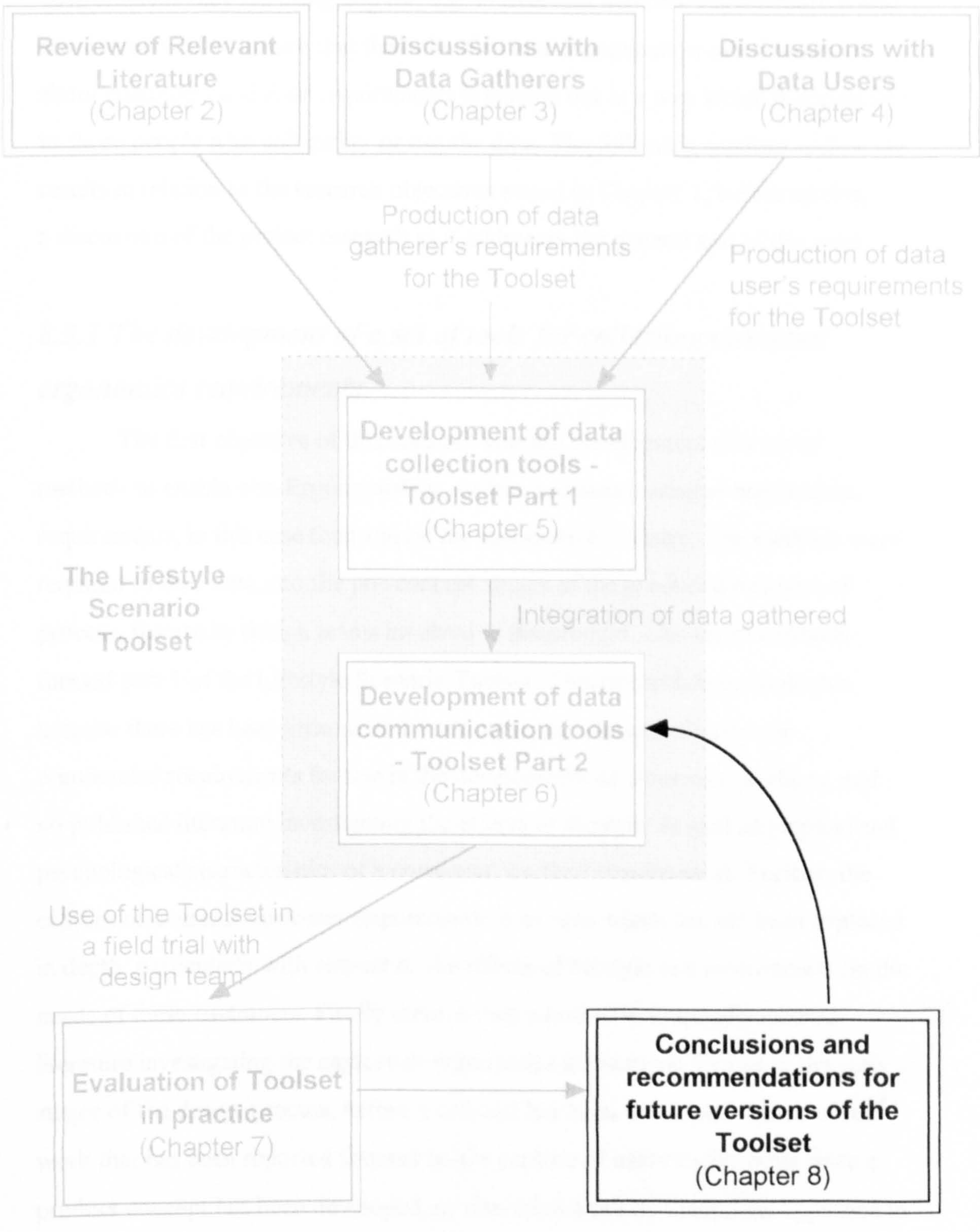


Figure 8.1 Chapter 8 in the context of the whole thesis

where the Designers have little knowledge or experience about the people and environments they are designing for, e.g. in overseas markets. Furthermore it was considered vital to ensure that the collection and dissemination of information about customers and their requirements is carried out in a way which is acceptable to those people who will gather or use the data. The following sections review the results in relation to the research objectives stated in Chapter 1, before turning to a discussion of the project research as it addresses the general aim of the work.

8.3.1 The development of a set of tools for collecting customer ergonomics requirements

The first objective of this research was the development of a set of methods to enable non-Ergonomists to collect overseas customer ergonomics requirements, in this case focusing on the automotive industry. The methods were required to feed data into the pre-concept stages of the product development process, for use by design teams involved in the process. This set of methods formed part 1 of the Lifestyle Scenario Toolset. This research was conducted because there has been little work investigating the capture of customer ergonomics requirements for use in the development of consumer products, and no published literature investigating the effects of lifestyle, as well as physical and psychological characteristics of a consumer, on their requirements. Further, the capture of overseas customer requirements is an area which has not been explored in depth, particularly with respect to the effects of lifestyle and environment on the needs of these customers. Finally there is only a limited amount of published literature investigating the capture of ergonomics information for use at the early stages of the design process, before a concept has been developed. Much of the work that has been reported focuses on the capture of user requirements once a product concept has been developed, or else takes a purely theoretical approach to the area rather than a practice centred perspective. In order to achieve this first objective a number of sub-objectives were specified, and are discussed below.

8.3.1.1 Establishing Data Gatherers' Requirements for the Lifestyle Scenario Toolset

The first sub-objective was to establish the data gatherers' requirements for the Lifestyle Scenario Toolset. The user-centred approach to design taken in this thesis emphasises the importance of eliciting the requirements of people who will use the Toolset to gather data, when developing the data collection methods for use in part 1 of the Lifestyle Scenario Toolset. By collecting these requirements part 1 of the Toolset could be tailored to meet the needs of the data gatherers in an appropriate manner. This ensured that part 1 of the Toolset was as usable and effective as possible, and maximised the probability of it being utilised to collect data in the future.

A series of interviews with the people who would use the Toolset to collect customer ergonomics requirements from overseas markets was undertaken. Interviews conducted with key members of the Marketing Research, Ergonomics and overseas operations from within the company generated a series of requirements and constraints which were used to shape the development of part 1 of the Lifestyle Scenario Toolset. The main requirements of the data gatherers were that the Toolset should need no expert knowledge, ergonomics or marketing research, to implement, and that if necessary it could be used by an external market research agency to collect data. They also did not want the tools to be complex, labour intensive or need extensive technology in order to implement them. They indicated that the data collection tools should be simple to understand with clear instructions about the information each would collect, and that the tools should be easy to translate into other languages. Further, they wanted the data gathered to be detailed and easy to communicate to the people who would use it in their work. Finally, the data gatherers stated that the data collection tools chosen for inclusion in part 1 of the Toolset must be cost effective in use.

Some of the key constraints on the development of part 1 of the Toolset were the lack of overseas expertise in the areas of ergonomics and marketing research. This meant that if there were problems with the use of the data collection

tools there was little opportunity to call in expert help to rectify the situation. Secondly the inconsistent nature of the overseas operations due to variations in their size and structure made the identification of key personnel in the overseas markets complex. It also made it difficult to develop a prescriptive method for implementing the Toolset in all markets, thus the use of the data collection methods needed to be fluid to fit in with the particular market in question. Finally the commercial nature of the product being developed meant that there was a tight time scale and budget imposed on the design process. Thus the development of data collection tools had to fit in with these constraints, and build on current practice where possible. However, at this stage there was little research investigating customer requirements capture within the company. It was difficult to fit in with current practice in part because of the lack of suitable research being conducted, and in part because the structure of the company meant that the Ergonomists and Market Researchers did not work closely together. Therefore it was complex trying to co-ordinate the research conducted by these two departments, and buy in at the early stages of the project was limited. Nevertheless towards the end of the research the Toolset was increasingly seen by both departments as being a useful set of tools to complement their research programmes and provide new and useful information. This also led to improved communication between the Ergonomics and Market Research Departments.

8.3.1.2 Selection of data collection tools for inclusion in the Lifestyle Scenario Toolset

The next sub-objective was the development of a set of data collection methods which met the requirements and constraints of the data gatherers. A wide range of tools and techniques which could be used to gather customer ergonomics information were discussed in the literature review (Chapter 2). Each of the possible methods was evaluated with respect to the data gatherers' needs (Chapter 3), and also their ability to capture useful and usable information about overseas customer ergonomics requirements. It was hypothesised that in order to increase the depth and validity of the data collected, and to build up a rich picture of the customers and their lifestyle a number of different data types and formats should

be collected. Therefore when evaluating the data collection tools for use in the Lifestyle Scenario Toolset it was vital to ensure that a range of techniques which collected different types and formats of information, e.g. quantitative, qualitative, pictorial, customer verbatims, were reviewed. A number of methods were considered to be suitable for development and inclusion in the Toolset, these were a questionnaire, driving diary and photographs, focus group, ergonomics audit and background information. Each of the methods provided a different type of information, for example quantitative data from the questionnaire, qualitative in-depth information from the diaries, rich visual information from the diary photographs and descriptive in-depth customer verbatims from the focus group. The data from each individual tool was used to complement and build on that gathered by the other tools included in part 1 of the Toolset. Thus each of the data collection tools could be used as a stand alone tool, could be used to feed data into the Toolset iteratively as needed, or could be used in conjunction with the other tools in part 1 of the Toolset to gather data from scratch. In this way the data collection Toolset developed formed a very flexible, adaptable set of methods for collecting overseas customer ergonomics requirements.

8.3.1.3 Evaluation of part 1 of the Toolset

The third sub-objective of this main objective was the evaluation of part 1 of the Lifestyle Scenario Toolset, to establish the usefulness to the company of the data collected and the usability of the data collection tools developed. Additionally the ability of the Toolset to meet the needs and criteria of the data gatherers identified in Chapter 3 was assessed. The data collection tools were evaluated by those people who had been involved in the collection of data using the Toolset, that is Market Researchers in the overseas operations and Ergonomists, both in the company and outside experts. These people had also been involved in identifying the requirements of the data gatherers and the constraints imposed on the data collection process. The evaluation indicated that all the tools could be used successfully to collect customer ergonomics data. The data gatherers reported that the tools they had implemented were easy to use and did not need any ergonomics expertise. However, in the future much of the work may be

contracted out to market research agencies because this is a standard practice to reduce the resource needed from within the company. A number of different types and formats of data was produced, all of which was new, previously uncollected information. The validity of the tools was tested by comparing the data collected using this Toolset to other research conducted by the company, which picked up information and themes in some of the same areas as this research, but not in as much detail. This comparison showed that the Lifestyle Scenario Toolset was identifying similar problems and information to that collected by the company, thus increasing confidence in the validity and reliability of the results. The tools collected a wide range of detailed information about customers, their vehicle, the environment they were living in and the tasks they carried out with their vehicle. In addition ergonomics requirements caused by the interaction between these factors were collected.

There were few problems ensuring that the language used in the Toolset was applicable to the American market because the tools developed used simple language, without any technical terminology or jargon. The Market Research Department from Land Rover North America helped to *translate* the data collection tools in this study, and it would be advised in the future when the Toolset is used in other markets to involve people from that market to translate the tools into their native tongue. Part 1 of the Toolset also required minimal technology to put in place; the cameras were the only technology needed to implement the Toolset, and these are now available in most countries. The Toolset was cost effective, especially in comparison to other market research studies carried out by the company.

All of the tools were recommended for inclusion in future versions of the Toolset because of the depth and range of information they produced. However, some changes may need to be made to the procedures used to make the process more efficient. The major change identified would be in the diary study, where the driving diary is linked to the photographs taken by customers. This link may need to be severed to ensure that delays in the study do not impinge on both the diary

information and photographs collected, and to enable photographs to be gathered independently of the diary data if desired.

8.3.2 The development of a set of tools for communicating customer ergonomics requirements

The second main objective of this research was the development of a set of methods to communicate customer ergonomics requirements to design teams who would use the information in the development of new products, in this case automobiles. The methods were intended to feed information into the pre-concept stages of the product development process, before any major decisions about the design of the product had been made. This set of data communication methods formed part 2 of the Lifestyle Scenario Toolset. This research was conducted because the literature identified miscommunication between disciplines as a major barrier to the integration of information in the development process (e.g. Ottum and Moore 1997). This problem has been identified in the relationship between Ergonomists and Designers (e.g. Woodcock and Galer Flyte 1995) and greatly affects the use of ergonomics information in the design process. Much of the research carried out in this area reports on, and suggests theoretical solutions to increase communication between the two disciplines, however, very little research actually addresses the practical development of methods to improve the situation in the design of consumer goods. By ensuring that the communication of customer information is done in a way which is acceptable to both the Ergonomists and Designers, uptake and incorporation of the information in new designs will be increased.

Another reason for conducting this research is that often Designers have little or no knowledge of the requirements of their overseas customers, who may be very different from the Designers themselves. The customers may have very different lifestyles and needs from the Designer and it is vital that the design team are aware of this when designing new products for overseas markets. In order to create an understanding of the consumer, and the reasons behind their requirements, it is important that the design team have a rich understanding of

their overseas customers. This helps Designers to think about overseas customer requirements, in addition to home market customer requirements when designing a new product. It was hypothesised that communicating different types of information in a range of formats and at a number of levels, enhances the depth and detail of information about customer ergonomics requirements available to Designers.

Further there has been only a limited amount of research published looking at the communication of ergonomics requirements in the development of consumer goods. Most of the research to date has focused on the incorporation of user requirements in the fields of Human-Computer Interaction (HCI) and work organisation (e.g. Allison et al 1992). Thus there is a need to extend this type of research to other fields, such as that of consumer goods.

Finally there is only a limited amount of published literature investigating the development of methods for communicating ergonomics information at the pre-concept stages of the design process. The literature identified the need to introduce ergonomics information into the development process at the early stages, while the design was still fluid and before constraints impinged on the possible design solutions chosen (e.g. Bruce et al 1995). However, most research has focused on the communication and development of customer needs once a concept has been produced by the design team. Little research has looked at the introduction of ergonomics information into the design process before a concept has been developed, thus the Lifestyle Scenario Toolset aimed to address this gap. In order to achieve this second objective a number of sub-objectives were outlined, and are discussed below.

8.3.2.1 Establishing Data Users Requirements for the Lifestyle Scenario Toolset

The first sub-objective was to determine the needs of the people who would use the data produced by part 1 of the Lifestyle Scenario Toolset. As identified in section 8.3.1.1 user-centred design advocates the involvement of

those people who will use a tool in its development, to ensure that the tool is tailored to meet their needs. By getting the data users to help develop the data communication tools the Toolset was more usable and effective at meeting their needs, thus increasing the likelihood of its acceptance and use by the design team.

A series of interviews was conducted with the people who would use the data generated by part 1 of the Toolset in their work, that is the design team including Designers, Concept Engineers and Ergonomists (see Chapter 4). These interviews generated a series of requirements and constraints which shaped the development of part 2 of the Lifestyle Scenario Toolset. Some of the key requirements of the data users were that the Toolset should present ergonomics information in language which was familiar to the design team, without jargon or technical terminology. The design team favoured the use of pictorial or visual information where possible, however, they also wanted the data to be presented at a range of levels so that they could back up the visual information with more detailed facts and figures. The design team also expressed the wish that the data communication tools were quick and easy to use, and they be located near to them in the design studio so that they were easily accessible when needed. These requirements are consistent with previous research findings relating to the way in which Designers work, and techniques which can be implemented to simplify the communication between Ergonomists and Designers (e.g. Pugh 1986).

One of the key constraints on the development of part 2 of the Toolset, as identified through these interviews, was the need to fit in with a real design project which was developing a new vehicle. This meant that a suitable design team who were at the pre-concept stages of the design process had to be identified and involved in the work. Additionally the Toolset had to collect and communicate information to the design team at the appropriate stage of the development process, before any decisions about which designs to take forward to the concept stage of the process had been made. This imposed a tight time schedule on the work because there was little time between the identification of a suitable team which had just been formed and their progressing the design process to develop a number of vehicle concepts. Secondly there were issues as to who should look

after the data produced by the Toolset. The Ergonomics Department were responsible for sponsoring this work and were understandably keen to maintain control of the data because of the high level of investment they had made. However, in order to make the Toolset more accessible to the design team, and therefore more likely to be used, the Toolset data was best placed in the design area, close to the Designers. This caused a certain amount of tension between the Ergonomists and the Designers, as the Ergonomists were concerned that they would lose control of 'their' data. However, the problem was resolved by placing the high level summaries and storyboards in the design area, whilst retaining the raw data and detailed information in the Ergonomics Department. Finally the company's clear desk policy made it difficult to leave information in one place all the time. Since most of the company's Designers used paper based communication when designing a new product, this initial Toolset was developed as a paper based version and backed up on computer. This meant that the paper version had to be stored somewhere convenient which would be obvious to the design team, yet not take up too much space in the design studio. Again differences between the culture in the Ergonomics and Design departments meant that it was easier and more convenient to leave the Toolset on a table in the Design area, where it could be accessed at any time by employees of the company. Conversely the raw data was locked away, and was only accessible by consulting one of the Ergonomists in the company. This meant it was less openly available and therefore less easy to browse through at short notice.

8.3.2.2 Selection and development of data communication tools for inclusion in the Lifestyle Scenario Toolset

The second sub-objective of this main objective was the development of a set of tools for communicating customer ergonomics information to design teams. A number of data communication tools were discussed in Chapter 2, and each was evaluated with respect to its ability to fulfil the requirements of the data gatherers, identified in Chapter 4. As with the data collection tools which formed part 1 of the Toolset, it was hypothesised that in order to increase the depth and validity of the information communicated to the design team, and to build up a rich picture of

the customers and their lifestyle a number of different data types and formats of information should be presented. Therefore the methods were also chosen to ensure that customers' ergonomics requirements were presented in a range of formats and at a number of different levels.

A number of high level summaries were produced from the information gathered through each of the individual data collection tools. These summaries were designed to enable members of the design team to explore the data collected without having to search through the raw data. They retained a moderate level of detail about the results from each tool, but at a level which could be used by members of the design team without needing interpretation from an Ergonomist. Where possible the summaries were presented graphically or pictorially, i.e. the high level summary from the Ergonomics audit tool was presented as a pictorial rating scale of the main findings. The raw data collected using part 1 of the Toolset was kept in the Ergonomics Department as it was felt by the Ergonomists in the company that the raw data, which provided the greatest level of detail about customer requirements, needed interpretation by themselves in order to make it usable by the Designers / Concept Engineers in the team.

The Designers / Concept Engineers also expressed a desire to have the main findings of the data presented at a high level which was quick and easy for them to use. Thus a series of hierarchical storyboards presenting customer information was developed. Three overview storyboards which showed information about the US customers, and seven task based storyboards presenting scenarios of vehicle usage were created. The task based storyboards showed how a range of tasks was carried out in the US, and some of the problems encountered by customers in that market. Scenarios were used because they built up a rich picture of the customer and their lifestyle, and they provided information about customer ergonomics requirements in a way which was flexible. In line with recommendations made in the literature about the presentation of data at the early stages of the design process, when the design being developed is still fluid, the data presented on the storyboards was not prescriptive. Thus it allowed the design

team to incorporate the information in their designs without being constrained by the data.

These storyboards were developed by systematically integrating the data collected using the individual data collection tools to create a rich picture of the customers' activities, requirements and lifestyle. For each of the scenarios developed information about the person, the vehicle they were using, how they carried out particular tasks and the environment in which they lived was combined. The most frequently occurring information was used as a basis for each of the storyboards, and unusual, extreme or influential information was included where it was considered necessary or informative.

Data was taken from each of the tools as appropriate; the questionnaire data was used to provide an estimation of the occurrence and magnitude of particular behaviour and requirements, and this was supplemented with information from the other tools. Each of the storyboards was developed to include a range of information formats, i.e. short bullet pointed scenarios, photographs, direct customer quotes and factual highlights from the data. These storyboards were placed in the design area in a highly visible position, so that they were available to the design team whilst they were designing the new vehicle they were working on.

In addition to the development of high level summaries and storyboards, an initial presentation was made to the design team to explain the information which was available to them and to discuss the data presented on the storyboards. At this stage any misunderstandings or questions the design team had about the Toolset could be answered by the Ergonomists, both internal and external to the company. This helped to increase awareness of the existence of the Toolset in the company, and improved the likelihood of the data being used by the design team.

8.3.2.3 Evaluation of the Toolset

The third sub-objective was the evaluation of part 2 of the Lifestyle Scenario Toolset, to determine the suitability of the data communication tools for conveying overseas customer information to design teams, and its ability to meet the data users' needs established in Chapter 4. The data communication tools were evaluated by the design team who used the information in their work developing a new vehicle. This team included Designers, Concept Engineers and Ergonomists. Some of these people had been involved in setting the criteria and requirements of the design team for the development of data communication tools.

The first stage of the evaluation was to assess the ease with which the data from the individual tools forming part 1 of the Toolset could be integrated. This was found to be unproblematic using the structured approach taken to the integration. Since each of the tools produced a different type of data, the storyboards could incorporate a range of information formats. This increased the depth and richness of the storyboards, and provided a more rounded picture of the customers and their lifestyles. The only tool's data that proved more difficult to incorporate was the Driving Diary. However, this was due in part to the time constraints on this study which meant that the data could not be as fully analysed as would have been liked, and was therefore not as easy to incorporate into the combined data. However, the photographs from this study proved to be invaluable for the storyboards.

The second stage of the evaluation established that the Toolset was well received by the design team. The data produced by the Toolset was considered to be new and useful by the Designers / Concept Engineers, and they were able to understand all the data presented to them. The hierarchical nature of the communication methods was liked by the design team, as it enabled them to use the Toolset at a level which was appropriate to their needs at the time. The storyboards were particularly well received, and generated a lot of discussion amongst the Designers / Concept Engineers, especially with regard to the photographs included on the storyboards. This was as expected since the

Designers / Concept Engineers had expressed a preference for pictorial information as one of their requirements. The location of the high level summaries and storyboards in the design area was also applauded by the designers, because they felt that their need for easy access to the data had been addressed. The design team was using most of the information provided on a day to day basis, and although they did not complete the activity logs provided for them, they expressed the opinion that the Toolset was providing them with new and useful information. They also reported that the information had challenged some of their preconceived ideas about customers in the US market and the way in which they carry out tasks with their vehicle.

Thus the data communication tools were considered to provide an acceptable means of conveying overseas customer ergonomics requirements to design teams. The storyboards and pictorial high level summaries were the most well received of the communication methods, and in future use of the Toolset it would be recommended that pictorial or graphical summaries of the other tools be developed if possible. The photographs were also popular with the design team because they conveyed such rich information about the customers, their vehicles, the environment in that market, and their lifestyles. The least used of the information presented was the video footage of the focus group. This was because of its long running time and in future use of the Toolset an edited version would be more acceptable. The design team expressed the opinion that short extracts of video footage relating to customer use of the vehicle would be helpful to them. However, in the first instance of using the Toolset to collect and communicate data it was not easy to gain support for use of some of the company's facilities such as the video editing suite. This was in part because the Toolset was unproved in its value at this stage, and there was a reluctance by some company personnel to provide resource until the Toolset had proven its worth. Since the Toolset has now proven to be a useful addition to the company's data collection methodology, future use of the Toolset should not be constrained by such limited resources.

8.3.3 General project aims

This thesis has shown that by gathering and communicating ergonomics information in a way which fits in with the needs of those who will collect it, and those who will use it, i.e. taking a user-centred approach, communication is improved between disciplines involved in the development process. The research has shown that the use of several different types and sources of information helps to capture and communicate customer ergonomics requirements in a way which is acceptable and usable by design teams working on the development of new products.

The Lifestyle Scenario Toolset developed in this work is now being taken on board by the company involved in this research. The company has proposed that the Toolset be used by company personnel on a wider range of projects to collect customer ergonomics requirements from people in other overseas markets. Some of the tools developed to collect data for the Toolset have been introduced into the company and it is planned to introduce others in the near future. Thus the Toolset is considered to have achieved its overall aim of using user-centred design to introduce customer ergonomics requirements to design teams, and increase their customer focus in the development of products for overseas consumers.

8.4 Contributions to knowledge

This thesis explored the issues surrounding the collection and dissemination of customer ergonomics requirements in consumer product design, and in particular the automotive industry. Emphasis was on the collection of overseas customers' requirements as these were considered to be those which UK design teams knew least about, and were therefore more difficult for them to envisage and design for. A review of the literature related to the design and development of new products, the capture of customer requirements and the communication of information between disciplines provided an overview of the state of research in these areas (see Chapter 2). A substantial body of research exists looking at the incorporation of user requirements in the area of human-

computer interaction (HCI) (e.g. Allison et al 1992). However, there has been little published about the incorporation of user ergonomics requirements into the development of consumer goods (e.g. Kaulio 1997) and less still about the needs of overseas customers (e.g. Kaplan 1998).

As was identified in the literature review, to ensure the effective use of consumer information it is important to incorporate it as early in the design process as possible. Nevertheless there has been limited research looking at the incorporation of customer requirements at the pre-concept stages of the design process. Therefore research investigating the collection and dissemination of overseas customer ergonomics requirements into the early stages of the process is needed. This is particularly true with regard to research focusing on the introduction of customer requirements in real life situations, that is research taking a case study approach rather than a wholly theoretical perspective.

The contributions to knowledge made by this thesis are the provision of methods for use by non-Ergonomists to gather overseas customer requirements to feed into the pre-concept stages of the design process. Also the development of methods for communicating the customer requirements to Designers in ways which will help to improve the communication between Ergonomists and people from other disciplines involved in the design process.

Another contribution to knowledge made by this work is the development of methods based on the way in which the design and development process works in practice rather than theory. There has been a lot of research published regarding theoretical aspects of the development of new products, and how design, ergonomics and customer requirements fit into this process. However, there has been little research documenting the implementation of these theories in the development of real life commercial products.

Finally this thesis contributes to knowledge by collecting and communicating information about customers' ergonomics requirements in the context of their lifestyle. Rather than presenting the requirements as a series of

statements, the Toolset uses a range of different types of data to provide a rich picture of customers needs. These needs are conveyed to the Designers in the form of stories, with pictures and quotes, to create a greater empathy between the design team and the customers they design for.

8.5 Directions for future research

The work presented in this thesis raised a number of additional research questions, and identified many avenues for further research. This section outlines some possible directions for future research.

Firstly, there is a need to conduct this research in other overseas countries to ensure that the Toolset is suitable for collecting customer requirements in a wider range of environments. The work in this thesis was restricted to two overseas markets, Australia and USA, due to time and cost constraints, however, it is vital that the Toolset now be tested on a broader range of customers. It would also be advantageous to test the Toolset on a sub-set of the population in some countries, for example the US market as it is very varied in some respects. Differences may exist between the ergonomics requirements of people on the East Coast and those living on the West Coast. These differences could be explored in large diverse markets to get a greater level of detail about particular customer groups.

The research reported in this thesis focused mainly on the needs of the drivers and passengers of a vehicle. In the future it would be useful to include the views of other people who deal with the vehicle, e.g. mechanics, chauffeurs, other road users, to provide a more balanced view of the vehicle. Nevertheless, in practice this may prove difficult to achieve because it can be complex trying to identify these people and get them involved in research of this nature.

This thesis was unable to find an acceptable way of collecting video footage directly from customers showing them using their vehicle and the

problems they encounter. Nevertheless, the design team involved in the research expressed a desire to have this type of footage available. The difficulties encountered in this research were due in part to the lack of time, money and resource available during this project. However, commitment from the company to implement the Lifestyle Scenario Toolset has now increased and in the future it should be easier to set up a study to include customer video footage in the Toolset. This may involve an employee from the company making accompanied journeys with customers or watching them complete tasks, and taking video footage of the events. It would be interesting to explore the nature of information which could be conveyed using video footage. Another technique which would be interesting to explore is that of a dynamic audit, that is for an expert Ergonomist to audit the vehicle as it is used to carry out a range of tasks. This may be time consuming initially, but could be conducted over a longer time scale and used to build up a database of information about different vehicles.

The Toolset developed in this thesis was designed to be generic, although in this case it was tailored to collect and communicate customer ergonomics requirements in the automotive industry. Future research could expand and adapt the use of this Toolset to investigate the incorporation of customer ergonomics information into the design of other products, such as white goods.

An area of research which has yet to be explored extensively in the design of consumer goods is that of the emotional aspects people expect from a product. Some work has begun in this area (e.g. Jordan 1998b) but more research is needed to establish how these requirements can be captured and incorporated into new designs for commercial products. The research in this thesis has started to explore these issues by incorporating lifestyle information into the customer requirements communicated to design teams. However, there is a need to develop methods for capturing and conveying aspects such as pleasure, pride and expectations created by a product, to design teams. It can sometimes be difficult for consumers to verbalise these needs, and often they do not realise that they exist because they are hidden requirements. However, it is important that future research tries to address these needs as they can have significant effects on the design of new products.

Finally research into the organizational aspects which affect the collection and use of customer requirements information in the design process, in real life situations is needed. There has been a moderate amount of research conducted looking at the theory of design management and organisational issues which influence the extent to which the development process is customer focused (e.g. Hart 1995), but research into the effect of these aspects in real world situations is limited. It would be interesting to investigate how these factors affect the implementation of a Toolset such as that developed in this research.

8.6 Final conclusions

From the research conducted in this thesis it can be concluded that collecting and communicating a range of types and levels of information about customer ergonomics requirements increases the acceptance and usability of this information to design teams working on the development of new products. By using a range of different types of information about customer requirements and presenting this at a variety of levels of detail, the data can be used by people with a wide diversity of backgrounds and needs from the data. The use of a range of techniques, that is triangulation, enriches the data and increases confidence in its validity. Further communicating customer requirements in a number of formats builds a rich picture of the customers and their lifestyles, and helps to build empathy between the design team and the consumers. This increases the prominence of consumer data, increases the focus on consumers in the product development process and leads to new designs which better meet the needs of the consumers who will use them.

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Appendix A

Section 1: Data Gatherers Requirements Interview Schedule

Section 2: Data Users Requirements Interview Schedule

Section 1:

Data Gatherers Requirements Interview Schedule

Data Gatherers Interview Schedule

Areas to discuss

- What sort of ergonomics information do the designers ask for at present - do they ask the Ergonomists to find information from books, etc. and/or do they ask for tests to be run?

- In what format(s) do the Ergonomists supply the data to the Designers?

- What areas of the car do you deal with - all, or is there someone else who deals with the interior, etc.?

- At what stages of the design process do the Designers ask for most information - do they ask at the earliest stages or do they ask once a problem has developed, and hope you can fix it?

- Do the Designers actively seek Ergonomics information, i.e. are they asking for information to incorporate into their designs?

- Can the Ergonomics Department supply the data the Designers are asking for in the UK and European markets - what happens if you cannot supply the information, do they wait for you to find the relevant data from literature or testing?

- What information is the Ergonomics Department able to provide about overseas markets at present and what sort of queries for additional information are you getting?

- Who do the majority of the queries come from, the designers, managers, etc.?

Section 2:

Data Users Requirements Interview Schedule

Data Users Requirements Interview Schedule

The initial meetings with designers are intended to investigate how customer and market information is incorporated into the current design process. Some of the issues which need to be discussed focus on the methods and techniques used by the Designers to design vehicles for overseas markets.

- What sort of questions do you need to know about a new vehicle for an overseas market, in terms of:
  - users
  - environment
  - activities for which the vehicle is to be used

- Who do you ask the questions of?

- How successful is the present process for supplying information?
  - What do you do at present if you don't have the information you want or you have to wait too long to get it?

- What sources and formats of user, environment and task information do you use to base the decisions and solutions on, e.g. formal reports, verbal, notes etc.?

- What are the types of design decisions regarding the users, environment and activities the vehicle will be used for, that the Designers have to make.
  - What are the givens and constraints - each design is presumably based on an existing product which is being sold in the UK.
  - How do you decide on the trade-offs - is there a systematic way you decide or is it up to the individual designer.

I also need to know about how the Lifestyle Scenario Toolset will fit into the design process, who would use it etc.

- What documentation is available to show where user requirements have been considered in past projects.
    - explicit, formal documentation
    - implicit, informal documentation, i.e. someone keeps notes on previous projects for their own use, although it is not a formal process.

- Do you use information from competition analysis - what sort of information does this provide?

- Discuss whether the Toolset, and mode of presentation as it stands will be useful to the designers who have to use it?

- Discuss how the Toolset will be implemented and who would do that, i.e. who would look after the data produced by the Toolset - all designers, key designers or Ergonomists?

- Discuss any extra information/ methods/ communication media etc. they feel would be useful to them in the design of vehicles for overseas markets.

Appendix B

Section 1: International Driver Questionnaire

Survey Pack

- Cover Letter
- Questionnaire schedule

Section 2: Driving Diary Pack

- Initial Letter
- Cover Letter
- Diary schedule

Section 3: Ergonomics Audit Form

Section 4: Focus Group Schedule

Section 5: Background Data Form

Section 6: Toolset Handbook

Section 1:

International Driver Questionnaire Survey Pack

- **Cover Letter**
- **Questionnaire schedule**

November 20, 1997

Dear Discovery Owner,

Many people feel that even new vehicles are not always as easy to use or as comfortable as they would like them to be. Loughborough University and Land Rover are currently looking into ways of improving Land Rover products in North America by gathering information about what customers want from their vehicle. As part of this process Loughborough University is conducting a postal questionnaire which collects information about vehicles, the people who use them and how they are used.

As a LandRover owner we would value your help in completing one of these questionnaires. This is your opportunity to influence future vehicle design. Completing a questionnaire takes approximately 30 minutes, and involves answering questions about your vehicle and the positive and negative aspects of using your vehicle. We have enclosed a small gift as a token of our appreciation of your help.

Please take the time to complete the questionnaire and return it in the enclosed pre-paid reply envelope to:

Driving Questionnaire,
LandRover North America,
5746 Palatine Road
Charlton, Ohio.

If you have any questions regarding completion of the questionnaire please feel free to contact:
C. L. Eost, Department of Human Sciences, Loughborough University, Leicestershire, LE11 3TU. UK.
Fax: +44 (0)1509 22222. E-mail: C.L.Eost@lboro.ac.uk, or call Land Rover Customer Care on
800-222-2222.

Your responses will be anonymous and confidential.

Once again thank you for your assistance.

Yours sincerely,

Questionnaire number: ❑❑❑❑❑

INTERNATIONAL DRIVER QUESTIONNAIRE

Despite the increasing sophistication of new vehicles many people still feel that they are not as comfortable or easy to use as they would like them to be. This is sometimes because companies don't have enough information about what their customers want from a vehicle.

- This questionnaire is about your vehicle and how you use it.
- Please answer all the questions.
- This questionnaire will take about 30 minutes to complete.
- If you have any questions about completing the questionnaire please contact:
  C. Eost, Department of Human Sciences, Loughborough University, Loughborough, Leicestershire, LE11 3TU. UK.
  Fax: +44 1509 223940. E-mail: C.L.Eost@lboro.ac.uk, or call Owner Care on # 800-637-6837
- Once you have completed your questionnaire please seal it in the pre-paid reply envelope and send it to:

Driving Questionnaire,
LandRover North America,
4371 Parliament Place,
Lanham,
MD 20706

All information in this questionnaire will be confidential and will not be shown to anyone else.

YOUR VEHICLE AND OTHERS YOU DRIVE

Q1: What make and model of vehicle do you currently drive?

Make: _____

Model: _____

Type of vehicle:

Sedan	❑	Pickup truck	❑
Station wagon	❑	Sports / Coupé	❑
Convertible	❑	Van / Minivan	❑
Hatchback	❑	Commercial purpose vehicle	❑
4X4 / SUV	❑	Other	❑

Year of registration: _____

Number of doors: _____

Q2: Does anyone else drive this vehicle, if so who?

_____

_____

_____

Q3: What made you decide on the vehicle you have now?

_____

_____

_____

_____

_____

_____

Q4: Did you look at other vehicles before choosing this one, and if so why did you reject them?

Yes ❑ No ❑

_____

_____

_____

_____

_____

Q5: What vehicle did you have before your current one?

Make: _____

Model: _____

continued

Type of previous vehicle:

Sedan	❑	Pickup truck	❑
Station wagon	❑	Sports / Coupé	❑
Convertible	❑	Van / Minivan	❑
Hatchback	❑	Commercial purpose vehicle	❑
4X4 / SUV	❑	Other	❑

Year of registration: _____

Number of doors: _____

I did not have a vehicle before this one ❑

Q6: Do you have access to any other vehicles?

No ❑ *Go to Q8*

Yes ❑ Please give details below.

Other vehicle 1

Make: _____

Model: _____

Type of vehicle:

Sedan	❑	Pickup truck	❑
Station wagon	❑	Sports / Coupé	❑
Convertible	❑	Van / Minivan	❑
Hatchback	❑	Commercial purpose vehicle	❑
4X4 / SUV	❑	Other	❑

Year of registration: _____

Number of doors: _____

Other vehicle 2

Make: _____

Model: _____

Type of vehicle:

Sedan	❑	Pickup truck	❑
Station wagon	❑	Sports / Coupé	❑
Convertible	❑	Van / Minivan	❑
Hatchback	❑	Commercial purpose vehicle	❑
4X4 / SUV	❑	Other	❑

Year of registration: _____

Number of doors: _____

Q7: Do you use the other vehicle(s) for any particular activities? Please explain.

Yes ❑ No ❑

_____

_____

_____

Q8: Which of the following features does your vehicle have, which would you like on a future vehicle (include any features of your current vehicle you want to keep) and which would you NOT like on a future vehicle?

	Have now	Would like	Would not like
Adjustable steering wheel/tilt	❑	❑	❑
Air conditioning	❑	❑	❑
Airbag - driver's side	❑	❑	❑
Airbag - passenger's side	❑	❑	❑
Anti theft device / alarm	❑	❑	❑
Audio system controls on steering wheel	❑	❑	❑
Automatic transmission	❑	❑	❑
Bike rack	❑	❑	❑
Child seat	❑	❑	❑
Compact disc player	❑	❑	❑
Cruise control	❑	❑	❑
Cup holders	❑	❑	❑
Exterior temperature indicator	❑	❑	❑
Fire extinguisher	❑	❑	❑
Heated front windshield	❑	❑	❑
Heated rear window	❑	❑	❑
Heated seats	❑	❑	❑
Heated washer jets	❑	❑	❑
Height adjustable driver's seat	❑	❑	❑
Height adjustable front seat belts	❑	❑	❑
Height adjustable passenger's seat	❑	❑	❑
Height adjustable rear seat belts	❑	❑	❑
In-vehicle telephone	❑	❑	❑
Lockable glove box	❑	❑	❑
Luggage net	❑	❑	❑
Pet guard	❑	❑	❑
Power locks	❑	❑	❑
Power mirrors	❑	❑	❑
Power steering	❑	❑	❑
Radio/ tape player	❑	❑	❑
Rear seat head restraints	❑	❑	❑
Roof-box	❑	❑	❑
Roof-rack	❑	❑	❑
Security box in vehicle	❑	❑	❑
Ski clips / rack	❑	❑	❑
Snow chains	❑	❑	❑
Storage areas in the trunk door	❑	❑	❑
Storage areas in the front doors	❑	❑	❑
Storage areas in the rear doors	❑	❑	❑
Storage in centre console	❑	❑	❑
Storage on or above sun visor	❑	❑	❑
Storage pockets in the rear of the front seats	❑	❑	❑
Sun blinds / shades	❑	❑	❑
Sun roof	❑	❑	❑
Sun visors	❑	❑	❑
Tinted glass	❑	❑	❑
Towing mirror	❑	❑	❑
Ultrasonic parking aid	❑	❑	❑

Other features I like on my vehicle:

1. _____
2. _____
3. _____

Other features I would like on my vehicle:

1. _____
2. _____
3. _____

continued ⇩

Q9: Are there any of the features in Q8 which you have on your vehicle but you don't want?

Which feature	Why you do not want it

Q10: Of the features you already have on your vehicle which three do you find most useful and why?

Which feature	Why you find it useful

Q11: If you could only choose three of the features in Q8 to have on a new vehicle which would you choose and why?

Which feature	Why you want it

Q12: Do you or any of your passengers ever have any vehicle related special needs or problems, e.g. stiff joints? Please explain.

Yes ❑ No ❑ *If no go to Q14*

Q13: When using your vehicle how do you cope with these problems?

HOW YOU USE YOUR VEHICLE

Q14: Do you have any problems getting in and out of your vehicle? e.g. seat too high or low

Q15: Are there any particular circumstances which make it easier or more difficult to get in and out of your vehicle?

Q16: How often do you use your vehicle for:

	Almost every day	At least once a week	At least once a month	At least every 3 months	At least once a year	Never/ not applicable
Highway driving	❑	❑	❑	❑	❑	❑
Out of town driving	❑	❑	❑	❑	❑	❑
Driving in town /city	❑	❑	❑	❑	❑	❑
Driving off road	❑	❑	❑	❑	❑	❑
Commuting to & from work	❑	❑	❑	❑	❑	❑
For business purposes	❑	❑	❑	❑	❑	❑
For shopping	❑	❑	❑	❑	❑	❑
Taking children to school	❑	❑	❑	❑	❑	❑
Towing a caravan/ trailer	❑	❑	❑	❑	❑	❑
Carrying adults in the front	❑	❑	❑	❑	❑	❑
Carrying children in the front	❑	❑	❑	❑	❑	❑
Carrying adults in the back	❑	❑	❑	❑	❑	❑

continued overleaf

	Almost every day	At least once a week	At least once a month	At least every 3 months	At least once a year	Never/ not applicable
Carrying children in the back	❑	❑	❑	❑	❑	❑
Carrying luggage or parcels	❑	❑	❑	❑	❑	❑
Carrying large items in the vehicle	❑	❑	❑	❑	❑	❑
Carrying items on a roof rack	❑	❑	❑	❑	❑	❑
Carrying sports or leisure equipment using the vehicle	❑	❑	❑	❑	❑	❑
Carrying pets in the vehicle	❑	❑	❑	❑	❑	❑
Using the rear seat folded down	❑	❑	❑	❑	❑	❑
Weekend trips	❑	❑	❑	❑	❑	❑
Holidays	❑	❑	❑	❑	❑	❑

Q17: Is there anything in the design of your vehicle which you feel makes driving difficult?

Q18: Is there anything in the design of your vehicle which you feel makes parking difficult?

Q19: Do you ever encounter weather which makes driving difficult, please specify?

If none go to Q21

Q20: How do these conditions change your driving behaviour?

Q21: Do you encounter any hazardous animals in your usual driving? Please specify.

If none go to Q23

Q22: How does this change your driving behaviour?

Q23: Do you ever get worried or frightened when using your vehicle? Please specify.

If not go to Q26

Q24: How does this change your driving behaviour?

Q25: Are there any vehicle design related ways which would help you in such situations?

Q26: Do you feel the security features you use on your vehicle are enough to protect you, your vehicle and its contents from crime? Please explain.

Q27: Do you ever have trouble loading things into and out of your vehicle. If so why is this?

Q28: Do you ever do anything other than driving in your vehicle? Please check all that apply.

- Eating ☐
- Drinking ☐
- Shaving ☐
- Putting on cosmetics ☐
- Watching movies ☐
- Changing diapers ☐

Others, please describe _____

Can you think of any features which would help with these activities?

Q29: When you get fuel for your vehicle do you:

- go to a self service garage ☐
- go to an attendant service garage ☐
- other _____

Does this ever cause you any problems?

Q30: How often do you get fuel for your vehicle?

- Less than once a month ☐
- Once a month ☐
- Every two weeks ☐
- Once every week ☐
- Several times a week ☐
- Other ☐

MAINTAINING YOUR VEHICLE

Q31: When your vehicle is washed is it:

- washed at home ☐
- washed using a manual garage car wash ☐
- washed using an automatic car wash ☐
- other _____

Does this ever cause any problems, e.g. reaching the roof to hand wash the vehicle?

Q32: How often is your vehicle washed?

- Less than once a year ☐
- Once a year ☐
- 2 - 4 times a year ☐
- Once a month ☐
- Every two weeks ☐
- Every week ☐
- Other _____

Q33: When the inside of your vehicle is cleaned is it:

- cleaned at home without a vacuum cleaner ☐
- cleaned at home using a hand held vacuum ☐
- cleaned at home using a regular vacuum ☐
- cleaned using a vacuum cleaner at a garage ☐
- other _____

Does this ever cause any problems, e.g. getting the vacuum cleaner in to the small areas?

Q34: How often is the inside of your vehicle cleaned?

- Once a year ❑
- 2 - 4 times a year ❑
- Once a month ❑
- Every two weeks ❑
- Every week ❑
- Other ❑

Q35: Do you carry out regular maintenance checks on your vehicle? Please describe what you do, how often and any problems you encounter?

Yes ❑ No ❑

Q36: Do you ever carry out any repairs or servicing of your vehicle yourself? Please specify. If not, why is this and where do you get them done?

Yes ❑ No ❑

YOU AND YOUR FAMILY

Q37: Please check the age group you are in:

- Under 17 ❑
- 17-24 ❑
- 25-34 ❑
- 35-49 ❑
- 50-69 ❑
- 70+ years ❑

Q38: Sex:

Male ❑ Female ❑

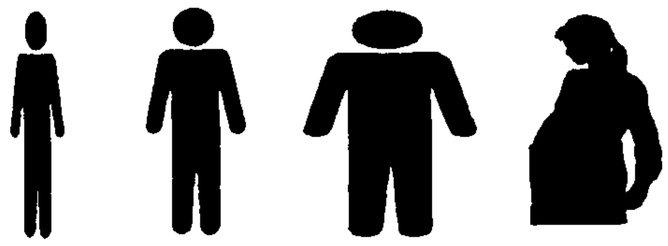
Q39: How tall are you?:

- Under 1.20m / 3'11" ❑
- 1.21 - 1.30m / 3'11" - 4'3" ❑
- 1.31 - 1.40m / 4'4" - 4'7" ❑
- 1.41 - 1.50m / 4'8" - 4'11" ❑
- 1.51 - 1.60m / 5'0" - 5'2" ❑
- 1.61 - 1.70m / 5'3" - 5'6" ❑
- 1.71 - 1.80m / 5'7" - 5'10" ❑
- 1.81 - 1.90m / 5'11" - 6'2" ❑
- 1.91 - 2.00m / 6'3" - 6'6" ❑
- Over 2.00m / 6'6" ❑

Q40: Which weight range are you in?:

- Under 40kgs / 88lbs ❑
- 40.1 - 50.0kgs/ 88lbs - 110lbs ❑
- 50.1 - 60.0kgs/ 111lbs - 132lbs ❑
- 60.1 - 70.0kgs/ 133lbs - 154lbs ❑
- 70.1 - 80.0kgs/ 155lbs - 176lbs ❑
- 81.1 - 90.0kgs/ 177lbs - 198lbs ❑
- 91.1 - 100.0kgs/ 199lbs - 220lbs ❑
- 100.1 -110.0kgs/ 221lbs - 242lbs ❑
- 110.1 - 120.0kgs/ 243lbs - 264lbs ❑
- Over 120kgs / 264lbs ❑

Q41: Which picture best describes your build?:



❑ ❑ ❑ ❑ Pregnant

Q42: What is your job?:

- Executive ❑
- Housewife ❑
- Manager ❑
- Manual/Factory ❑
- Office/Clerical ❑
- Professional ❑
- Retired ❑
- Self-employed ❑
- Student ❑
- Teacher/Lecturer ❑
- Shop assistant ❑
- Skilled tradesman ❑
- Unemployed ❑
- Other ❑

Q43: Marital status:

- Single ❑
- Married ❑
- Cohabiting ❑
- Separated/ Divorced ❑
- Widowed ❑
- Other ❑

Q44: How many people are there in your household (include yourself)?

There are ..... people in my household

How many children in the following age groups live in your household?

- Under 1 _____
- 1-4 years _____
- 5-8 years _____
- 9-12 years _____
- 13-16 years _____
- Over 16 years _____

continued over leaf

OTHER INFORMATION

Q45: Is there any other information about your vehicle or driving which you would like to tell us about?

continued

Section 2:

Driving Diary Pack

- Initial Letter
- Cover Letter
- Diary schedule

November 20th 1997

Dear Discovery Owner,

Many people feel that even new vehicles are not always as easy to use or as comfortable as they would like them to be. Loughborough University and Land Rover are currently looking into ways of improving Land Rover products in North America by gathering information about what customers want from their vehicle. As part of this process Loughborough University is conducting a Driving Diary which collects information about vehicles and how they are used.

As a Land Rover owner we would value your help in completing one of these diaries. This is your opportunity to influence future vehicle design. Completing a Driving Diary would involve briefly filling in details of your driving activities over a 7 day period (to be chosen by you), and also taking a series of photographs of your vehicle and where you drive it, using a disposable camera supplied with the diary.

As a token of our appreciation for your help we will send you a free Land Rover T- shirt or sports hat on completion of the diary.

The diaries will be sent out between November 20th - December 20th 1997

If you would like to take part in this survey please complete the reply slip below and send it in the pre-paid reply envelope to Driving Diary, Land Rover North America, 5746 Palatine Road, Charlton, Ohio 20706, or call Owner Care on # 800-222-2222. You will then be sent your Driving Diary and camera.

All information given in this survey will be confidential

Sincerely,

Detach here

Name: _____

Address: _____

_____

_____

_____

Please tick as appropriate:

Yes, I would like to take part in the 'Driving Diary' survey ❑

No, I would not like to take part in this survey ❑

November 28, 1997

Dear Discovery Owner,

Thank you for agreeing to complete a Driving Diary. This pack contains a Driving Diary booklet, a disposable camera and a pre-paid reply envelope. All instructions on how to complete the diary, and which pictures to take are given in the diary booklet, please read them before you begin to fill in the diary.

Once you have completed your diary and photographs please fill in the form to receive your free Land Rover T- shirt or sports hat. Then put the diary and camera in the pre-paid envelope provided and send them to:

Driving Diary,
Land Rover North America,
5746 Palatine Road,
Charlton, Ohio

If you have any problems or questions regarding completion of the Driving Diary please contact:
C. L. Eost, Department of Human Sciences, Loughborough University, Leicestershire, LE11 3TU. UK.
Fax: +44 (0)1509 222222. E-mail: C.L.Eost@lboro.ac.uk, or Owner Care, Land Rover North America, 5746 Palatine Road, Charlton, 4371. Tel. #800-222-2222.

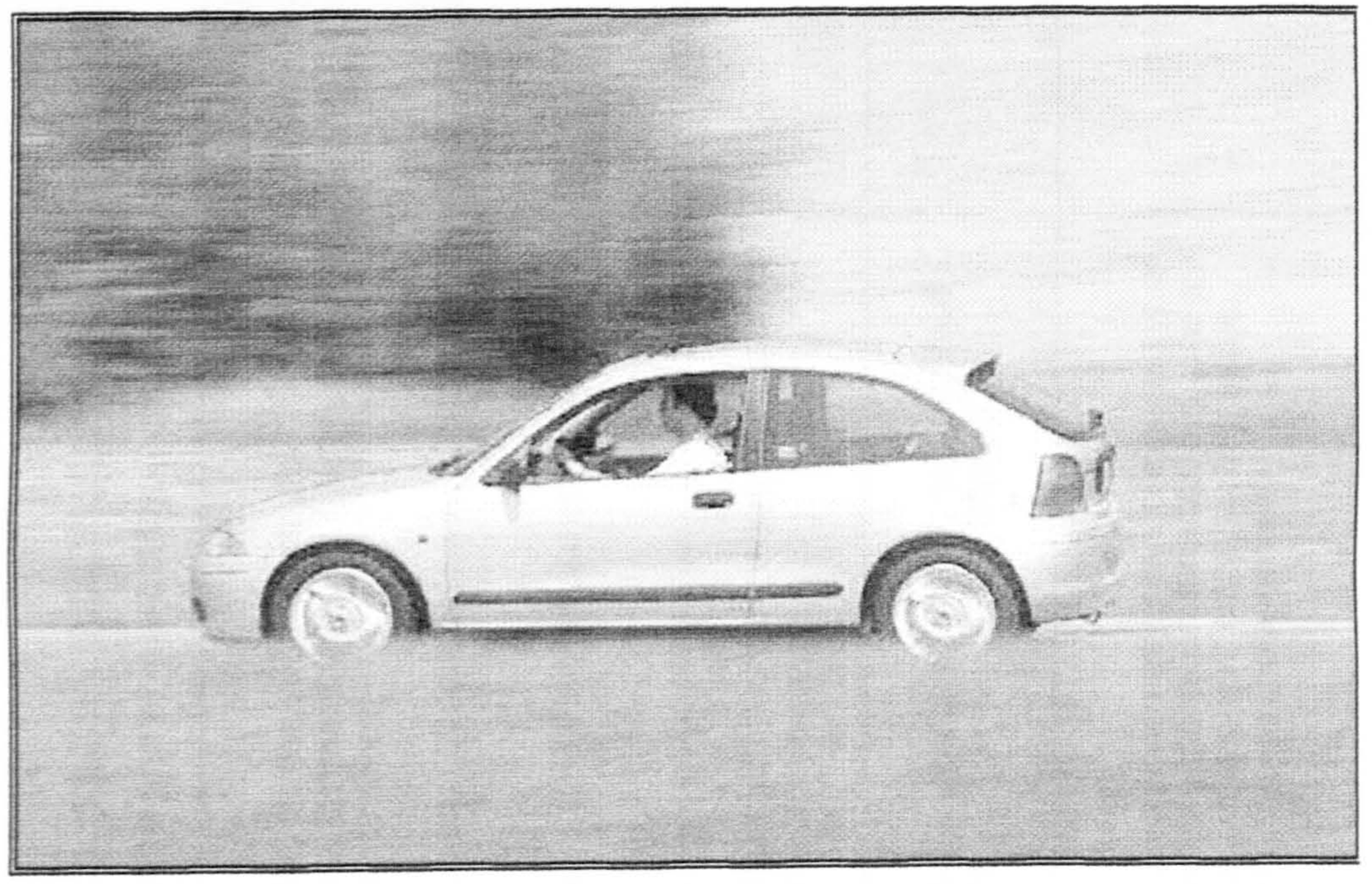
All information given in this survey will be confidential.

Once again thank you for your assistance.

Yours sincerely,

Diary number

DRIVING DIARY



Driving Diary

Read this first:

Many people feel that even new vehicles are not always as easy to use or as comfortable as they would like them to be. This is sometimes because vehicle companies don't have enough information about what people who use their vehicles want.

This diary is about your vehicle and how you use it.

Please complete the diary for one week (seven days):

> Fill in the 'Daily Diary' pages for six days and the 'In Depth Diary' pages for one day.

On the day you fill in the 'In Depth Diary' pages please also take the photographs listed using the camera provided.

Please fill in your diary as soon after each trip as you can, but do not fill it in whilst driving.

Feel free to add any comments or extra information you think might be helpful.

At the start of the week fill in the sheet 'About the users of this vehicle'

As an added incentive we will give you a free LandRover T-shirt when you send us back your completed diary and camera. So don't forget to tell us what size T-shirt you would like and where to mail it to, in the section provided.

What sort of roads did you drive on?					
Did you use your in-vehicle entertainment system? (please tick one or more)	❑ Yes radio ❑ Yes tape player ❑ Yes C.D. player ❑ No ❑ Do not have one				
What was the purpose of this journey?					
Where did you park when you reached your destination?					
Did you put anything in, out, on or off the vehicle at your destination?					
Do you have any ways of making your journey more comfortable, e.g. use a lumbar support, cover leather seats with a rug in hot weather?					

TODAY IS _____

	TRIP 3	TRIP 4
Who are you, e.g. driver 1,2, etc.?		
Time journey started / finished		
Approximately how long (in distance) was your journey?		
Where did you get your vehicle keys from, e.g. kitchen drawer?		
Where was your vehicle parked?		
Did you have to do anything before you got into the vehicle, e.g. de-ice the windows and locks		
Did you use any special equipment in or on the vehicle, e.g. child seat, roof rack?		
Did you have to alter the seat, steering wheel or mirror positions when you got into the vehicle?		

If you have any questions about filling in this diary please contact Charlotte Eost, Department of Human Sciences, Loughborough University, Loughborough. LEICS. LE11 3TU. UK.
Fax: +44 1509 223940. E-mail: C.L.Eost@lboro.ac.uk.

Once you have completed your diary please seal it in the pre-paid return envelope and send it to:

Driving Diary
c/o P. Montopoli,
LandRover North America
4371 Parliament Place,
Lanham.
MD20706

Diary checklist

Please make sure that by the end of your seven diary days you have:

1. Completed the section called 'About the users of this vehicle'.
2. Filled in six 'Daily Diary' pages.
3. Filled in the 'In Depth Diary' pages on one day.
4. Taken the photographs using the camera provided.
5. Filled in all the questions on the other pages of the diary.

All information in this diary will be confidential and will not be shown to any one else.

About the users of this car

1. What make and model of vehicle is this?

Make _____ Model _____

Type of vehicle:

Sedan	❑	Pick up truck	❑
Station wagon	❑	Sports/ Coupé	❑
Convertible	❑	Van / Minivan	❑
Hatchback	❑	Commercial purpose vehicle	❑
4X4 / SUV	❑	Other	❑

Year of registration _____ Number of doors _____

2. Who are the main drivers of this vehicle, e.g. myself, my husband, my daughter and what job, if any, do they do?

	Who	Job	Male	Female
Driver 1:	_____	_____	❑	❑
Driver 2:	_____	_____	❑	❑
Driver 3:	_____	_____	❑	❑
Driver 4:	_____	_____	❑	❑

3. What are the ages of the drivers of this vehicle (please circle)?

Driver 1: 17-24 / 25-34 / 35-49 / 50-69 / 70+ years

Driver 2: 17-24 / 25-34 / 35-49 / 50-69 / 70+ years

Driver 3: 17-24 / 25-34 / 35-49 / 50-69 / 70+ years

Driver 4: 17-24 / 25-34 / 35-49 / 50-69 / 70+ years

What sort of roads did you drive on?	❑❑❑❑❑ Yes radio Yes tape player Yes C.D. player No Do not have one				
Did you use your in-vehicle entertainment system? (please tick one or more)	❑❑❑❑❑ Yes radio Yes tape player Yes C.D. player No Do not have one				
What was the purpose of this journey?					
Where did you park when you reached your destination?					
Did you put anything in, out, on or off the vehicle at your destination?					
Do you have any ways of making your journey more comfortable, e.g. use a lumbar support, cover leather seats with a rug in hot weather?					

TODAY IS _____

	TRIP 1							TRIP 2
Who are you, e.g. driver 1,2, etc.?								
Time journey started / finished								
Approximately how long (in distance) was your journey?								
Where did you get your vehicle keys from, e.g. kitchen drawer?								
Where was your vehicle parked?								
Did you have to do anything before you got into the vehicle, e.g. de-ice the windows and locks								
Did you use any special equipment in or on the vehicle, e.g. child seat, roof rack?								
Did you have to alter the seat, steering wheel or mirror positions when you got into the vehicle?								

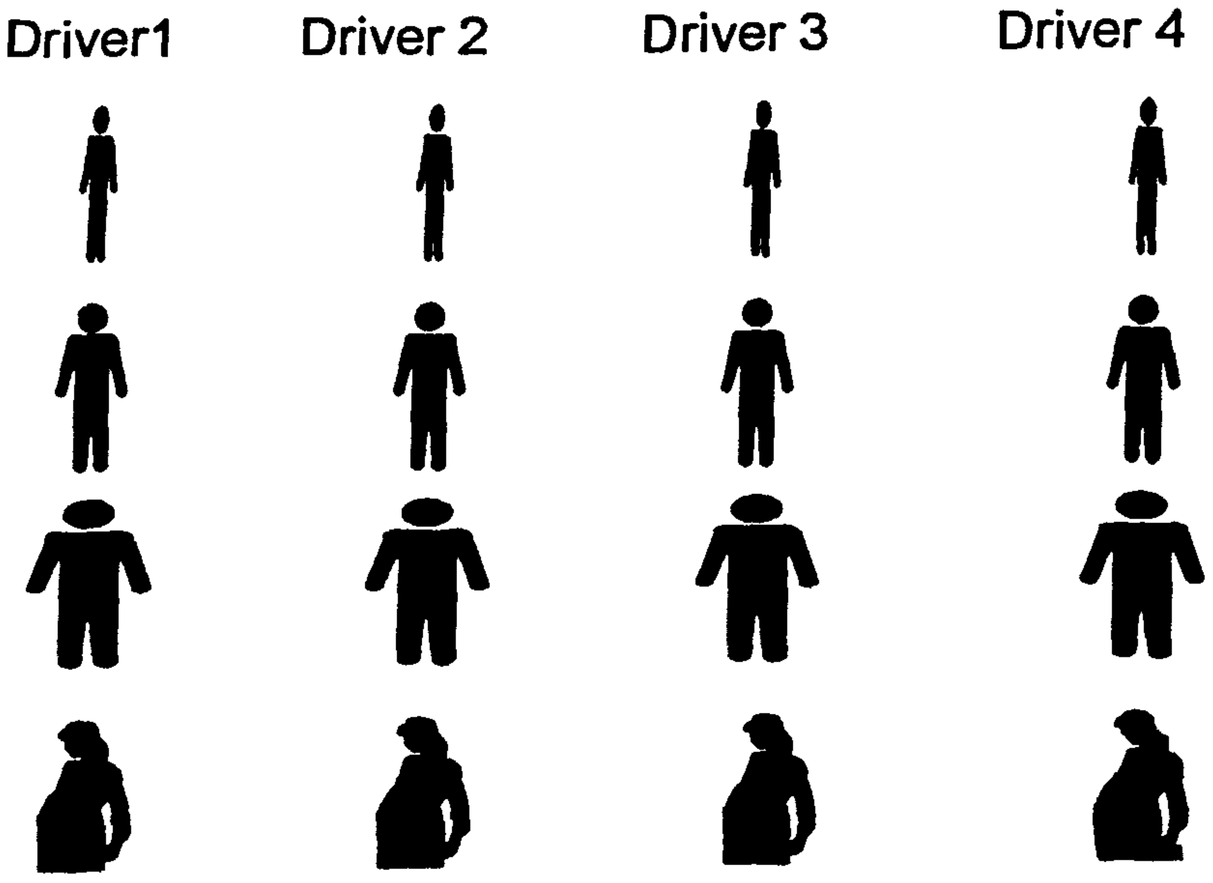
4. How tall are the drivers ?

	Driver 1	Driver 2	Driver 3	Driver 4
Under 1.20m / 3'11"	❑	❑	❑	❑
1.21 - 1.30m / 3'11" - 4'3"	❑	❑	❑	❑
1.31 - 1.40m / 4'4" - 4'7"	❑	❑	❑	❑
1.41 - 1.50m / 4'8" - 4'11"	❑	❑	❑	❑
1.51 - 1.60m / 5'0" - 5'2"	❑	❑	❑	❑
1.61 - 1.70m / 5'3" - 5'6"	❑	❑	❑	❑
1.71 - 1.80m / 5'7" - 5'10"	❑	❑	❑	❑
1.81 - 1.90m / 5'11" - 6'2"	❑	❑	❑	❑
1.91 - 2.00m / 6'3" - 6'6"	❑	❑	❑	❑
Over 2.00m / 6'6"	❑	❑	❑	❑

5. How much do the drivers weigh?

	Driver 1	Driver 2	Driver 3	Driver 4
Under 40 Kgs / 88lbs	❑	❑	❑	❑
40.1-50.0 Kgs / 88lbs-110lbs	❑	❑	❑	❑
50.1-60.0 Kgs / 111lbs-132lbs	❑	❑	❑	❑
60.1-70.0 Kgs / 133lbs-154lbs	❑	❑	❑	❑
70.1-80.0 Kgs / 155lbs-176lbs	❑	❑	❑	❑
80.1-90.0 Kgs / 177lbs-198lbs	❑	❑	❑	❑
90.1-100.0Kgs / 199lbs-220lbs	❑	❑	❑	❑
100.1-110.0Kgs / 221lbs-242lbs	❑	❑	❑	❑
110.1-120.0Kgs / 243lbs-264lbs	❑	❑	❑	❑
Over 120.0 Kgs / 264lbs	❑	❑	❑	❑

6. Which picture best describes each drivers' build?
Please circle.



7. Do any of the main drivers of this vehicle have access to any other vehicles?

No ☐ *Go to Q8*

Yes ☐ Please give details below.

Other vehicle 1

Make _____ Model _____

Type of vehicle

Sedan	☐	Pick up truck	☐
Station wagon	☐	Sports/ Coupé	☐
Convertible	☐	Van / Minivan	☐
Hatchback	☐	Commercial purpose vehicle	☐
4X4 / SUV	☐	Other	☐

Year of registration _____ Number of doors _____

What sort of roads did you drive on?	residential roads	residential roads	residential roads
Did you use your in-vehicle entertainment system? (Please tick one or more.)	☐☐☐☐ Yes radio Yes tape player Yes C.D. player No Do not have one	☐☐☐☐ Yes radio Yes tape player Yes C.D. player No Do not have one	☐☐☐☐ Yes radio Yes tape player Yes C.D. player No Do not have one
What was the purpose of this journey?	brought friend to lunch at my house	pick a friend up for lunch	brought friend to lunch at my house
Where did you park when you reached your destination?	in my garage	on friend's driveway	in my garage
Did you put anything in, out, on or off the vehicle at your destination?	yes - child seat	no	yes - child seat
Do you have any ways of making your journey more comfortable, e.g. use a lumbar support, cover leather seats with a rug in hot weather?	as before	use cushion for lumbar support	as before

EXAMPLE

TODAY IS Saturday	TRIP 1	TRIP 2
Who are you, e.g. driver 1,2, etc.?	2	2
Time journey started / finished	10.30 - 10.40am	11.00 - 11.10am
Approximately how long (in distance) was your journey?	5km	5km
Where did you get your vehicle keys from, e.g. kitchen drawer?	table in the hall	from my handbag
Where was your vehicle parked?	in my garage	on friend's driveway
Did you have to do anything before you got into the vehicle, e.g. de-ice the windows and locks?	open garage	no
Did you use any special equipment in or on the vehicle, e.g. child seat, roof rack?	no	put child seat in the back seat of the car
Did you have to alter the seat, steering wheel or mirror positions when you got into the vehicle?	yes - seat and rear view mirror	no

Other vehicle 2

Make _____ Model _____

Type of vehicle

Sedan	❑	Pick up truck	❑
Station wagon	❑	Sports/ Coupé	❑
Convertible	❑	Van / Minivan	❑
Hatchback	❑	Commercial purpose vehicle	❑
4X4 / SUV	❑	Other	❑

Year of registration _____ Number of doors _____

8: Do you use the other vehicle(s) for any particular activities?
Please explain.

Yes ❑ No ❑

_____

_____

_____

9. Are there any features of the vehicle you have now which you find particularly useful? What are they and why do you find them useful?

_____

_____

_____

10. Are there any features of the vehicle you have now which you find annoying or difficult to use? What are they and why do you find them difficult or annoying?

_____

_____

11. Are there any features you wish you had on your vehicle to make it easier or more pleasant to use? Please explain.

_____

_____

_____

12. In what month and season, of the year are you completing this diary?

_____

_____

13. Which of the following features does this vehicle have, which would you like on any future vehicle (include any features you would like to keep from the vehicle you have now)and which would you not like on a future vehicle?

Feature	Have now	Would like	Would not like
Adjustable steering wheel / tilt	❑	❑	❑
Air-conditioning	❑	❑	❑
Airbag, driver's side	❑	❑	❑
Airbag, passenger's side	❑	❑	❑
Anti theft device / alarm	❑	❑	❑
Audio system controls on steering wheel	❑	❑	❑
Automatic transmission	❑	❑	❑
Bike rack	❑	❑	❑
Child seat	❑	❑	❑

Photographs to take for the driving diary

Please take these photographs before and on one of the journeys you make today. **NOTE: DO NOT TAKE ANY OF THE PHOTOGRAPHS WHILST DRIVING THE VEHICLE, PLEASE ENSURE YOU ARE PARKED AT THE SIDE OF THE ROAD WITH THE HANDBRAKE ON.**

1. Photograph of the piece of paper on which your diary code has been printed (this code will be used only to keep the correct diaries and films together)
2. Front of the vehicle.
3. Back of the vehicle.
4. Side of the vehicle.
5. Picture of you (optional).
6. Picture of any passengers (optional).
7. Picture of the inside of the vehicle from the driver's door looking towards the dashboard.
8. Picture of the inside of the vehicle from the passenger's door looking towards the dashboard.
9. Picture of sunroof and opener and/or soft top opening mechanism if applicable.
10. View of where your vehicle is parked.
11. View(s) of the road ahead.
12. View(s) of the road etc. to the side of the vehicle.
13. Picture of typical road signs seen on the journey.
14. Picture of traffic lights seen on journey, if applicable.
15. One or more pictures of road junctions encountered on the journey.
16. One or more pictures of other road users encountered on the trip.
17. Any other problems or features you encountered which you feel had an effect on the journey.

Feature	Have now	Would like	Would not like
Compact disc player	❑	❑	❑
Cruise control	❑	❑	❑
Cup holders	❑	❑	❑
Exterior temperature indicator	❑	❑	❑
Fire extinguisher	❑	❑	❑
Heated front windshield	❑	❑	❑
Heated rear window	❑	❑	❑
Heated seats	❑	❑	❑
Heated washer jets	❑	❑	❑
Height adjustable driver's seat	❑	❑	❑
Height adjustable front seat belts	❑	❑	❑
Height adjustable passenger's seat	❑	❑	❑
Height adjustable rear seat belts	❑	❑	❑
In-vehicle telephone	❑	❑	❑
Lockable glove box	❑	❑	❑
Luggage net	❑	❑	❑
Pet guard	❑	❑	❑
Power locks	❑	❑	❑
Power mirrors	❑	❑	❑
Power steering	❑	❑	❑

Feature	Have now	Would like	Would not like
Radio / tape player	❑	❑	❑
Rear seat head restraints	❑	❑	❑
Roof box	❑	❑	❑
Roof rack	❑	❑	❑
Security box in vehicle	❑	❑	❑
Ski clips / rack	❑	❑	❑
Snow chains	❑	❑	❑
Storage areas in the front doors	❑	❑	❑
Storage areas in the rear doors	❑	❑	❑
Storage areas in the trunk door	❑	❑	❑
Storage in or above sun visor	❑	❑	❑
Storage in the centre console	❑	❑	❑
Storage pockets in the rear of the front seats	❑	❑	❑
Sun blinds / shade	❑	❑	❑
Sun roof	❑	❑	❑
Sun visors	❑	❑	❑
Tinted glass	❑	❑	❑
Towing mirror	❑	❑	❑
Ultrasonic parking aid	❑	❑	❑

IN-DEPTH DIARY

Other features I like on my vehicle: _____

_____

Other features I would like on my vehicle: _____

_____

Q14. Are there any of the features in Q13 which you have on your vehicle which you don't want.

	Which feature	Why you do not want it
1.	_____	_____
2.	_____	_____
3.	_____	_____

Q15. If you could only choose five of the features in Q13 to have on a new vehicle which would you choose and why?

	Which feature	Why you want it
1.	_____	_____
2.	_____	_____
3.	_____	_____
4.	_____	_____
5.	_____	_____

Trip 2	Trip 3	Trip 4
none ❑ children ____ adults ____ elderly ____ pets ____ other ____	none ❑ children ____ adults ____ elderly ____ pets ____ other ____	none ❑ children ____ adults ____ elderly ____ pets ____ other ____

TODAY IS ----------

	Trip 1
Who are you, i.e. driver 1, 2, etc.?	
Time trip started/ended	
How long (in distance) was your trip	
What was the purpose of your trip?	
What types of road did you travel on, e.g. highways, city streets?	
What passengers did you take with you on this trip?	none ❑ children _____ adults _____ elderly _____ pets _____ other _____
Did you or any of your passengers have any special requirements or disabilities, e.g. child seat?	
What was the weather like on this trip	
Did you do anything else in the car, e.g. lunch?	
Did you tow anything or put anything on to the car, e.g. trailer, bicycles, roof rack?	
Was there anything else about your trip or the car that you would like to mention, e.g. difficulty with the security of having a convertible top?	

DAILY DIARY

TODAY IS --Monday---

	Trip 1	Trip 2	Trip 3	Trip 4
Who are you, i.e. driver 1, 2, etc.?	1			
Time trip started/ended	8.45 - 9.30am			
How long (in distance) was your trip?	12 miles			
What was the purpose of your trip?	Commuting to work			
What types of road did you travel on, e.g. highways, cuty streets?	City roads Highway			
What passengers did you take with you on this trip?	none ❑ children ____ adults ____ elderly ____ pets ____ other ____	none ❑ children ____ adults ____ elderly ____ pets ____ other ____	none ❑ children ____ adults ____ elderly ____ pets ____ other ____	none ❑ children ____ adults ____ elderly ____ pets ____ other ____
Did you or any of your passengers have any special requirements or disabilities, e.g. child seat?	I get backache from driving - use a cushion for lumbar support			
What was the weather like on this trip?	Some light rain, with sunny intervals			
Did you do anything else in the car, e.g. lunch?	Put Make up on for work			
Did you tow anything or put anything on to the car, e.g. trailer, bicycles, roof rack?	No			
Was there anything else about your trip or the car that you would like to mention, e.g. difficulty with the security of having a convertible top?	It was a sunny day and the sun visors are too small to be effective - got sun glare			

TODAY IS _____

	Trip 1	Trip 2	Trip 3	Trip 4
Who are you, i.e. driver 1, 2, etc.?		1	2	2
Time trip started/ended		5.15 - 6.00pm	8.00 - 8.15pm	10.30 - 10.45pm
How long (in distance) was your trip		12 miles	1/2 mile	1/2 mile
What was the purpose of your trip?		drove home from work	drove to cinema	drove home from cinema
What types of road did you travel on, e.g. highways, city streets?		City roads Country roads	City roads Highways	City roads Highways
What passengers did you take with you on this trip?	none ❑ children _____ adults _____ elderly _____ pets _____ other _____	none ❑ children _____ adults 1 elderly _____ pets _____ other _____	none ❑ children _____ adults 2 elderly _____ pets _____ other _____	none ❑ children _____ adults 2 elderly _____ pets _____ other _____
Did you or any of your passengers have any special requirements or disabilities, e.g. child seat?		as before	no	no
What was the weather like on this trip		cloudy	it was dark and raining lightly	dark, no rain
Did you do anything else in the car, e.g. lunch?		listened to music	Listened to music and ate takeaway meal	listened to music
Did you tow anything or put anything on to the car, e.g. trailer, bicycles, roof rack?		no	no	no
Was there anything else about your trip or the car that you would like to mention, e.g. difficulty with the security of having a convertible top?		no	it was difficult to find somewhere to park close to the cinema	no

MPLE

TODAY IS _____

	Trip 1	Trip 2	Trip 3	Trip 4
Who are you, i.e. driver 1, 2, etc.?				
Time trip started/ended				
How long (in distance) was your trip?				
What was the purpose of your trip?				
What types of road did you travel on, e.g. highways, city streets?				
What passengers did you take with you on this trip?	none ❑ children _____ adults _____ elderly _____ pets _____ other _____	none ❑ children _____ adults _____ elderly _____ pets _____ other _____	none ❑ children _____ adults _____ elderly _____ pets _____ other _____	none ❑ children _____ adults _____ elderly _____ pets _____ other _____
Did you or any of your passengers have any special requirements or disabilities, e.g. child seat?				
What was the weather like on this trip?				
Did you do anything else in the car, e.g. lunch?				
Did you tow anything or put anything on to the car, e.g. trailer, bicycles, roof rack?				
Was there anything else about your trip or the car that you would like to mention, e.g. difficulty with the security of having a convertible top?				

Other comments

Are there any other things about your vehicle or any of your trips this week which you would like to mention. Please tell us about them below.

Section 3:

Ergonomics Audit Form

Ergonomics Audit

Product: _____

Date of completion: ❑❑ ❑❑ ❑❑

Completed by: _____

Ergonomics Audit

Key - ✓ = Good, O.K.= Acceptable, ✗ = Poor

GENERAL

Task/ feature / Assessment		Location	Accessibility	Suitability for purpose	Ease of use	Overall rating	Comments
DOORS							
Outside	door handle						
	door opening/ closing						
	boot/ trunk handle						
	boot/ trunk opening/ closing						
Inside	door handle						
	door opening/ closing						
	boot/ trunk handle						
	boot/ trunk opening/ closing						

Assessment / Task/ feature	Location	Accessibility	Suitability for purpose	Ease of use	Overall rating	Comments
INGRESS/ EGRESS						
Getting in of front seats						
Getting out of front seats						
Getting in of rear seats						
Getting out of the rear seats						
Getting in third row seats						
Getting out of third row seats						
INSIDE						
Leg room driver						
front passenger						
rear passenger						
third row seats						

Task/ feature		Location	Accessibility	Suitability for purpose	Ease of use	Overall rating	Comments
Head room	driver						
	front passenger						
	rear passenger						
	third row seats						
Elbow room	driver						
	front passenger						
	rear passenger						
	third row seats						
SEATS							
Front seats	size						
	shape						
	comfort						

Task/ feature / Assessment		Location	Accessibility	Suitability for purpose	Ease of use	Overall rating	Comments
	fore/aft movement						
	up/down range						
	seat back recline range						
	seat tilt range						
	head restraints overall						
	- size/shape						
	- up/down						
	- comfort						
	folding seat up/ down						
Rear seats	size						
	shape						

Task/ feature / Assessment	Location	Accessibility	Suitability for purpose	Ease of use	Overall rating	Comments
comfort						
fore/aft movement						
up/down range						
seat back recline range						
seat tilt range						
head restraints general						
- size/shape						
- up/down						
- comfort						
folding seat up/ down						
Third row seats size						

Task/ feature	Assessment	Location	Accessibility	Suitability for purpose	Ease of use	Overall rating	Comments
	shape						
	comfort						
	fore/aft movement						
	up/down						
	seat recline						
	head restraints						
	- size/shape						
	- up/down						
	- comfort						
	folding seat up/ down						
SEAT BELTS							
Front	adjustablility						
	geometry belt						

Task/ feature	Assessment		Location	Accessibility	Suitability for purpose	Ease of use	Overall rating	Comments
		clasp						
Rear	adjustability							
	geometry	belt						
		clasp						
3rd row	adjustability							
	geometry	belt						
		clasp						

Assessment / Task/ feature	Location	Accessibility	Suitability for purpose	Ease of use	Visibility	Overall rating	COMMENTS
STORAGE SPACE							
Glove compartment							
Front door bin							
Seat pocket (rear of front seat)							
Front ashtray							
Coin holder							
Sun visor							
Central bin (between front seats)							
Boot/trunk							
Front facia							
Luggage cover							
Cup holder							
Back door glove box							
Storage box above sun visor							

Task/ feature \ Assessment	Location	Accessibility	Suitability for purpose	Ease of use	Visibility	Overall rating	COMMENTS
Rear roof pockets							
Rear ashtray							
SUNROOF							
Front							
Rear							
Blinds							
VISIBILITY							
Front windscreen from front seat							
Rear windscreen from front seat							
Front side window from front seat							
Rear side window (B/C pillars) from rear seat							
Rear side window (C/D pillars) from rear seat							
Roof lights							
Sun visors							

Task/ feature / Assessment	Location	Accessibility	Suitability for purpose	Ease of use	Visibility	Overall rating	COMMENTS
Windscreen wipers							
Wing mirrors							
Rear view mirrors							
Blind spots							
INTERIOR LIGHT							
illumination level							
direction of light							
LOADING/ UNLOADING							
boot							
passenger seat area							
rear seat area							
roof rack/ box							
ROUTINE MAINTENANCE							
opening/ closing bonnet / hood							
locating bonnet / hood stay							

Task/ feature / Assessment	Location	Accessibility	Suitability for purpose	Ease of use	Visibility	Overall rating	COMMENTS
closing bonnet / hood							
checking/ filling oil							
checking/ filling fuel							
checking/ filling engine coolant							
checking/ filling windscreen washer							
checking tyres							
filling with fuel							
MISCELLANEOUS							
in -vehicle technology, e.g. phone							
route guidance equipment							
parking aid							

CONTROLS

Task/feature \ Assessment	Location	Visibility	Grouping	Crowding	Consistency	Display clarity	Tactility	Ease of use	Stereotypes	Fitness for purpose	Comprehensability	Overall rating	Comments
PRIMARY CONTROLS													
Ignition key													
Steering wheel													
Brake pedal } automatic													
Clutch pedal } automatic													
Accelerator pedal													
Hand brake													
Gear stick - automatic													
Cruise control													
SECONDARY CONTROLS													
Windscreen wipers front													
rear													
Front window washer													
Rear window washer													
Indicator stalks													

Task/feature \ Assessment		Location	Visibility	Grouping	Crowding	Consistency	Display clarity	Tactility	Ease of use	Stereotypes	Fitness for purpose	Comprehensability	Overall rating	Comments
Height adjustment for steering wheel														
Vehicle horn														
Windows	front													
	rear													
	rear window locks													
Head/side lights														
	dipped													
	main beam													
	fog lights (front)													
	fog lights (rear)													
Hazard warning														
Heated front windscreen														
Heated rear windscreen switch														

Task/ feature / Assessment		Location	Visibility	Grouping	Crowding	Consistency	Display clarity	Tactility	Ease of use	Stereotypes	Fitness for purpose	Comprehensability	Overall rating	Comments
Rear view mirror adjustment														
Rear view mirror anti-dazzle														
Wing mirror adjustment														
Heater/ air conditioning	temperature													
	fan speed													
	flow direction													
	vents													
Heated front seat controls														
Interior light control														
Sunroof opener														
Rear sunroof opener														
Rear sunroof lock														
Child locks														
In-car entertainment	on/off													

Task/ feature \ Assessment	Location	Visibility	Grouping	Crowding	Consistency	Display clarity	Tactility	Ease of use	Stereotypes	Fitness for purpose	Comprehensability	Overall rating	Comments
volume													
radio tuning													
pre-select station													
cassette operation													
cassette eject													
c.d. player operation													
c.d. changer													

DISPLAYS

Task/ feature \ Assessment	Feature location	Feature visibility	Feature grouping	Feature crowding	Feature consistency	Display clarity	Ease of use	Feature stereotypes	Display-control relationship	Fitness for purpose	Comprehensability	Overall rating	Comments
Speedometer													
Vehicle mileage indicator													
Trip mileage indicator													
trip reset													
Tachometer (RPM)													
Temperature gauge													
Fuel gauge													
low fuel indicator													
Engine check light													
Symbols on gear lever													
Battery level gauge													
Oil pressure gauge													
Park brake on indicator													

Task/ feature \ Assessment	Feature location	Feature visibility	Feature grouping	Feature crowding	Feature consistency	Display clarity	Ease of use	Feature stereotypes	Display-control relationship	Fitness for purpose	Comprehensability	Overall rating	Comments
Fuel economy meter													
Trip computer													
Outside temperature indicator													
Windscreen wipers													
Indicator direction symbols													
Lights side lights on													
headlights - dipped													
full beam													
fog lights (front)													
fog lights (rear)													
Hazard warning light indicator													
Heater/ air-conditioning unit temperature													
fan speed													

Task/ feature / Assessment		Feature location	Feature visibility	Feature grouping	Feature crowding	Feature consistency	Display clarity	Ease of use	Feature stereotypes	Display-control relationship	Fitness for purpose	Comprehensability	Overall rating	Comments
	flow direction													
	vent controls													
Window operation	front & rear (from front seat)													
	rear (from rear seat)													
Symbols on interior light														
Symbols on sun roof operator														
In car entertainment	on/off													
	volume													
	radio tuning													
	pre-select station													
	cassette operation													
	cassette eject													
	c.d. player operation													
	c.d. changer													
Vehicle horn														

Section 4:

Focus Group Schedule

Topics to discuss in the focus groups

The following is a list of topics to discuss at the focus groups. The instructions will help you to decide which topics you should discuss, using the results of the audit, diary and questionnaire to guide you.

1. **Vehicle features (from the audit, diary and questionnaire results)**

   - ingress and egress from the vehicle
   - interior space - head, leg and elbow room
   - seats
   - storage space
   - visibility
   - sun roof
   - loading and unloading vehicle
   - routine maintenance
   - primary and secondary controls
   - displays

2. **Vehicle related tasks (from the audit, diary and questionnaire results)**

   - cleaning the inside and outside
   - commuting
   - driving
   - getting in and out
   - leisure and social usage
   - loading and unloading
   - maintenance
   - parking
   - refuelling
   - school runs
   - security
   - shopping
   - vacations

3. **People related issues (from the diary and questionnaire results)**

   Is there anything particular about the people using the vehicle

- age
- sex
- mobility
- etc.

4. Environment related issues (from the diary and questionnaire results and the background information)

Is there anything particular about the environment in which the vehicle is to be used.

- weather conditions
- terrain
- etc.

Section 5:

Background Data Form

Background Information

Please read the instructions for this section and fill in details under the following headings. Attach any extra information to the back of the form.

Population composition
Age distribution - what is the age profile.
Gender distribution - what is the gender distribution
Family size - what is the average size and composition of families
Population distribution - where do people live
Population trends - is the population increasing or decreasing, and at what rate

Culture
Language - languages spoken and their distribution throughout the country
Important customs, beliefs and attitudes

Environment
Size of the country
Climate
Location

Maps - please attach or indicate where these can be obtained

Terrain

Environment - what is the environment like, is it very rural or urban, etc.

Technology
Availability of technology

Technology infrastructure

Section 6:

Toolset Handbook

THE LIFESTYLE SCENARIO TOOLSET

Guidelines for use

CONTENTS

1. INTRODUCTION

What is the Lifestyle Scenario Toolset

The Lifestyle Scenario Toolset is a set of methods designed to enable Rover to gain a greater understanding of their potential customers' ergonomics requirements. In particular it enables the company to gain a fuller picture about what their overseas customers want from a new vehicle. This Toolset has been developed with Rover's overseas customers, offices and dealerships in mind.

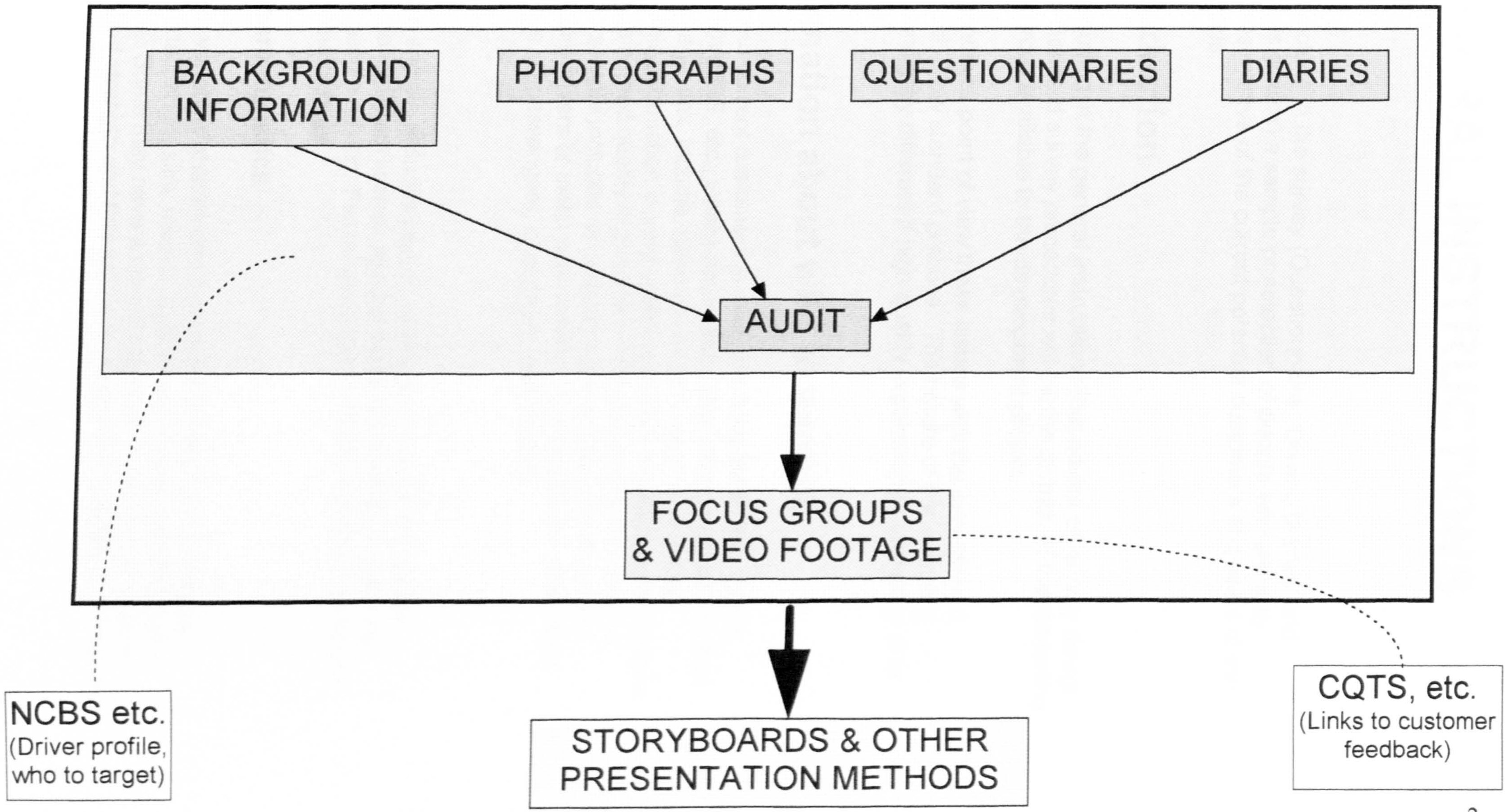
The tools and methods in the Toolset can be used as separate units, however a fuller idea of the ergonomics issues and therefore of what customers want will be gathered if all the tools are used, and the results combined in an overall picture.

The customer ergonomics information in the Toolset is collected using six methods:

- a 'Driving Diary'
- a postal questionnaire
- an Ergonomic audit (competition analysis)
- group discussions / focus groups
- video footage
- background information about a market

Each of these tools, the methods needed to use them and the type of information they provide is described in this handbook. There is also a general information section on methods which are used with more than one tool in the Toolset.

Map of Lifestyle Scenario Toolset
(showing how tools fit together)



2. GENERAL INSTRUCTIONS

AIM:

- To include in the survey (Questionnaire, 'Driving Diaries' and Focus groups) a sample or selection of people who are truly representative of the current potential customers and users of the vehicle.

2.1. Introduction

It has been assumed in the general instructions that advice on survey design, sampling and standard survey procedures will be the domain of the marketing research resources available to the development project.

From and ergonomics point of view these issues with the exception of sampling should follow standard practice. The nature of the sampling however will be slightly different if high quality ergonomics information is to be gathered.

2.2. Information about who to sample

Information about current customers is available from the NCBS, CQTS, MARITZ, JD POWERS, etc., where applicable. This will provide information for example on age, sex, income, general vehicle usage, and family composition. This information is very useful in initially structuring the sample. In addition to gain good quality ergonomics information it is important to ensure that the sample includes as wide a range as possible of people including not only drivers or initial purchasers of the vehicle but also other potential users e.g., passengers, chauffeurs, maintainers.

Ages

Ensure that the sample includes people of all ages, drivers will not be younger than the minimum licence age but in many countries there is no upper limit for people driving. Passengers can be of any age from new born infants to extreme old age.

Physical Characteristics

People come in variety of shapes and sizes so it is important to include people who are tall, short, slim, rotund, agile or with impairment through disability or age. Some may have a limited range of movement, and some may be of limited strength and this will have an effect on people's interaction with the vehicle.

Cognitive abilities

Some people can take in information and deal with it very quickly whereas others may take longer to absorb information and make decisions, longer to spot changes in their environment, or longer to respond to those changes.

2.3. How to get a representative sample

Sometimes it is possible to select people into the sample specifically on their height or their strength or other characteristics. Where this isn't possible then in order to obtain a sample which is likely to contain a wide variety of people samples should be free from bias towards one group or another.

The important thing to remember is that the ergonomics issues will be highlighted most effectively if a wide variety of people in terms of physical, psychological and social characteristics are included.

If a product is specifically targeted towards a section of the population then the sample should be drawn from that group of people, but should include as much variety as possible in the sample.

3. POSTAL QUESTIONNAIRE

AIM:

- To collect a large amount of descriptive information which is representative of a wide variety of customers and vehicle usage.

3.1. Introduction

The postal questionnaire covers a wide variety of ergonomics related topics including the vehicle itself, reasons for purchase, and vehicle usage. This survey collects larger amounts of ergonomics information which is less detailed than that gathered using the 'Driving Diary', but which is more representative of the variety of people who will use the vehicle.

3.2. Using the postal questionnaire

1. Who should take part?

Find out who the participants in this study should be. See the section in the General Instructions called 'How to decide who your participants should be' for help in selecting suitable people to ask.

2. How many people?

This information can be obtained from the New Car Buyers Survey or similar sources of information. This will depend on the time and money resources available for this survey.

3. How to set up the postal survey

Once you have a list of people who could take part in this section of the Toolset send out the questionnaire with a covering letter (see example letter A) and a pre-paid reply envelope. The covering letter should explain the purpose of the questionnaire, i.e. for Rover to gather information from their potential customers about what they want in a vehicle, and give details of what participants should do with their completed questionnaire. If an incentive is being offered include a gift certificate with space for participants to write their name, address and preferred incentive.

4. Reminders

After a suitable length of time, e.g. 2 weeks after sending out the first letter, a follow up letter or postcard can be sent out (see example letter B). Since the study is anonymous you will not know who has replied, so this letter will have to be posted to all the people who were sent the first letter. It should reiterate the aims of the study, thank those people who have already sent back their completed questionnaire and remind people to return their completed questionnaire, giving them an extra 5-7 days to do so.

5. Receiving completed questionnaires.

As the questionnaires are returned remove the gift certificate from each envelope and note the names and addresses for fulfilment of the incentive, if offered. Once the final cut off date for returns has passed gather together the questionnaires and send them in a parcel to the data analysis centre (you will have been told where this is when you received your Toolset).

NB. An incentive such as entry into a prize draw, or Rover branded product, on return of a completed questionnaire should increase the response rate for the questionnaire.

3.3. What you get from the questionnaire survey

1. Information on many ergonomics aspects which is representative of a variety of people / potential customers and vehicle usage in the potential new market.

This information is used to give weight to the Scenarios, feed into Product Development and answer queries during Development.

3.4. Example letters for use with the questionnaire

The following letters are examples of those to be sent out for the questionnaire survey.

Loughborough University
Department of Human Sciences, Loughborough University, LOUGHBOROUGH, Leicestershire, LE11 3TU, UK.
Fax: +44 (0) 1509 233940 E-mail: C.L.Eost@lboro.ac.uk

7 March 2000

EXAMPLE
LETTER A

Joe Bloggs
14 Palatine Road
ARLINGTON HEIGHTS
Illinois
IL6005
USA

Dear Discovery Owner,

Many people feel that even new vehicles are not always as easy to use or as comfortable as they would like them to be. Loughborough University and Land Rover are currently looking into ways of improving Land Rover products in North America by gathering information about what customers want from their vehicle. As part of this process Loughborough University is conducting a postal questionnaire which collects information about vehicles, the people who use them and how they are used.

As a LandRover owner we would value your help in completing one of these questionnaires. This is your opportunity to influence future vehicle design. Completing a questionnaire takes approximately 30 minutes, and involves answering questions about your vehicle and the positive and negative aspects of using your vehicle. We have enclosed a small gift as a token of our appreciation of your help.

Please take the time to complete the questionnaire and return it in the enclosed pre-paid reply envelope to:

Driving Questionnaire,
LandRover North America,
4371 Parliament Place,
Lanham, MD20706.

If you have any questions regarding completion of the questionnaire please feel free to contact:
C. L. Eost, Department of Human Sciences, Loughborough University, Leicestershire, LE11 3TU. UK. Fax: +44 (0)1509 233940. E-mail: C.L.Eost@lboro.ac.uk, or call Land Rover Customer Care on # 800-637-6837.

Your responses will be anonymous and confidential.

Once again thank you for your assistance.

Yours sincerely,

Loughborough University
Department of Human Sciences, Loughborough University, LOUGHBOROUGH, Leicestershire, LE11 3TU, UK.
Fax: +44 (0) 1509 233940 E-mail: C.L.Eost@lboro.ac.uk

7 March 2000

EXAMPLE
LETTER B

Joe Bloggs
14 Palatine Road
ARLINGTON HEIGHTS
Illinois
IL6005
USA

Dear Mr Bloggs:

A while ago we sent you a questionnaire from Loughborough University and Land Rover about your vehicle and driving. Your name was randomly selected from all those who own a Discovery in the USA.

If you have already returned the questionnaire please accept our sincere thanks. If not please do it today. Your responses are very important to give us an accurate picture of how LandRover owners use their vehicles and how we can improve future vehicles.

If you did not receive the questionnaire, or you would like a replacement one please contact: Owner Care, Land Rover North America, 4371 Parliament Place, Lanham, MD20706. Tel: # 800-637-6837.

Sincerely,

4. THE 'DRIVING DIARY'

AIM:

- To collect high quality detailed information on all the things people do with their vehicles.

- To provide photographs of the usage of vehicles.

4.1. Introduction

The 'Driving Diary' is a method for collecting detailed information about how and when people use their vehicle. This diary requires the participants to fill in details of how they used their vehicle for 7 days in total. On 6 days they are asked to fill in general information about the journeys they made. On the remaining day they are asked to describe their journeys in more detail, for example whether they had to change anything on or in the vehicle before they could complete their journey. Also on this day the participants are asked to take a series of photographs using a disposable camera (supplied by Rover). The photographs will be used to build up a collection of pictures from a wide variety of markets in diverse areas of the world.

The diary includes a short questionnaire at the front to gather information about the participants who are being asked to complete the diary. The questionnaire includes details about the drivers, the cars they drive and where and when the diary is being filled in.

The photographs and diary information is used to help build task related, people related and environment related scenarios.

4.2. How to use the diary

1. Who should take part?

Find out who the participants in this survey should be. See the section in the General Instructions called 'How to decide who your participants should be' for help in selecting suitable people.

2. How many people?

This information can be obtained from the New Car Buyers Survey or similar sources of information. It will depend on the amount of time and money available for this survey.

3. How to set up the Driving Diary survey

Once you have a list of people who could take part in this section of the Toolset send out a letter to ask them if they are willing to take part (see example letter C). Make sure the letter includes details of:

- exactly what the person will have to do if they agree to take part, i.e. how long the diary has to be filled in for, and what activities you're interested in.

- when the diary survey will begin (it does not matter what day of the week the diary is started on as long as it is filled in for seven consecutive days).

- how and where the reply slip should be returned if they decide to take part. Include a reply slip and a pre-paid envelope for the response. The reply slip should ask for the person's name and address and allow them to either agree to completing a driving diary, decline to help and, if applicable, decline from participating in this survey but allow them to offer to help in another part of the Toolset, e.g. the questionnaire or group discussion. Briefly describe these alternatives.

- the anonymous nature of the study. This should be emphasised as it usually helps to increase the positive replies.

4. Sending out the diary packs

Once the date for returning replies has been reached the diary packs should be sent out to those people who have agreed to take part. Each diary pack contains a cover letter (see example letter D), 1 diary booklet, 1 disposable camera, a sheet of paper with the participant code on it and a pre-paid reply envelope or label. The participant code consists of a two letter country code, e.g. AU for Australia, and a participant number - you will be told your country code at the beginning of the survey. The diary packs should be sent out in a padded envelope with either a pre-paid reply label (to stick on the original envelope for reuse) or a second pre-paid addressed padded envelope to enable the diary and camera to be returned. For details of the cameras to be sent out see the section 'Diary Cameras'. The diaries have instructions about how to complete them at the beginning, however a contact telephone, fax or e-mail address should be provided in case the participant has any questions or problems which need to be answered.

5. Receiving completed packs

Ensure participants know when their diary and camera must be returned by, e.g. three weeks from the date they were sent out. As the diaries are returned note participants name and address and requested incentive from

the form on the back of the diary, if incentives are being offered. Once the return date has passed send the returned cameras to be processed (unless otherwise instructed use the processors you would normally use). The participants will have been asked to photograph their participant code to identify the films and ensure they are kept with the correct diary.

6. Reminders

Also at this stage you may need to send out a follow up letter (see example letter E) or postcard. Since the study is anonymous you won't know who has returned their diary, so this letter will have to be sent to all the people who agreed to take part in the study. It should reiterate the aims of the study, thank those people who have already sent back their completed diary and camera and prompt those people who have not replied to return their completed diary, giving them an extra 7-10 days to do so.

7. Processed Photographs

When the pictures are returned from the processors put each diary together with its corresponding set of pictures in an envelope. Send the envelopes together in a package to the data analysis centre (you will have been told where this is when you received your Toolset).

4.3. Diary cameras

The diary cameras should be 24 exposure, with flash disposable cameras. If these are not available and alternative similar type of disposable camera should be substituted. If disposable cameras are not available the diary can still be completed without them. If this is the case send out the alternative diary format (Driving Diary B), without the instructions for taking the pictures.

4.4. What should be included in each diary pack

Please ensure that each diary pack contains:

- 1 COVER LETTER
- 1 DIARY BOOKLET (with the appropriate participant code filled in)
- 1 DISPOSABLE CAMERA
- 1 INSERT SHEET WITH THE PARTICIPANT CODE ON IT (to be photographed by the subjects to identify the film)
- 1 PRE-PAID REPLY RETURN PADDED ENVELOPE

NB. Because this method of collecting data needs commitment from the participants the response rate may be quite low. Inclusion of an incentive, such as entry into a prize draw should help to produce more responses.

4.5. What you get from the diary pack

The diary pack will provide you with:

1. Detailed lifestyle information on actual vehicle usage in daily life
2. Photographs of potential customers actually using the vehicle and it's features

This information is used to build up Scenarios and answer queries during Development

4.6. Example letters for diary survey

The following letters are examples of those to be sent out for the diary survey.

Text cut off in original

Loughborough University

Department of Human Sciences, Loughborough University, LOUGHBOROUGH, Leicestershire, LE11 3TU, UK.
Fax: +44 (0) 1509 233940 E-mail: C.L.Eost@lboro.ac.uk

7 March 2000

EXAMPLE LETTER C

Joe Bloggs
14 Palatine Road
ARLINGTON HEIGHTS
Illinois
IL6005
USA

Dear Mr Bloggs:

Many people feel that even new vehicles are not always as easy to use or as comfortable as they would like them to be. Loughborough University and LandRover are currently looking into ways of improving LandRover products in North America by gathering information about what customers want from their vehicle. As part of this process Loughborough University is conducting a 'Driving Diary' which collects information about vehicles and how they are used.

As a LandRover owner we would value your help in completing one of these diaries. This is your opportunity to influence future vehicle design. Completing a 'Driving Diary' would involve filling in details of your driving activities over a 7day period (to be chosen by you), and also taking a series of photographs of your vehicle and where you drive it, using a disposable camera supplied with the diary.

The diaries will be sent out between September 24th - October 17th 1997.

If you would like to take part in this survey please complete the reply slip below and send it in the pre-paid reply envelope to Department of Human Sciences, Loughborough University, LOUGHBOROUGH, Leics, LE11 3TU. UK. You will then be sent your 'Driving Diary and camera.

If you are unable to help with the 'Driving Diary' but would like to help us in the future we are also conducting a postal questionnaire (which takes approximately 30 minutes to complete), and holding a series of focus groups (approximately 2hrs each, discussing positive and negative aspects of your vehicle and driving it). If you would like to participate in either of these activities please indicate your preference on the reply slip below and return it to the above address. You will then receive further details.

All information given in this survey will be anonymous and confidential

Sincerely,
Charlotte Eost

Detach here

Name: _____

Address:

_____
_____
_____
_____
_____

Please tick as appropriate:

Yes, I would like to take part in the 'Driving Diary' survey ❑

I do not wish to complete a 'Driving Diary' but I would like to receive more information about:

the postal questionnaire ❑

the focus groups ❑

I do not wish to take any part in this research ❑

Please return this slip in the pre-paid rely envelope to:
Department of Human Sciences, Loughborough University, LOUGHBOROUGH, Leicestershire, LE11 3TU, UK

Loughborough University

Department of Human Sciences, Loughborough University, LOUGHBOROUGH, Leicestershire, LE11 3TU, UK.
Fax: +44 (0) 1509 233940 E-mail: C.L.Eost@lboro.ac.uk

7 March 2000

EXAMPLE LETTER D

Joe Bloggs
14 Palatine Road
ARLINGTON HEIGHTS
Illinois
IL6005
USA

Dear Mr Bloggs:

Thank you for agreeing to complete a 'Driving Diary'. This pack should contain a 'Driving Diary' booklet and a disposable camera and a pre-paid reply envelope. All instructions on how to complete the diary, and what pictures to take are given in the diary booklet, please read them before you begin to fill in the diary.

If you have any problems or questions regarding completion of the 'Driving Diary' please contact Charlotte Eost in the Department of Human Sciences at Loughborough University, UK. by fax (fax number +44 (0)1509 233940 or E-mail (address C.L.Eost@lboro.ac.uk).

As a gesture of our appreciation for your help your participant code will be entered into £100 prize draw when you return your completed diary pack.

All information given in this survey will be anonymous and confidential.

Once again thank you for your assistance.

Sincerely,

Charlotte Eost

Loughborough University
Department of Human Sciences, Loughborough University, LOUGHBOROUGH, Leicestershire, LE11 3TU, UK.
Fax: +44 (0) 1509 233940 E-mail: C.L.Eost@lboro.ac.uk

7 March 2000

EXAMPLE
LETTER E

Joe Bloggs
14 Palatine Road
ARLINGTON HEIGHTS
Illinois
IL6005
USA

Dear Mr Bloggs:

You recently agreed to take complete a 'driving diary' run by Loughborough University and LandRover. However, some of the diaries and camera have not yet been returned, and since the survey will be ending soon we would like to collect all the information as soon as possible. If yours is one of the diary packs that has not been sent back we would like to give you a further 10days in which to complete it. If you did not receive your diary pack or would like a replacement one please contact: C. Eost, Department of Human Sciences, Loughborough University, LOUGHBOROUGH, Leics, LE11 3TU. UK.

We would also remind you that all returned completed diaries will be entered into a draw for £100.

If you have already sent back your diary pack, please ignore this letter and we would like to take this opportunity to thank you for your help.

Sincerely,

Charlotte Eost

5. ERGONOMICS AUDIT

AIM:

- To systematically identify critical ergonomics issues associated with the user interaction with vehicle features.

5.1. Introduction

An ergonomics audit is a systematic means of assessing the features of a product or product concept in terms of the users' interaction. It is usually based on a user analysis to identify the likely characteristics of the user population and any special attributes that may make a difference to their performance, and a task analysis to specify in detail the tasks and activities undertaken by the user(s) and the order in which they are performed. It is sometimes termed an 'expert appraisal'. A checklist is drawn up and the product or product concept assessed in terms of the items on the checklist. It can also be used in comparative evaluation.

5.2. Conducting the audit

1. Clarify the aim of the audit.

2. Think about - what cars should be used
who are the likely users
what are their special characteristics
what tasks and activities are they likely to carry out
what features should be included in the audit
what criteria of assessment should be used
what data should be collected
how the data should be analysed
how the results should be presented
how the audit should be reported

Whilst carrying out the audit it is important to take into consideration as wide a range as possible of the potential users and the associated tasks, as well as the environment in which the tasks will be carried out and the context of use.

3. Conduct the audit. The audit can be used to assess a whole vehicle or part of a vehicle. If the audit is used for only part of a vehicle you may want to go into more depth with the evaluation criteria, i.e. break the components down further.

4. A worked example of an audit has been provided to provide guidance.

5.3. WORKED AUDIT EXAMPLE

Ergonomics Audit

Product: LandRover Discovery Tdi ES Auto

Date of completion: 28 08 97

Completed by: Charlotte Eost & Margaret Galer Flyte

1. Introduction

The aim of this audit is to evaluate the features, controls and displays of the vehicle in question, in this case the LandRover Discovery Tdi ES Automatic. The audit provides a structured way to assess the vehicle features for ease of use, clarity, location, grouping etc. for all potential users. Although the vehicle must be able to accommodate all users, both domestic and international, with a wide range of physical attributes for the purpose of the audit some assumptions must be made about the user of the vehicle in order to focus the assessment. However, where users in other countries and/or other driving conditions may have different assessment criteria, i.e. different road conditions or preferences for soft/hard seats, it is possible to add to or change the audit.

The audit considers general features of the vehicle, vehicle controls (primary and secondary) and vehicle displays

2. Audit assumptions

This vehicle audit uses a number of assumptions to clarify the assessment requirements. These assumptions are listed below:

2.1. Vehicle Selection

The LandRover Discovery Tdi ES was chosen for auditing because of its close ties with the new L35/L36, and the fact that the new vehicle is to be targeted towards those markets where the Discovery is already sold. The Discovery is an established vehicle and as such knowledge of the problems associated with it should be available via customer feedback. The Tdi ES was chosen because it represents the top end of the discovery range and therefore has many of the features available on this vehicle.

2.2. Audit scope

The audit covers the features present, the controls (both primary (those which operate the vehicle) and secondary (those which do not directly control the vehicle)), and the vehicle displays associated with the features and controls. The audit was carried out on the stationary vehicle due to time and space difficulties.

2.3. Environment

The audit assumes that the driver and passengers are located in their seats correctly. The exterior conditions are assumed to be relatively calm, i.e. no hurricanes, monsoons, dust storms etc. The audit considers general on road driving, but not off road or other extreme conditions.

2.4. The driver and passengers

The driver and passengers are assumed to be wearing normal clothes and shoes without thick coats, large boots, gloves or a hat.

2.5. User consideration

The audit considers the UK population unless otherwise stated, and evaluates the vehicle with regard to size, weight and age.

Typical user characteristic of this vehicle in the UK are as follows:

Sex: Male
Marital status: Married with no children
Average age: 45 years
Average income: £42 000
Typical occupation: Mainly owners of companies, professional, clerical or retired
Cars in household: Most have 2 vehicles
Vehicle usage: see below

	%		%
Driving in town/ city	87	Carrying children in the back	40
Out of town driving	86	Carrying luggage or parcels	57
Motorway driving	33	Carrying sports/ leisure equipment	33
Off road driving	16	Carrying items on a roof rack	2
Commuting	57	Using rear seat folded down	14
Business	47	Weekend trips (at least once a month)	51
Shopping	78	Towing a caravan/ trailer (at least once a year)	54
School runs	20	Holidays (at least once a year)	82
Carrying adults in the back	28		

It can be seen from the usage figures above that although the LandRover Discovery is a 4X4 vehicle designed to be effective off road, it is rarely used for this intended purpose. Most of the driving done in the Discovery is in or out of town, and the most common usage activities are commuting and shopping.

3. The structure of the audit

The vehicle audit was developed from literature and known usage situations for the vehicle. The audit used a structured checklist and photographs to analyse the vehicle.

3.1. Audit checklist

The checklist developed allows evaluation of all vehicles using the same criteria and therefore can be used for assessing other vehicles at a later date. The checklist is organised into general features, controls (primary and secondary) and displays.

For each feature on the checklist assessment is made and general subjective comments added. The items are evaluated for large, small, old people etc. to cover the extremes of possible user in terms of size, agility, vision, stereotypes etc.

3.2. Photographs

Photographs of important features assessed in the audit were taken in order to provide a visual record of the features, which enables people to see what is being discussed without having to visualise it for themselves.

3.3. Analysis of the features

The audit assessed each feature using a three point scale:

✓ = Good, o.k. = Adequate, ✗ = Poor

The audit did not use measurement techniques such as pressure points on the seat, or anthropometric measurements, to assess the vehicle due to time constraints. These measurements can be conducted at a later stage if needed. A drinks can, coins and a bag full of shopping, etc. were used to assess some of the features and spaces.

4. Assessment criteria

The criteria used to assess the features in this audit were chosen by breaking down the task each is to be used for, e.g. finding the feature, recognising it, using it and if applicable, reacting to the outcome of the using it. The criteria used for each section of the audit are described in detail below.

4.1. Criteria for general features

The assessment of the general vehicle features was carried out using the following criteria.

- Location

- Accessibility
- Suitability for purpose
- Ease of use
- Visibility (where appropriate)

4.1.1. Location

The features should be positioned where they can be used comfortably by all users, i.e. they are not too far/ near to the ground, or out of the natural reach of the user.

4.1.2. Accessibility

The features should be easy to access by all of the user population from the smallest to the largest user.

4.1.3. Suitability for purpose

The physical shape of the feature or space should be suitable for its intended use, e.g. foot room located where people would want to put their feet.

4.1.4. Ease of use

The feature or space should be easy to use without having to compromise posture etc.

4.1.5. Visibility

The feature should be easy to see without having to move from the natural position associated with it in order to find it.

4.2. Criteria for controls and displays

The criteria used to asses the primary and secondary controls and displays were (some of these criteria were used only for assessing controls (C), some only for displays (D) and some for both (C&D), these are indicated below):

- Location (C&D)
- Visibility (C&D)
- Grouping (C&D)
- Crowding (C&D)
- Consistency (C&D)
- Clarity (C&D)
- Tactility (C)
- Display-control relationship (D)
- Stereotypes (C&D)
- Fitness for purpose (C&D)
- Comprehensibility (C&D)

4.2.1. Location

The controls should be within the reach envelope of the user, from their preferred seat position. The smallest user should be able to use the control without significant abdominal movement, which would make controlling the vehicle more difficult.

4.2.2. Visibility

The controls and displays should be within view of the operator, where appropriate. The most important controls and displays should be located so that the driver need only use eye movement to see them.

4.2.3. Grouping

The controls and displays should be grouped together in a logical manner and location, where the user can easily find them. Controls should be grouped no more than 3 horizontally and 3 vertically, with no overlapping features. Controls and displays for a particular feature should be grouped together wherever possible, e.g. vehicle lights.

4.2.4. Crowding

Controls and displays should be positioned so as to avoid crowding and confusing information presentation. Controls located by feel alone should be spaced to avoid interference from other controls.

4.2.5. Consistency

Controls and displays should be consistent throughout the vehicle. Safety critical controls, i.e. primary controls, should be consistent across vehicle makes and manufacturers to ensure that users can move from one vehicle to another without endangering themselves or their passengers through lack of understanding.

4.2.6. Display clarity

Comprehension of a display or symbol is vital for the safe operation of a vehicle. The clarity of a display is dependant on several factors which include:

Brightness - the display should be bright enough to read in a light or dark environment without dazzling.

Contrast - there should be a large enough contrast between the characters and the back ground to ensure ease of reading.

Glare and reflection - location and shading to minimise reflections from other vehicle instruments and external light sources, especially in darker conditions.

Resolution - the characters must be large enough to be viewed from a normal viewing position when seated appropriately in the vehicle.

Symbols - symbols used should conform to industry standards. Where other symbols are used they should be clear and logical.

Colour - colour should be appropriately employed to attract users attention to the most important controls and displays. Colour stereotypes should also be observed wherever possible.

4.2.7. Tactility

Control tactility is affected by various attributes:

Shape - the shape of a control can be used to identify it without having to see it and can be particularly useful for those features which are hidden or are out of the range of eye movement of the user.

Size - the size of a control can sometimes be used to identify it if there is sufficient variation in the size.

Feel - the feedback from a control, such as the force needed to operate it or the sound of a control when it has been successfully utilised can be very useful to know whether the action has been carried out appropriately.

Texture - varying the texture of controls can be helpful in identifying them without having to look at them.

4.2.8. Display-control relationship

The type of display employed to show information about a control should be suitable for that purpose. The display should enable easy recognition and comprehension of the data it is showing. There are several types of display usually found in a vehicle:

- Qualitative displays - display rates of change, e.g. the red zone at the top of a revs counter which indicates that the revs are too high, but not necessarily how high.
- Quantitative displays - assign numerical values to a variable, e.g. speedometer. Can be fixed scale-moving pointer, moving scale-fixed pointer or digital.
- Continuous displays - used where the variable can take any value on the scale, e.g. speed.
- Discrete displays - used where the variable can take only one of a set of values, e.g. gear stick.
- Status displays - similar to discrete displays but used when the choice of values is very restricted, e.g. lights are on or off.

- Alphanumeric displays - used where information is presented using letters or numerals, e.g. a digital clock.
- Representational displays - used when the information is presented using pictures to show various conditions, e.g. fasten seat belt display.
- Symbolic displays - used when the information is to be conveyed using icons which may only indirectly represent the condition, e.g. a triangle on the hazard warning light.

Use of an inappropriate type of display for a particular control can be dangerous and lead to unsafe driving.

4.2.9. Stereotypes

Features should conform to population stereotypes wherever possible, since this will enhance the ease of operation.

There are two types of stereotypes:

- Natural, e.g. the right turn of a steering wheel turns the vehicle to the right

- Expected or dominant, e.g. European people read from left to right whereas Japanese people read from top to bottom.

4.2.10. Ease of use

Each of the features should be easy to use without excessive movement of limbs or torso. Where features, controls or displays are to be used in conjunction with one another they must both be readily accessible and simple to use simultaneously.

Ergonomic Audit - LandRover Discovery

Key - ✓ = Good, O.K.= Acceptable, ✗ = Poor

GENERAL

Task/ feature \ Assessment	Location	Accessibility	Suitability for purpose	Ease of use	Overall rating	Comments
Getting out of the rear seats	✗	✗	✗	✗	✗	• Had to fall out with difficulty because of the restricted space • Interior door handle is on unstable door which if not used can knock elbow when getting out
Getting in third row seats	✗	✗	✗	✗	✗	• Access is encouraged on left hand side by use of rubber bumper tread and handle • Very high bumper / step upwards • Handle very useful • Low head clearance on entry - poor even for shorter people • Bumper may be dirty and hard not to brush up against it
Getting out of third row seats	✗	✗	✗	✗	✗	• Low head clearance on exit • Long drop from bumper to ground • Inside handle on back door not accessible from left side, and not easy to use to help getting out of back
INSIDE						
Leg room driver	✓	✓	✓	✓	✓	• In alignment, no offset • Left foot footrest (on automatic) is good • Narrows as seat goes rearward, may be problematic for people with big feet
front passenger	✓	o.k	✓	✓	✓	• Good alignment, no offset • Narrows as seat goes back, may be problematic for people with big feet

CONTROLS

Task/ feature \ Assessment	Location	Visibility	Grouping	Crowding	Consistency	Display clarity	Tactility	Ease of use	Stereotypes	Fitness for purpose	Comprehensability	Overall rating	Comments
PRIMARY CONTROLS													
Ignition key	✗	✗	-	✗	✓	-	✓	o.k	✓	✓	✗	o.k	• *Ignition key very long* • *Ignition in cramped space: difficult; especially for larger hands* • *Knock other controls trying to use, wrist hits washer stalks.* • *Nor easy to manoeuvre in confined space and difficult to find where to put key* • *Close to instrument panel - easy to break finger nails trying to get key into space* • *Awkward angle.*
Steering wheel	✓	✓	-	✓	✓	-	o.k	✗	✓	o.k	✓	✓	• *Wheel is chunky - difficult for smaller grip* • *Supports for centre of wheel are where hands should be and are thick: get in the way.* • *Whole centre of wheel pressed for horn - also contains airbag: big & obstructive,* • *Feel is good but stitching at back may be annoying on airbag supports.* • *Horn too easy to operate especially when exiting the vehicle*

DISPLAYS

Task/ feature \ Assessment	Feature location	Feature visibility	Feature grouping	Feature crowding	Feature consistency	Display clarity	Ease of use	Feature stereotypes	Display-control relationship	Fitness for purpose	Comprehensability	Overall rating	Comments
Speedometer	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Good clear display, easy to read, letters upright • Primary display white - easy to see and read • Good secondary display colour (green) less obtrusive. Is this swapped over on continent? • Pointer reaches numbers and may slightly obscure them but numbers big enough to show round • 70 should be at the direct top for easy use, looks slightly offset
Vehicle mileage indicator	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Standard
Trip mileage indicator	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Quite easy to read - standard
trip reset	✓	✗	✓	✓	✓	✗	✓	o.k	✓	o.k	o.k	o.k	• Bit dark and small to see, • Not where expected in centre of speedometer
Tachometer (RPM)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Good big white letters and marks • Marks not overcrowded, good amount of labelling • Numbers upright • Pointer reaches and may slightly obscure numbers, but numbers big enough to see round
Temperature gauge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Good only need to know if getting hot/cold - danger level
Fuel gauge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	• Good no need for numbering • Red area quite small,

6. FOCUS GROUPS

AIM:

- To discuss in more detail particular aspects, good and bad, of the vehicle and driving.

- To review and discuss new ideas and alternative solutions to problems encountered using the vehicle, where appropriate.

6.1. Introduction

The focus groups will address some or all of the following topics. The particular issues to be addressed will depend on the results of the audit, questionnaire and diary studies. The focus groups should look at both the positive and negative features of the vehicle and driving.

6.2. What topics to discuss

1. **Vehicle features (from the audit, diary and questionnaire results)**

   - ingress and egress from the vehicle
   - interior space - head, leg and elbow room
   - seats
   - storage space
   - visibility
   - sun roof
   - loading and unloading vehicle
   - routine maintenance
   - primary and secondary controls
   - displays

2. **Vehicle related tasks (from the audit, diary and questionnaire results)**

   - cleaning the inside and outside
   - commuting
   - driving
   - getting in and out
   - leisure and social usage
   - loading and unloading

- maintenance
- parking
- refuelling
- school runs
- security
- shopping
- vacations

3. **People related issues (from the diary and questionnaire results)**
   Is there anything particular about the people using the vehicle

   - age
   - sex
   - mobility
   - etc.

4. **Environment related issues (from the diary and questionnaire results and the background information)**
   Is there anything particular about the environment in which the vehicle is to be used.

   - weather conditions
   - terrain
   - etc.

6.3. How to set up the focus group

1. Who should take part?

Find out who the participants in this discussion group should be. See the section in the General Instructions called 'How to decide who your participants should be' for help in selecting suitable people.

2. How many people?

Each focus group should contain 8-10 participants, to allow each person the opportunity to take part in the discussion fully. The number of focus groups to be run will depend on time and money constraints.

3. How to set up the focus group?

Once you have identified the potential participants for the focus group send out a letter asking if they would be willing to take part. Make sure the letter

includes details of what the discussion session will involve, how much time it will take, when it will take place and a brief outline of the area of interest.

You will need to book a focus group facility, or find a suitable area for conducting the discussion session. It is usual to provide participants with tea, coffee etc. and sometimes light refreshments depending on how long the session will last, and at what time of day it is conducted.

If the session is to be tape recorded or videoed you will need to have the appropriate equipment set up ready before the session begins. Participants permission for recording must be obtained before the session begins.

It is expected that participants will be provided with and incentive for taking part in the focus group, this can be monetary or more often gift certificates, gifts etc.

4. The focus group facilitator

The person who leads the focus group (facilitator) should have experience in running these kinds of discussion session. They will need to be skilled in techniques for keeping the discussion on track, ensuring all the participants have their say if they want, and that most of the topics are covered. If no suitable person is available these groups may need to be conducted through a market research agency with the facilities and expertise to conduct such a session.

7. VIDEO FOOTAGE

AIM:

- To provide a dynamic visual record of the usage of vehicles in the environment of the new market.

7.1. Introduction

This section describes the video footage to be taken for the Toolset. This footage will be used to show the variety of environments and ways in which vehicles are used in different countries. You are being asked to film a variety of scenes and tasks being carried out, using the video camera provided by Rover. There are a few points you may need to consider before you start recording.

7.2. Who should do the recording

The video recording should be carried out by two Rover employees, one employee should drive the vehicle whilst the other is taking the video footage.

7.3. Before you go

Below are some points to think about.

1. Make sure you understand how your video camera works before you go out to film with it. Try it out before you go so that you are familiar with how it operates.

2. Remember to take enough film with you for all the footage you have to take. You should be able to fit it all on to two 45minute tapes, but take a spare one just in case.

3. Remember to take enough charged batteries for the video camera with you.

4. If your video camera has a time display or other indexing system make sure you know how to use this, and ensure it is switched on during filming. This will make it much easier to analyse the tape.

5. When you are filming try not to film towards the sun, because it makes it difficult to see what is happening on the tape.

6. If you are moving the camera or using the zoom function remember to do so slowly. Moving or zooming fast can make people feel ill when they watch the video footage!

7. Remember to take a copy of the list of things you have to film, and keep it where you can read it easily

Once you have checked the camera, film and batteries you are ready to start filming.

Below is a list of the things to be filmed, however if there are other things not on the list which you feel are important to help understand the special features of the market, e.g. good features, bad features, road conditions etc. please don't hesitate to film these as well. For each item on the list please explain out loud WHERE YOU ARE and WHAT YOU ARE FILMING (and also the TIME AND DATE you are filming if this feature is not available on the video camera you are using). It is very important that you include this information, and that it can be heard on the video footage - people in the UK may not be familiar with everything you are filming and need your explanation to help them.

7.4. What to film

1. Outside of the vehicle, showing front, back, sides, fuel cap position.
2. Inside of the vehicle, including facia and instrument layout, steering wheel position, seat belt position, and rear passenger area of vehicle.
3. Driver getting into and out of the vehicle.
4. Driver altering the driving position set up in the vehicle. This should include setting the seat position, height and back angle, altering the seat belt height, adjusting the steering wheel and changing the mirrors.
5. Driver seated at the wheel.
6. General views of journey whilst driving:
    - footage of the roads and roadside, i.e. buildings and trees alongside road.
    - footage of other road users encountered on the journey.
    - selection of junctions, road signs etc. on the journey.
    - any other road features which are felt to be important on the journey.
7. Footage of passengers:
    - rear seat passengers, including children, if possible (but be aware of their safety). This should include getting in and out of the vehicle, using the seat belt and general seat position.

- footage of the front passenger. This should include getting in and out of the vehicle, using the seat belt and general seat position.

8. Refuelling of the vehicle, show how the petrol cap works and how the task is carried out. If the fuel station is attendant service explain this and film how the task is carried out.

9. Loading and unloading boot/ trunk of vehicle. Please show the boot being loaded and unloaded using suitable objects e.g. shopping or overnight bag.

10. Loading and unloading items into the rear passenger area. As above use a suitable object.

11. Loading and unloading items into the front passenger area. As above.

12. Driver using tape / radio / CD player. Show the driver, or whoever usually uses the tape / radio / CD player:

    - inserting a tape into the player, and setting it to play
    - tuning the radio to a chosen radio station
    - inserting a CD into the player, and setting it to play

13. Driver using in-car navigation system, if fitted. Film the driver using the system to get suitable directions for part of a journey.

14. Other features to include. The ergonomics audit (see section 4) will have identified features of the vehicle or activities on which more information is needed. Include video recordings of these as well.

8. BACKGROUND INFORMATION

AIM:

- To provide the context for ergonomics information collected using the Lifestyle Scenario Toolset.

8.1. Introduction

The background data for this Toolset is used to give people developing the vehicle a better understanding of the ergonomics needs of the customers in the markets in which the vehicle is to be sold. It provides a context for the information collected using the other methods in the Toolset. The background data should give details about aspects such as the population composition, culture, economy, legal system, environment, legal and political system, availability of technology, and the trading laws of your country. For each piece of background data you should note WHERE the information came from and WHEN the information was written. Then if anyone wants to check the source for more information they will be able to. Where particular background information is not available or is incomplete indicate this on the forms.

8.2. What information to collect

The information to collect is given under a series of headings. For each heading section there is a sheet which should be filled in with the relevant information. Any additional information which you think would be useful can be added on extra blank sheets of paper. A list of the information to be gathered is given below. A Rover project collecting some of this data has been set up in product validation, and should be consulted for relevant data in the first instance.

Population composition

- Age distribution - what is the age profile.
- Gender distribution - what is the gender distribution.
- Family size - what is the average size and composition of families.
- Population distribution - where do people live.
- Population trends - is the population increasing or decreasing, and at what rate.

Culture

- Language - languages spoken and their distribution throughout the country.

- Important customs, beliefs and attitudes.

Environment

- Size of the country
- Climate
- Location
- Maps
- Terrain
- Environment - what is the environment like, is it very rural or urban, etc.

Technology

- Availability of technology
- Technology infrastructure

Appendix C

Section 1: Audit Summary

Section 2: Focus Group Selected Transcript

Section 3: Background Data

Lifestyle Scenario Toolset

Ergonomics Audit

Summary of results

Ergonomic Audit - LandRover Discovery

Point score: ✓ = 1, O.K.= 0, ✗ = -1

Summation of each section columns: ☺ = good 😐 = neutral ☹ = poor

GENERAL

Task/ feature \ Assessment		Location	Accessibility	Suitability for purpose	Ease of use	Overall subjective rating
DOORS OPENING AND CLOSING						
Outside *Photo. no: 1*	✓	3	2	1	1	1
	o.k	0	1	3	1	3
	✗	1	1	0	2	0
	SUM	☺☺	☺	☺	☹	☺
Inside *Photo. no: 5*	✓	1	1	2	1	2
	o.k	0	0	0	1	0
	✗	0	0	1	1	1
	SUM	☺	☺	☺	😐	☺
INGRESS/ EGRESS						
Front *Photo. no: 2*	✓	0	0	0	0	0
	o.k	0	0	0	1	0
	✗	2	2	2	1	2
	SUM	☹☹	☹☹	☹☹	☹	☹☹
Rear *Photo. no: 3*	✓	0	0	0	0	0
	o.k	0	0	0	0	0
	✗	2	2	2	2	2
	SUM	☹☹	☹☹	☹☹	☹☹	☹☹
3rd row *Photo. no: 10, 11*	✓	0	0	0	0	0
	o.k	0	0	0	0	0
	✗	2	2	2	2	2
	SUM	☹☹	☹☹	☹☹	☹☹	☹☹
INSIDE						
Leg room *Photo. no: 5, 21, 27*	✓	2	1	2	2	2
	o.k	1	1	0	0	0
	✗	0	1	1	1	1
	SUM	☺☺	😐	☺	☺	☺

Task/ feature / Assessment		Location	Accessibility	Suitability for purpose	Ease of use	Overall subjective rating
Head room *Photo. no: 20, 22*	✓	3	3	3	3	3
	o.k	0	0	0	1	1
	✗	1	1	1	0	0
	SUM	☺☺	☺☺	☺☺	☺☺☺	☺☺☺
Elbow room *Photo. no: 20,22*	✓	0	0	0	0	0
	o.k	2	2	2	2	2
	✗	2	2	2	2	2
	SUM	☹☹	☹☹	☹☹	☹☹	☹☹
SEATS						
Front seats *Photo. no: 3,4,8,17,18*	✓	3	3	6	5	6
	o.k	0	1	2	3	3
	✗	0	1	3	2	2
	SUM	☺☺☺	☺☺	☺☺☺	☺☺☺	☺☺☺
Rear seats *Photo. no: 23,24*	✓	0	3	2	4	2
	o.k	2	1	2	0	2
	✗	1	0	2	1	2
	SUM	☹	☺☺☺	😐	☺☺☺	😐
3rd row seats *Photo. no: 15,16*	✓	0	0	0	0	0
	o.k	0	0	3	1	2
	✗	1	2	1	3	2
	SUM	☹	☹☹	☹	☹☹☹	☹☹
SEAT BELTS						
Front *Photo. no: 3*	✓	0	1	2	1	1
	o.k	3	1	1	1	2
	✗	0	1	0	1	0
	SUM	😐	😐	☺☺	😐	☺
Rear *Photo. no: 23*	✓	0	2	0	2	0
	o.k	2	0	2	0	2
	✗	0	0	0	0	
	SUM	😐	☺☺	😐	☺☺	😐

3rd row *Photo. no: -*	✓	0	0	0	0	0	
	o.k	1	1	1	1	1	
	✗	1	1	1	1	1	
	SUM	☹	☹	☹	☹	☹	

Task/ feature / Assessment		Location	Accessibility	Suitability for purpose	Ease of use	Visibility	Overall subjective rating
STORAGE SPACE							
Photo. no: 5,12,17,19,21,23,25	✓	8	6	8	6	8	4
	o.k	4	2	2	3	3	6
	✗	3	6	6	5	3	4
	SUM	☺☺☺☺☺	😐	☺☺	☺	☺☺☺☺☺	😐
SUNROOFS							
Photo. no: 23,24	✓	2	1	1	0	1	0
	o.k	0	0	0	0	2	2
	✗	1	0	2	1	0	1
	SUM	☺	☺	☹	☹	☺	☹
VISIBILITY							
Forward *Photo. no: 4,19*	✓	/	/	0	1	/	0
	o.k	/	/	1	0	/	0
	✗	/	/	0	1	/	1
	SUM	/	/	😐	☹	/	☹
Side *Photo. no: -*	✓	/	/	1	1	/	1
	o.k	/	/	2	2	/	2
	✗	/	/	0	0	/	0
	SUM	/	/	☺	☺	/	😐
Rearwards *Photo. no: -*	✓	0	0	0	0	0	0
	o.k	1	1	1	2	1	1
	✗	1	0	2	1	0	2
	SUM	☹	😐	☹☹	☹	😐	☹☹
Other *Photo. no: 23*	✓	1	1	2	2	1	1
	o.k	2	0	0	1	0	2
	✗	0	0	1	0	0	1
	SUM	☺	☺	☺	☺☺	☺	😐

Task/ feature / Assessment		Location	Accessibility	Suitability for purpose	Ease of use	Visibility	Overall subjective rating
INTERIOR LIGHTING							
Not working	✓						
	o.k						
	✗						
	SUM						
LOADING/UNLOADING							
Photo. no: 24,25	✓	/	0	0	0	/	0
	o.k	/	2	2	0	/	2
	✗	/	2	2	4	/	2
	SUM	/	☹☹	☹☹	☹☹ ☹☹	/	☹☹
ROUTINE MAINTENANCE							
Petrol filler cap *Photo. no: -*	✓	0	0	0	0	0	0
	o.k	0	1	1	0	1	0
	✗	1	0	0	1	0	1
	SUM	☹	😐	😐	☹	😐	☹

CONTROLS

Task/ feature \ Assessment		Location	Visibility	Grouping	Crowding	Consistency	Display clarity	Tactility	Ease of use	Stereotypes	Fitness for purpose	Comprehensability	Overall subjective rating
PRIMARY CONTROLS													
Photo. no: 4,6,7,19	✓	1	4	1	3	5	2	3	1	3	2	2	1
	o.k	2	0	0	1	0	1	1	3	0	4	1	5
	✗	4	1	2	3	0	0	3	3	1	1	1	1
	SUM	☹☹☹	☺☺☺	☹☹	😐	☺☺☺☺☺	☺☺	😐	☹☹	☺☺	☺	☺	😐
SECONDARY CONTROLS													
Steering wheel controls *Photo. no: 4*	✓	7	3	7	9	7	4	10	7	8	7	2	4
	o.k	1	1	1	1	3	1	1	3	2	2	4	6
	✗	3	7	3	0	0	6	0	1	1	2	5	1
	SUM	☺☺☺	☹☹☹	☺☺☺	☺☺☺☺☺	☺☺☺☺☺	☹☹	☺☺☺☺☺	☺☺☺☺☺	☺☺☺☺☺	☺☺☺☺☺	☹☹☹	☺☺☺
Dashboard controls *Photo. no: 4,6,19*	✓	0	0	0	2	4	0	1	3	2	2	0	1
	o.k	1	2	1	1	0	2	1	0	1	1	1	1
	✗	3	2	2	0	0	2	2	1	0	1	3	2
	SUM	☹☹☹	☹☹☹	☹☹☹	☺☺	☺☺☺	☹☹	☹	☺☺	☺☺	☺	☹☹☹	☹

Task/feature \ Assessment		Location	Visibility	Grouping	Crowding	Consistency	Display clarity	Tactility	Ease of use	Stereotypes	Fitness for purpose	Comprehensability	Overall subjective rating
Centre console controls *Photo. no: 17,18*	✓	1	3	0	3	3	1	2	1	4	2	1	0
	o.k	3	1	1	1	0	0	2	3	0	2	0	3
	✗	0	0	3	0	1	3	0	0	2	0	3	1
	SUM	☺	☺☺ ☺	☹☹ ☹	☺☺ ☺	☺☺	☹☹	☺☺	☺	☺☺	☺☺	☹☹	☹
ICE *Photo. no: 19*	✓	5	5	8	4	7	0	2	3	6	6	2	3
	o.k	2	1	0	2	0	4	6	3	0	1	3	3
	✗	1	2	0	2	0	4	0	2	0	1	3	2
	SUM	☺☺ ☺☺	☺☺ ☺	☺☺ ☺☺ ☺☺ ☺☺	☺☺	☺☺ ☺☺ ☺☺ ☺	☹☹ ☹☹	☺☺	☺	☺☺ ☺☺ ☺☺	☺☺ ☺☺ ☺	☹	☺
Air-conditioning/Heater *Photo. no: 19*	✓	4	3	4	4	4	0	1	1	3	3	1	1
	o.k	0	1	0	0	0	3	2	3	0	1	2	2
	✗	0	0	0	0	0	1	1	0	1	0	1	1
	SUM	☺☺ ☺☺	☺☺ ☺	☺☺ ☺☺	☺☺ ☺☺	☺☺ ☺☺	☹	😐	☺	☺☺	☺☺ ☺	😐	😐
Other *Photo. no: 20,23,24,25*	✓	3	5	5	4	5	1	5	5	5	4	2	4
	o.k	3	1	0	0	0	2	1	1	0	2	0	2
	✗	1	1	0	0	0	3	1	1	0	1	5	1
	SUM	☺☺	☺☺ ☺☺	☺☺ ☺☺ ☺	☺☺ ☺☺	☺☺ ☺☺ ☺	☹☹	☺☺ ☺☺	☺☺ ☺☺	☺☺ ☺☺ ☺	☺☺ ☺	☹☹ ☹	☺☺ ☺

DISPLAYS

Task/feature \ Assessment		Feature location	Feature visibility	Feature grouping	Feature crowding	Feature consistency	Display clarity	Ease of use	Feature stereotypes	Display-control relationship	Fitness for purpose	Comprehensability	Overall subjective rating
DASHBOARD DISPLAYS	✓	11	10	11	11	11	9	11	9	11	10	10	9
	o.k	0	0	0	0	0	1	0	1	0	1	1	2
Photo. no: 9	✗	0	1	0	0	0	1	0	1	0	0	0	0
	SUM	☺☺ ☺☺ ☺☺ ☺☺ ☺☺	☺☺ ☺☺ ☺☺ ☺	☺☺ ☺☺ ☺☺ ☺☺ ☺	☺☺ ☺☺ ☺☺ ☺☺ ☺	☺☺ ☺☺ ☺☺ ☺☺ ☺	☺☺ ☺☺ ☺☺ ☺☺	☺☺ ☺☺ ☺☺ ☺☺ ☺	☺☺ ☺☺ ☺☺ ☺☺	☺☺ ☺☺ ☺☺ ☺☺ ☺	☺☺ ☺☺ ☺☺ ☺☺	☺☺ ☺☺ ☺☺ ☺☺	☺☺ ☺☺ ☺☺ ☺
STEERING WHEEL STALK DISPLAYS	✓	4	3	5	5	5	2	3	4	5	6	3	4
	o.k	1	0	0	0	0	3	1	2	1	0	1	2
Photo. no: 4	✗	1	3	0	0	0	1	2	0	0	0	2	0
	SUM	☺☺ ☺	😐	☺☺ ☺☺ ☺	☺☺ ☺☺ ☺	☺☺ ☺☺ ☺	☺	☺	☺☺ ☺☺	☺☺ ☺☺ ☺	☺☺ ☺☺ ☺☺	☺	☺☺ ☺☺

Task/ feature \ Assessment		Feature location	Feature visibility	Feature grouping	Feature crowding	Feature consistency	Display clarity	Ease of use	Feature stereotypes	Display-control relationship	Fitness for purpose	Comprehensability	Overall subjective rating
OTHER DASHBOARD DISPLAYS													
Photo. no: 4,6,19	✓	1	1	2	2	2	0	0	1	2	2	0	0
	o.k	0	0	0	0	0	2	1	1	0	0	1	1
	✗	1	1	0	0	0	0	1	0	0	0	1	1
	SUM	😐	😐	😊😊	😊😊	😊😊	😐	☹	😊	😊😊	😊😊	☹	☹
HEATER/ AIR CONDITIONING													
Photo. no: 19	✓	3	3	3	3	3	0	3	2	1	3	2	2
	o.k	1	1	0	0	0	2	1	1	2	1	1	1
	✗	0	0	0	0	0	1	0	1	1	0	1	1
	SUM	😊😊 😊	😊😊 😊	😊😊 😊	😊😊 😊	😊😊 😊	☹	😊😊 😊	😊	😐	😊😊 😊	😊	😊
IN-VEHICLE ENTERTAINMENT													
Photo. no: 19	✓	3	3	/	/	/	1	4	3	3	2	1	3
	o.k	2	1	/	/	/	2	1	1	0	1	1	1
	✗	2	3	/	/	/	4	2	1	4	4	5	3
	SUM	😊	😐	/	/	/	☹☹ ☹	😊😊	😊😊	☹	☹☹	☹☹ ☹☹	😐
OTHER DISPLAYS													
Photo. no: 20,23,24,25	✓	4	2	/	/	/	1	2	2	2	2	1	1
	o.k	0	1	/	/	/	1	0	0	0	0	1	1
	✗	0	1	/	/	/	2	2	2	2	2	2	2
	SUM	😊😊 😊😊	😊	/	/	/	☹	😐	😐	😐	😐	☹	☹

Lifestyle Scenario Toolset

Discussion Group

Selected Transcript

Land Rover Discovery Focus Group - 11/2/98
Sturgess Land Rover Leicester

INTRODUCTION, WHO'S WHO

MW		She is a reluctant owner, it was her husband's choice of vehicle
	10:51	"very comfortable and easy to drive"
		"I like the fact that it holds seven people"
	10:55	"been on and off-road course, reluctantly, but I enjoyed it"
	11:00	"useful for towing the caravan"
	11:32	"I don't know that it would be my ideal vehicle if I was given free range but it suits our needs"
RW		
	11:54	"Had a Range Rover in Nigeria in 1977"
	12:30	"Really harping back to where it would go, where the Range Rover went"
		"It was my choice, really a toy"
	12.54	"I fancied one"
	13:00	Until recently went to work in it, but now have a company car and I let that take the wear and tear
		"now goes out at weekends"
	13:25	"second one [Discovery] the first was stolen out of the garage"
PB		Mainly has it because it's a company car
	14:35	"If the chance came to buy one in that range [luxury] then I would buy one"
DJ		
	14:53	"This is my second Discovery, my first one was also stolen"
	15:05	"This one has a category one hatcher system so I have a reduction on my insurance"
	15:15	"Had an Alfa.....made redundant.....came down to Volvo T5 or Land Rover"
	15:45	"Decided in retirement Land Rover would be the better one"
	16:00	"Do long distances in it"

	16:20	"Now I'm retired Discovery suits my way of life....now drive sedately"
IS		
	17:00	"Second Discovery, bought second because first was such a good vehicle"
		"As a mechanical vehicle I don't think you can beat them"
	17:20	"I'm a builder, can put things in trailer and go.....I'm an off-roader"
	17:50	"I can spend 3 hours behind the wheel non-stop and find it very comfortable to drive"
	17:55	"I like the position you can just see so far ahead on the motorway that when everybody else is braking like hell, you've got four cars warning that something's happening up in front"
DJ	18:26	"I don't think I'd do that [take it off road] not seriously"
JK		
	18:46	"Second Land Rover"
	18:54	"When I first tried a Land Rover I thought it was awful. I wasn't strong enough to put the clutch in and I couldn't stand the noise"
	19:15	"The difference [of the new automatic] was significant"
	19:19	"I wanted a car that would slow me down"
	19:34	"And if I did have an accident I wanted to stand a better chance than the other guy"
	19:45	"I was involved in towing a horse box with a horse in, which is very heavy, where you're always in a muddy field....and nine times out of ten guys with ordinary cars would go in, it would rain and they'd get stuck. It was a good social thing"
	20:15	"You can put as much as you want into it, it doesn't go any faster and it doesn't go any slower. It cruises well"
	20:27	"It's a pity that the people who design them don't drive them"
	21:23	"I like driving it, my wife likes driving it and it's good in traffic and dare I say it, turning out of a road people think "forget it, let him out""
	21:45	"Nine times out of ten....my car has a fair amount of horse shit in it and it's ideal that you just take out the mats, hose them down and put 'em back in again and off you go"

	22:09	"I would go for something big and slow, that's got a bit of street cred and doesn't look out of place anywhere"
CH	22:30	"Currently got three Discoveries"
	22:56	"I use them for towing exhibition cars around"
	22:58	"I buy them because there aren't really any alternatives that are affordable to my business"
		"Waiting to see if the new model is too luxurious and goes too upmarket for me and I'll be pushed back to a 110 again"

WHY DISCOVERY

JK	24:25	"Space inside is the big difference"
	24:48	"I want to be able to stand up in mine and get changed if we go skiing…there's limited headroom inside all these others"
IS	25:10	"All the others have every accessory……but with the Discovery you can open it up and hose the inside of the door panels"
JK	25:22	"It's working vehicle"
CH	25:30	"Most of the others are Japanese…. at least Land Rover gives a few people jobs"
RW	25:40	"It looks classy as well, compared to a Shogun etc.. Some of the Japanese ones are very bulbous and dripping in chrome and don't look the part"
CH	26:08	"Most of them aren't capable of doing what we're doing"
DJ	26:37	"I have a daughter who doesn't travel very well, but she will travel very well in the Discovery and that's certainly something to do with being able to see, and that's sitting up high"
	26:50	"Also have a Mum and Mother-in-law and they both like it. They're in their 70s and my daughter is in her 20s so there's an awful big age gap there"

	27:15	"They like getting in to this car"
RW	27:30	"The airiness is a good point to pick up on, I have the dual sunroofs in mine and with the alpine lights the glass area is quite deep and it's a nice sort of airy feel"
IS	27:41	"The only problem is that it's like a green house in the summer…"
RW	27:43	"…not if you've got air conditioning"
	28:40	"again you're using yours as a tool of the trade, and I've declared mine as a toy now"
DJ	30:26	"I think you drive this very different vehicle…. in a very different way and I think you do relax, you do feel, you know, a bit superior really"
JK	30:58	"It's difficult to be a boy racer in a Discovery"
	31:20	"You don't feel like you're doing 70 miles per hour because of the size of it"
MW	31:41	"It's not a nippy vehicle at all, it's a big comfortable vehicle"

COMMAND DRIVING POSITION

JK	32:14	"You can't see traffic lights, if you're first in the queue you can not see traffic lights"
	32:29	"If you're at the traffic lights….you've really got to crane your neck"
CH	32:30	"Especially with this latest one where they've got the bonnet, windscreen [indicates higher and lower respectively]"
IS	32:44	"You get used to it"
JK	32:45	"Maybe if you're shorter…"
MW	32:47	"…yes I can't say I've noticed that's a particular problem"
	32:54	"I like the driving position, I like being up high….people don't cut you up"

	33:15	"I feel much safer in the Discovery"
MDGF	34:36	"You could drop the seat down?"
JK	32:37	"No, not on our basic [ones]"
IS	34:47	"But then you're ruining your driving position"
JK	35:00	"Because not everything on the car is adjustable, you move one thing and everything else stays the same"
	35:03	"Strange shaped people at Land Rover"

INGRESS/ EGRESS

DJ	36:12	"I think you have to learn. You have to say left foot up, give yourself enough space in order to get your right foot in. But she [elderly arthritic mother] contends with it quite well"
	36:32	"In some respects it's more difficult for her to go down [into a car], it's more easy for her to go up"
	36:57	"Yes I've got a running board, and clearly that does help"
JK	37:23	"There's quite a few grab handles you can pull yourself in"
	37:41	"The bad news….is reminding them not to stand on the step. It's only a bit of plastic, otherwise they snap that off and you have to buy another one"
	37:41	"You can get through those [plastic step] quite quickly"
DJ	37:43	"Sometimes there is a bit of confusion [as to how to get in]"
	37:47	" Coming out of course is so easy…it's just a slip and a slide at the end of it"
	38:00	"She [elderly arthritic mother] just gets one foot on there [running board], and controls it to a certain extent, and of course I'm there anyway"
MW	38:28	"I think it's easier with the side steps for elderly persons to get in"
DJ	38:38	"If I didn't have side steps, with my mum, then I think I would be in trouble"

RW	38:57	"The only thing I'm conscious of , is from a friend who had an older one [Discovery] and the seat was all rotted away here [indicates side of seat squab] where he got off and just slid to the ground"
IS	39:15	"Two things I've found about the side steps. One, I used to get mud up the back of my trousers every time I jumped out, and the other thing is when I went off-roading.....I managed to fold them up and couldn't get me doors open"
RW	39:48	"If I go off-roading mine come off. I've got just two bolts at the front, two at the back and they [the running boards] go in the garage"
CH	39:54	"They've changed the seat base on the newer ones. They've got a cubby hole and I find that I catch my foot on the corner of that every time I get out, which was not a problem before"
	40:22	"It's always covered in mud on this corner [indicates right hand front corner] because you catch it as you get out"

CD CHANGER DOOR

IS	40:32	"Since I've had one [CD changer] I don't think it's [the door] stopped on for more than a week"
PB	40:41	"It clips in, but there's a proper catch"
	40:47	"It seems a bit pointless having the door on the front [of the CD changer] when it's open from the back..."
RW	40:48	"....yeah, but...there's a cross member at the back"

FACIA & DASHBOARD

CH	41:03	"Does anyone else find it irritating that they don't put a softer surface round behind the ignition....to stop it rattling"
	41:21	"Those things make it feel more luxurious, if you don't have your keys rattling"
RW	41:28	"The keys do rattle on the steering column shroud"
	41:32	"And on the facia itself, you can see where they mark it"

BACK SEAT

JK	41:51	"I'd love to know the shape of the model of the person they designed the back seat for….it's a person no more than one metre high, with the head rest"
	42:04	"Anyone older than ten years old and the head rest is completely wrong….not adjustable"
	42:16	"It hasn't been designed it's just a lump in the seat, totally impractical, totally useless"

ARM REST

JK	42:28	"If you drive….and you put your arm on the door [the door pull handle], because there's no where else to put your elbow, there's like this razor sharp edge which goes right into the joint of your elbow"
	42:40	"If you think "Oh I'll just shut the door" and you're unfortunate enough to get your knuckles behind the offending article [door pull handle] you can't get your knuckles out"
CH	43:00	"The one [door pull handles] that gives me bad elbows
RW	43:22	"My elbow don't fit there….where does it fit?"
IS		"…on the window top"
RW		"…that's right"
JK	43:37	"You can get a Toyota, they do a wonderful job….their elbow spaces, you can put your elbow there"
JK	43:51	"It's [steering wheel] designed just at the right diameter so you can't see any of the dials or gauges down the two sides"
IS	44:00	"You can see the dials in the middle, but all the switches…you have to kind of look round [moves his head to one side]…they'd be better on that centre console"
RW	44:52	"You don't need to know where they are, you can just feel it [the switch]"
DJ	45:20	"If visibility is important, you can't see them"

JK	45:35	"Your dashboard shouldn't be a maze"
RW	46:25	"I think the current Discovery…the dashboard is very good, a very pleasing one. The radio is mounted in a good place, you don't have to keep fiddling with that….because you've got your controls round here [steering wheel]"
IS	46:44	"You don't get stuff drop off the dash down the cassette player"

ELECTRIC WINDOW SWITCHES

DJ	47:00	"Can I just bring up one little irritating point on design, which sometimes I get confused at, and other people get confused at, and that's electric windows" [General agreement from the rest of the group]
	47:10	"There are four switches….they're wrong. The lower ones should be the front windows, and the other ones should be the back"
	47:36	"They don't match where the windows are spatially"
MW	47:42	"I don't like electric windows….if you stop somewhere and it gets hot, if you've got electric windows you've got to put the ignition on to move the window"
IS	48:24	"Press the buttons and see what happens" [his method for using the electric windows]

REAR WINDOW SWITCHES

RW	48:34	"It's a bit disconcerting if you put your briefcase behind the driver's seat and you go round a corner and the briefcase slides…..it's the right height to press the button on the rear window….you're going round the corner and the rear window is going wide open"

REAR INGRESS / EGRESS

JK	49:11	"Rear wheel arch, big problem, even if you want to stand on the back to get up on the top either to wash it or get something off the roof, you've [either] got to put one foot in the car and the other on the wheel"
	49:25	"If you try and put both feet in the car you'll probably end up on your back

IS	49:41	"Another thing with the wheel arch, you can't get two child seats in the back....because the bottom of the child seat sits on the wheel arch and is like this [moves hands to show tipping inwards]"
	50:03	"...you cannot put two child seats and have a youngster sitting in the middle with the lap belt on"
JK		"I don't like the lap belt for the centre seat, I think that's bad, most modern cars.....you get a proper [seat belt]"
RW	50:24	"The actual opening at floor level is also quite narrow, because the wheel arch comes down"
	50:34	"If there's a problem getting in the back it's because there's not enough room to shuffle your feet"
IS	50:42	"There's a problem getting out, because you're jumping out you can catch your foot on the door pillar"
JK	50:46	"Or your back on the wheel arch"
PB	50:50	"It's not very comfortable if you've got three largish adults in the back, you tend to sit a bit on the wheel arch"
JK	51:18	"I like to be in the back, I think it's great" "No problem [space around you], in fact it's even better because just in front of you the roof goes up"
	52:09	"You have to arrange your luggage to make a head rest because there's not one in the vehicle....so you can lean back without your head falling into the back compartment"
IS	52:24	"The front seats have got the hard head restraints more than rests....you still can't drop the seat back and rest your head on those"
	52:35	"It's not a solid plastic [front headrest] but it's not a comfortable plastic"
RW	52:42	"...you can get after market covers"
IS	52:45	"...but it's all after market, why should it be after market when a straight forward Rover car has a lovely headrest on it?"

CH	52:50	"And why isn't that adjustable"
DJ	53:09	"It's not uncomfortable, but it could be better….it tends to push your head forward"
	53:31	"Sometimes it just irritates me, because I can just feel it brushing the back of my head"
DJ	55:02	[Talking about elderly relatives getting in the back] "Unless you do it properly then I find their feet will get caught up"

LONG JOURNEYS

JK	56:25	"It's good if you're driving….but I wouldn't want to be on a long journey in the back"
RW	56:52	"Or fold the sleeping bag up and use that as a headrest [in the rear of the vehicle on long journeys]"
RW	57:46	"Maybe do 350, 400 miles and you come out it without no angles and corners….quite relaxing, quite comfortable"
IS	57:59	"Towing a caravan all the way back from Scotland….I got back and felts no aches, pains or anything"
PB	58:31	"The lumbar support seems too far out, you're pushed forward by it, you can't sort of wind it back so the back of the seat curls round your back"
RW	58:52	"I have the lumbar support wound right off, you know, I don't use it, and I find it very comfortable"
CH	58:58	"I have mine [lumbar support] wound right out. My son….when I get in his [Discovery] he has it wound right in"
IS	59:12	"I don't know where mine [lumbar support] is!"
PB	59:22	"I just think there ought to be more range on it"
	59:38	"It feels about the right place….we've got one or two small petite ladies who've commented on it, they're not heavy enough to get back into the seat"
RW	1:01:27	"There's plenty of movement on the driver's seat, I can actually get it too far back which is unusual. On saloons I could do with a couple of extra notches"

DJ	1:02:10	"One thing I did do as far as the accelerator is concerned....as I'm somewhat short, I had to have that repositioned. I had clutch and brake level, fine, this thing [accelerator pedal] was down here [motions towards the floor]. I couldn't get an adjustment on that until I had it modified to bring it up, so I had them across"
	1:02:53	"A short person will have difficulty. I was stretching then I had to come up to brake and clutch"
IS	1:04:14	"I've never had any problems with it"
	1:06:04	"One thing I've done several times....I've gone for the clutch, been out in mud or oil or something, slipped off it [clutch], your foot slides up and it will actually get caught in the mechanism at the top"

THINGS TO KEEP

IS	1:08:17	"If they push it up the market too much there's going to be a lot of people ...saying bye to the Discovery" [General group agreement about not making it too computerised]
DJ	1:09:17	"The one thing they mustn't get rid of is this space"
	1:09:34	"If the space goes from a Discovery point of view then it's gone [reason for purchasing vehicle]"
MDGF	1:09:40	"Is that a feeling of space of actual space?"
Unanimous		"Both"
JK	1:09:48	"You've got a lot of air inside the car"
RW	1:10:24	"It will carry a double bed when my daughter moves flat at University"
	1:10:35	"It's a struggle with a four door filing cabinet because of the length"
DJ	1:11:13	"If it's anything else it's about good space inside"
CH	1:11:32	"It's a very versatile vehicle"
DJ	1:11:45	"Everybody likes getting into it, without exception...."Isn't this spacious"...."Can't you see out of it well""
MW	1:12:09	"The position of being up high...I wouldn't want it to be altered"

RW	1:12:18	"It's the big glass height....the Discovery's got more glass than metal to look at it side on"
	1:12:28	"Try and maintain the outline with the kick up over the back seat, that's quite distinctive"
	1:12:40	"The fine crease round it [the bonnet], that makes the bonnet high without looking high, that's very distinctive"
JK	1:13:01	"All they've got to do is stick another foot in it, make it a bit longer" "When you come to the back, the back seat leans at a wonderful angle like that [indicates angle], so you can't actually get that much in the back"
	1:13:31	"Bit more sound proofing, better headlights so we can see where we're going, and then just leave it alone"
IS	1:13:40	"I think it's brilliant, what it'll do off road in tick over is unreal"
	1:14:08	"A bit more length to turn the back seats round, the very back seats [jump seats]....I've got four children and it'd be nice to have them all facing the same direction, because I don't think those back seats are very safe"
JK	1:14:24	"It sometimes makes them feel sick travelling sideways, I find"
RW	1:14:42	"If they do do that and make the back seats face the proper way round, please don't do what they do on one the Japanese ones, where you've got these sort of great Eiffel Towers strewn around in the side of the back windows"
IS	1:14:54	"It's a Mitsubishi Shogun, I looked at one of those before I looked at the Discovery, and I thought "Well there's all the room in the back gone""
RW	1:15:01	"They give you a video on how to fold those seats down I think, and a four week training course"
IS	1:15:28	"It was something different [jump seats] so the kids were always in there"
DJ	1:15:56	"It doesn't seem to be very well designed for carrying things....I'm also concerned if I want to fill it up I'm always feeling....what's going to happen if this starts coming forward [luggage]"
	1:16:17	"To really use the capacity I'd have to have a dog guard....if you could have some innovation where you could actually give me something that I

		could, for example, hinge and drop down, and then I could really load it up in safety. Then I would be very pleased with that"
JK	1:16:59	"If you hit something solid all that's [luggage] going to come forward"
IS	1:17:12	"[Luggage] slides over into the passenger seat"
CH	1:17;34	"I had the misfortune to roll....all those have a dog guard because they're only two seats....the trolley jack and everything all hurtled forward and hit the dog guard and would probably have killed us both had the dog guard not been there"
JK	1:18:03	"So it's not just a dog guard it's for safety"
DJ	1:18:26	"If you carry five people, you see, and you're carrying luggage it's not that big unless you stack it up"
RW	1:18:35	"The floor plan is not great, the volume is"
IS	1:18:56	"The only problem with putting a dog guard in is if you've got children's seats in the very back [jump seats]....you've got a dog guard in, a rear impact shunts the back door in, you can't get the back door open. How do you get in to get those kids out without having a very strong person to rip a dog guard out?"
PB	1:19:20	"I don't like the idea of taking children in the back with a dog guard, because it's so close [motions to the side of the head]"
	1:19:27	"That's the only problem with the side facing rear seats [they are close to the back window]...children love them....all kids do"

PUTTING THE JUMP SEATS IN PLACE

JK	1:20:01	"There's no anchorage points....where can I tie this to?"
IS	1:20:08	"They need to be below the floor level....if you do flatten the back end out to use the whole back end for carrying, whilst the safety belt anchorage bolts are hidden under the floor...you've still got the two catches of the safety belt floating around"
CH	1:21:12	"If you have forward facing seats you're not going to be able to fold them away as neatly as the present arrangement"

JUMP SEAT DESIGN

RW	1:21:31	"Very clever little design that [jump seats]….it takes you, oh, a couple of minutes"
	1:21:53	"For what they are they're an excellent design"
IS	1:22:05	"You can pull them down without the leg out. I've seen that done and it cracks the plastic"

GETTING IN AND OUT OF THE JUMP SEATS

JK	1:22:17	"No problem, just miss the tow bar with your shin"
IS	1:22:25	"You couldn't get any elderly people, but then they're an extra little seat when required. They're not supposed to be an everyday seat"
DJ	1:22:33	"I don't think there is much design though put into the back end to get people in and out"
RW	1:23:11	"I think the rear seats [jump seats] are fine for what they are, if you go much further and have the forward facing ones you seem to gain very little, and it brings all sorts of other problems like storage and safety"
JK	1:24:06	"I can't remember the last time I came up behind another Discovery, with the seven seats, and anybody sat in the back [jump seats]. Very rarely"
MW	1:24:26	"I think people who want to carry a lot of people would choose a different type of vehicle"
DJ	1:24:56	"The rear seat need something doing, I don't think it corresponds with the front from a comfort point of view"
	1:25:11	"Something innovative there [luggage restraint] to help me load it and use the capacity that's undoubtedly there"

SMALL PARCELS /LUGGAGE

JK	1:26:43	"It starts off in the bag and then when you get home it's out of the bag
MW	1:26:51	"[Carry it] right in the back, there's not a problem with the shopping"
DJ	1:27:19	"You do have that tunnel in front of the back seat, it is safer in the sense of slotting them [shopping bags] in, and you can slot them in very easily, but it's not really designed for carrying that….it seems to me the back is where it should be"

CARRYING THINGS ON THE ROOF

IS	1:27:47	"I carry materials on the roof and I feel sometimes the roof rack's not long enough....but that's just with my trade"
RW	1:28:19	"Again it's like the rear seats [jump seats], for what it [roof rack] is it's a super design"

LOADING THE ROOF RACK

IS	1:28:30	"You have to open the driver's door and stand on the seat"
RW	1:28:32	"...Sturgess do a very nice after market field step"
IS	1:28:37	"...but where do you store that without it rolling round the back?"
	1:28:50	"It's difficult to tie stuff on to the roof rack on the very back bar because it's so close to the roof"

PARKING IN CAR PARKS

JK	1:29:12	"I think as a courtesy from Rover it would be nice if they gave you a list of NCP car parks you can actually go in to"
MW	1:29:38	"It's frightening sometimes, the ones you do go into, it is very close to the roof"
CH	1:29:44	"Then again we've all said how we like the height"

SUNROOFS

IS	1:30:13	"I find my sunroofs rattle....when they're put back
JK	1:30:29	"They're flimsy, poor quality"
RW	1:30:34	"It's quite good the way they've done it because it doesn't impinge on the car headroom....but they do rattle"
JK	1:30:47	"But they're exactly the same as the Vauxhall Calibra....they make no noise, you wind them back and they stay where you put them"

OTHER GOOD THINGS

PB	1:31:35	"The price and I think the versatility of it, because we all use it for different things"
JK	1:33:06	"Not THAT many people have been in a Discovery....when they first get in they say "Geez, I didn't realise they were this posh inside"....and they're usually quite pleasantly surprised"

IS	1:33:33	"I think they need to be kept simple, we don't want to end up with, like a Range Rover, with tons of computers"
	1:33:38	"I want the vehicle kept simple so if it goes wrong it's cheap or cheapish....to repair, and it's just a good vehicle"
CH	1:34:33	"Basically they've got the vehicle about right at the moment, and it'd be better to evolve it slowly and improve it, rather than radically change it and make it into something different"
JK	1:34:46	"Want's fine tuning....it's ninety eight percent there"
RW	1:35:44	"Improve the build quality"

THINGS TO CHANGE

JK	1:36:19	"Those 'orrible things you shut the doors with"
CH	1:36:31	"The creaking dashboard and the trim, I mean I like the design of the dashboard, but when you look down the side of the console those two bits of cardboard, sort of hanging out"
JK	1:36:56	"Keep the nets in the back for sweeties and maps"
RW	1:37:05	"They've changed the door bins"
CH	1:37:07	"....yeah, they've made them unusable"
RW	1:37:16	"...they've now got a decent bit at the front but it goes down to nothing at the back, for no good reason as far as I can see"
IS	1:37:28	"I'd like to see somewhere you've got that great big area of dash between the instrument binnacle and the well on the passenger side....you've got sunglasses, mobile phone, you end up shoving them all down by the gear lever. The amount of times I've wondered why it won't go into gear....if there was a little dip in the front there up near the windscreen, you could throw all your pencils, bits and bobs in, rather than have it right over on the passenger side where it's no good to us because we can't reach it"
	1:37:51	"Bit more simple storage for small things"
PB	1:37:55	"What they should have done with the dashboard....is had it moulded all in one....it would look more finished"

IS	1:40:07	"Does anyone have any problems with that silly little can container....I like the idea, but if you've got a can in it, for one, when your can's empty it does nothing but rattle, surely you could get some plastic fingers or something to stop it"
JK	1:40:18	"...or make it [cup holder] deeper"
IS	1:40:21	"...and also you can rap your fingers on it when you're changing gear"
JK	1:40:59	"If you've got a can that's fine, it's designed for a can, but if, for example, you've got a small bottle of water, forget it"
CH	1:41:04	"...it falls out doesn't it"

Lifestyle Scenario Toolset

Background data

(taken from the World Market Matrix)

Background Data

This data has been gathered by Steve Nicholl in the Product Validation Department using the World Market Matrix. The matrix is currently being developed to collate data regarding physical and legal aspects of world markets. For more information about the matrix please contact Steve Nicholl in Product Validation (ext. 43780). This booklet shows selected information from the US market data.

USA Data

Sales Volumes

VEHICLE DENSITY		SALES	
Vehicles per thousand population 1997	Projected vehicles per thousand population 2000	Land rover 1997	Discovery 1997
462	443	24940	15480

Market conditions

ROAD TYPES	ROAD CONDITIONS	OVERTAKE	ROAD FEATURES	DRIVING CONDITIONS	DRIVING STYLES
Divided highways	Some well maintained	Both left and right	Expansion joints	Load balance risk (idle + a/c for long periods)	Generally well disciplined
Primary roads	Some poorly maintained		Speed bumps	Off roads	Heavy police presence
Secondary roads	Salt / grit used on roads		Road flooding risk	Sand driving	
City			High ramp angles	Towing popular	
Unsealed (dirt/dust) roads			High altitude roads		

Fuels

PETROL	DIESEL	ALL GASOLINE
Leaded unavailable	Spec. 45 index	All gasoline is available as Conventional, Oxygentated and Reformulated
Leaded, 89-95, 92-96, 94-100	Sulphur content 0.05%	

Climate

RAINFALL	TEMPERATURE °C	ALTITUDE
Typical example: Miami	Lowest: Fairbanks, Jan -54 °C	Capital city (Washington D.C.): 22m above sea level
	Highest: Death Valley, July 57 °C	Some areas over 2300m above sea level
	Average: Cold Feb -32°C Hot July 47°C	
	Capital city (Washington D.C.): min -3°C max 31°C	