The use of images and descriptive words for the development of an image database for product designers

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Abstract

This research aims to understand the role images currently play within the design process, in order to develop a classification of image types and reference keywords to construct an electronic image database for professional use in product design.

Images play an important role in the design process, both in defining the context for designs and in informing the creation of individual design. They are also used to communicate with clients, to understand consumers, to assist in expressing the themes of the project, to understand the related environments, or to search for inspiration or functional solutions. Designers usually have their own collections of images, however for each project they still spend a significant amount of time searching images, either looking within their own collection or searching for new images. This study is based on the assumption that there is a structure that can show the relationship between the image itself and the information it conveys and can be used to develop the database. A product-image database will enable designers to consult images more easily and this will also facilitate communication of visual ideas among designers or between designers and their clients, thus augmenting its potential value in the professional design process. Also, the value of an image may be enhanced by applying its linguistic associations through descriptions and keywords which identify and interpret its content.

Through a series of interviews, workshops, and understanding relevant issues, such as design method, linguistic theory, perception psychology and so on, a prototype database system was developed. It was developed based on three information divisions: SPECIFICATION, CHARACTERISTIC, and EMOTION. The three divisions construct a model of the information which an image conveys.

The database prototype was tested and evaluated by groups of students and professional designers. The results showed that users understand the concept and working of the database and appreciated its value. They also indicated that the CHARACTERISTIC division was most valuable as it allows users to record images through their recollection of feelings.

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Declaration

I hereby declare that those parts of this thesis which contain previously published material, or unpublished material available in the public domain, are clearly acknowledged as such in the text through use of referencing to their original source. Those parts of this thesis otherwise unreferenced may thus be regarded as wholly original and the thesis as a whole the result of the efforts of the author.

The images used in the main body of the thesis are attributed. Images which were used in the workshop are reproduced in Appendix B1. The publications from which these were taken are identified, specific publications and page references are not.

A CD of the prototype of the database, ImageNexus, is included as part of this thesis. For copyright reasons, the CD can only be used for academic purposes related to this research. The images in the database have been taken from those used in the workshop and their sources have not been specifically identified. They should not be used in the future development of ImageNexus without consulting the original sources. Those parts of the database otherwise unreferenced may be regarded as original and the database as a whole is a result of the efforts of the author.

Glossary

This glossary is specialised to this research and the first use of the term in the research is referenced.

1. **Category** (p.38)
   A general concept that marks divisions or coordinations in a conceptual scheme; in this research the function of image database was based on structured categories.
2. **CHARACTERISTIC division** (p.97)
   One of information divisions defined within this research. It is about the subjective, conceptual information of images.
3. **Closed question** (p.87)
   'Closed' questions structure the answers by allowing only answers which fit into categories that have been established in advance by the research
4. **Conceptual/tangible information** (p. 97)
   The interpretation of the information within an image such as colour and material for tangible information and characteristic and value for conceptual information.
5. **Descriptive words** (p. 4)
   Words that are used to describe image, objects, events, etc., generally they are adjectives.
6. **EMOTION division** (p.97)
   One of information divisions defined within this research. It provides users with a record of their emotional reactions to images.
7. **Front-end phase** (p.4)
   Refers to the Conceptual Design phase in the product design process.
8. **Image database** (p.3)
   A searchable database of images.
9. **Innovation design** (p.7)
   Innovation design develops tangible visions and possible short- and long-term concepts and scenarios, supported by technology roadmaps, to generate innovative design and new value propositions.
10. **Knowing-in-action** (p.80)
    Knowing-in-action is tacit knowledge which enables us to execute

tasks fairly automatically.

11. **Members/exemplars** (p.38)

    Single entities that belong to a category and are called exemplars or members of the category.

12. **Open-end question** (p.87)

    'Open-end' questions are those in which the question itself is standardised but the response is freely worded;

13. **Perception** (p.7)

    The process of acquiring, interpreting, selecting, and organizing sensory information.

14. **Product Semantics** (p.4)

    The study of meaning in products.

15. **Prototype theory** (p.39)

    The theory that the meanings of words or concepts is organised in the mind by a system of family resemblances.

16. **Qualitative research** (p.84)

    Any kind of research that produces findings not arrived at by statistical procedures or quantification.

17. **Quantitative research** (p.84)

    The research that examines phenomenon through the numerical representation of observations and statistical analysis.

18. **Reflection-in-action** (p.80)

    Reflecting-in-action is an intuitive, unexpected response during knowing-in-action (work).

19. **Semantics** (p.35)

    The study of meaning in language.

20. **SPECIFICATION division** (p.97)

    One of information divisions defined within this research. Its content is about the product's physical properties and tangible context.

21. **Visual language** (p.7)

    The idea that communication occurs through visual symbols, as opposed to verbal symbols, or words.

22. **Workshop** (p.5)

    A set of activities designed to promote feedback about a topic.

Chapter 1
Introduction

1.1
Research background

Since the Industrial Revolution and the emergence of mass production, industrial design[1] has gradually evolved, alongside marketing strategies developed from the placing of products in the marketplace to the successful generation of sales.

In the course of the 1920's and 1930's products crafted for mass production were becoming accessible and for the first time affordable to the average consumer (Kunstsenter 1991). What is known today as Industrial Design was started by designers who had the scope to embellish, or 'style', products. During the 1930's and 1940's, the impact of industrial design increased thanks to the development of new materials, such as aluminium and a variety of never-before-seen plastics. At that time industrial design focussed on functionality, aesthetic simplicity and affordability. With the digital treatment of information came a new and fundamental shift in the production and distribution of products. Nowadays products are produced not only just to be accepted by consumers, but more importantly to increase consumers' quality of life. As Esslinger, founder of Frog, said, "We believe consumers don't just buy a product, they buy value in the form of entertainment, experience and self-identity (Sweet 1999, p.9)."

Sweet (1999, p.14) stated that "Aesthetics are only part of our job, the integrated process allows us to look at products, brands or companies as a whole." Sweet's statements show design is now concerned with the making of objects or artefacts that people want, consistent with patterns of value. Certainly it is obvious that design involves a thinking process and activities, such as information research, concept generation, sketching, etc. Indeed, one of the main jobs of today's designers is to

[1] Recently, industrial design is more commonly referred to as product design.

bring the value of technology into consumers' everyday lives. Therefore designers have to understand the user's actions and reactions to everyday life. Using imagery to understand daily life experiences, designers can cater for the needs and wants of different consumer groups with diverse lifestyles. As a result, designers need a greater stimulus to enhance their thinking processes and activities, because nowadays consumer products, it seems, such as furniture, tableware and electronic products are produced in a similar way to fashion, they change every season. The role of product 'branding' has also become an essential marketing tool and one which designers must visually incorporate into their design solutions.

The urge of inspiration has led designers to use and depend on more and more images. As images are easy to access they can bring more reality to visual ideas to inspire designers imaginations.

1. 2 Rationale for research

Within the design process there are a number of factors that could affect a design outcome. However, the end product does not just depend on a good design process model. It is also influenced by a designer's capability and his having the right design tools - theory, methods and processes as well as experience and knowledge of the industry. A designer's knowledge is generated and accumulated through action (Narváez 2000). Designers use knowledge to create and evaluate their work; this serves as a continuous aid, helping them to build on their existing knowledge.

According to Dahl and Chattopadhyay (2001), designers use memory-based visual images as the main source of ideas. Visualisation is an essential tool in the design process, providing a means of exploring basic problems, and potential solutions. Vihma (1995) stated that design proposals often use other designs as a reference through the resemblance of forms in spite of differences in materials, construction and aesthetics. Such a metaphorical method can connect two similar forms which differ in other respects (Vihma 1995). Therefore, it is to be expected that using a categorised image database could enhance the memory-based visual ability of a design professional.

Even in the early days of industrial design history, Austen (1978) argued that within a library to support the design process there might be books, periodicals and comprehensive coverage of information on existing products, and also a large collection of product samples and an extensive referral service to sources of expertise in industry and research organisations. According to Formosa (1991), an insufficient flow of information leads to inadequately designed products and he believes that information could enhance the design process; in the proper environment it will feed creativity. Designers frequently search for and use information to help them to construct new knowledge related to the design topic, simultaneously searching for new information that will help to determine design constraints and produce a satisfactory design. (Lahti et al. 2000)

There have been several investigations (Hsiao and Chen 1998 and Hsiao and Wang 1998) into the method of gathering appropriate resources for designers in order to improve creativity and the design solution. Most research focuses on providing designers with information about human factors. Design today is being recognised as a critical factor within industry and the marketplace. Within the design process more information is needed than just ergonomics. Therefore, a product database based on today's computer technology can give designers more information easily and quickly. Most existing databases for product design have been defined by product type, as in the Design Index[1]. However, it is argued here that consideration should be given to the classification on other functional bases, such as controls, colour, material, shape, texture.

[1]Product indexing
For a number of years the Design Council maintained the Design Index, a record of some 7,000 'well designed' British consumer goods. (Austen 1978) The Design Council Archive moved to the Design History Research Centre at the University of Brighton in 1994, and comprises a photographic record of selected products, together with their specifications, costs, and the name of the designer and manufacturer. (See chapter 2.3.2.1, p.54)

Designers primarily use visual material within the front-end phase (concept generation), but it is also used throughout the whole design process. This enables them to achieve the information and stimulus for the creativity they require. For many designers, they search for images through the use of books, magazines, journals, and the Internet etc. The new information technologies enable methods by which to search for information using keywords. As shown in 'Design for ease of use: Product semantics and Design Education' (Huang 1996), there was a significant positive result when using product semantics to assist in the design process. This research resulted in 14 keywords to describe products. Although those keywords were mostly concerned with products functions, such as handles and buttons, this is a precedent for developing a database with descriptive keywords for images.

According to Baxter (1995), before the design process was put into practice, images were taken as a designers' approach to explore the concept. Monö (1997) commented that a designer should aim at understanding product language better in order to be able to improve his design. If that were the case, then images based on classifications by product language would provide designers with more inspiration.

This research proposes to provide the designer with an appropriate resource – an image database with a clear keyword system and simple usability.

1.3 Aim of research

Due to technological improvement and the changing social environment, product design is not just about providing a client/user with a product. It is often more important for designers to create new values for existing products. Images play an important role in the design process, in defining the context for design and informing the creation of individual designs (Eckert and Stacey 2000).

The aim of this study is to develop a collection of key descriptive words and construct a prototype electronic image database for product designers' professional use. This study is based on the assumption that a keyword structure can show the relationship between the image itself and the information it conveyed and can be used to develop the database. The study therefore addresses understanding of:

1). The reasons designers use images in the design process;
2). How they store and access images;
3). The words they use in describing visual features in the images;
4). The way images are used in communication.

1.4 Structure of thesis

This thesis is organised under the following structure: research context and methods (Chapters 1-3), results and findings of the fieldworks (Chapters 4-5), database system developments and evaluations (Chapter 6-7) and conclusions (Chapter 8).

Chapter 1 Introduction

Research background and the aim of the thesis are given in this chapter.

Chapter 2 Literature review

This chapter provides a historical review of product design process, design methods and basic understanding of language and image management. It includes also a survey of current image databases.

Chapter 3 Research methodology

This chapter describes research structure, research methods and the methodology used throughout this research.

Chapter 4 Interviews and workshop

The settings, procedures and the results of interviews and the workshop are given in this chapter.

Chapter 5 Classifications

This chapter describes the application of analysis from Chapter 4 to develop an image information model and classify descriptive keywords.

Chapter 6 Image database development

This chapter describes the development process of the image database and its usages.

Chapter 7 Image database evaluation and discussion
System evaluation procedures and results are given in this chapter.
Chapter 8 Review and conclusions
This chapter reviews and summarises the major findings of the current research. Studies for future work are suggested and discussed.
Chapter 9 Critical context of the research

1.5 Publications

On the basis of the studies stated in this thesis, the author has published three conference papers, as listed below. (See Appendix G)

1. Wu, C. and Johnston, M., (2003) 'Investigating and classifying visual references used in product design', *Proceedings of the 6th Asian Design International Conference*, Tsukuba, Japan, published in CD format.

2. Wu, C. and Johnston, M., (2004) 'The development of a visual reference database for product designers' use', *Proceedings of the 4th International Conference on Design and Emotion*, Ankara, Turkey, published in CD format.

3. Wu, C. and Johnston, M., (2005) 'The use of images and descriptive words in the development of an image database for product designers', *Proceedings of the 1st International Conference on Design and semantics of form and movement*, Newcastle, UK, pp59-69.

Chapter 2
Literature review

The aim of this research is to understand the role images play within the design process, and the language used by product design professionals in describing images, in order to establish an image database which will enable them to access images more easily. Therefore this research involves the following three domains: product design, language and image, as illustrated in Figure 2.0-01. The "overlapping set" of the three domains represents the area of current research.

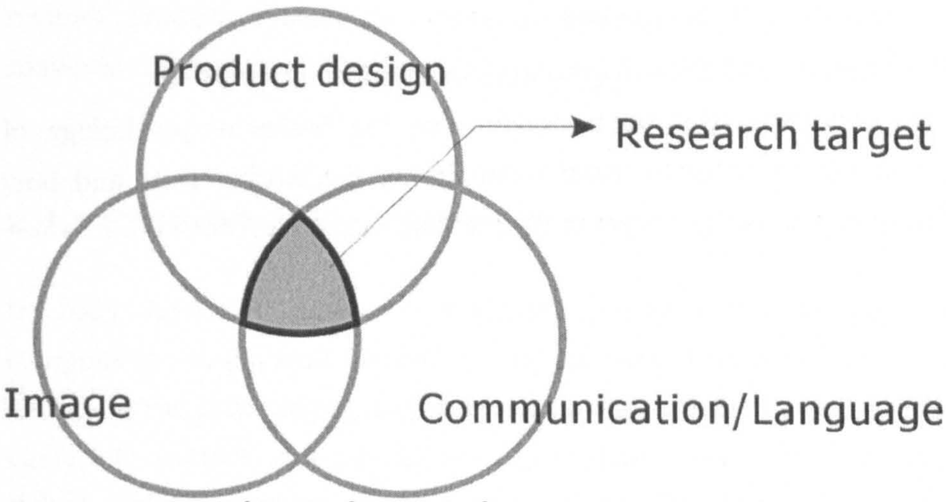


Figure 2.0-01: Research target of current study.

The literature review places emphasis on these three areas but also investigates some other disciplines (product semantics, interactive design, perception psychology) which support the research.

Product design (Section 2.1, p.9)
This section focuses on relevant areas of product design: product design process, innovation design, design methods, design emotion and product context. The study is used to establish an understanding of the role which images play within the design process.

Language (Section 2.2, p.35)
This section basically focuses on design languages, e.g. visual language and product semantics. Linguistics is also reviewed in order that it may

assist in classifying descriptive keywords. Finally, design communication is discussed with a view to analysing the designer's means of communication within the design process.

Images (Section 2.3, p.51)

This section provides an overview of the need for using images, image data management and an image database survey in design-relevant areas.

Database and interaction design (Section 2.4, p.69)

This section describes the process of developing a database, the principles of web-based interface design, and methods of evaluating applications.

Perception and thinking in action (Section 2.5, p.77)

This section focuses on understanding the basics of psychology of perception in order to assist in analysing fieldwork results and how designers knowledge reflect in their action.

2.1
Product Design

This section presents product design literature topics which were selected to support the research. Section 2.1.1 looks at the product design process in order to appreciate the detail of design activities. Section 2.1.2 investigates the relevant design methods based on the use of images. 'Innovation design' is also introduced in Section 2.1.3 because it has gradually become a division of product design. It is important to understand this new design sector and its idea generation methods. 'Design emotion' is included in Section 2.1.4 because it was one of the topics which arose from the survey (see Chapter 4, p.100). Section 2.1.5 reviews product context in order to understand the information conveyed through products.

2.1.1 Product design process

In 1963 Alexander defined design as 'finding the right physical components of physical structure', and in 1966 Farr suggested that 'design is the conditioning factor for those parts of the product which come into contact with people' (quoted in Jones 1992, p.3).' In 1995, Eekels and Rooxenburg (1995, p.3) wrote that 'product design is the process of devising and laying down the plans that are needed for the manufacturing of a product.' Then, in 2002, Bruce and Bessant (p.19) stated that 'design is not only a process linked with production but also a powerful means of conveying persuasive ideas, attitudes and values.' These statements demonstrate that the purpose of product design has changed; it has developed from making a product to fit people's needs to adding value to a product for the benefit of corporations and users.

However, to understand, or to be involved in a profession it is initially important to comprehend the inherent procedures. As Twiss suggests (quoted in Hollins and Hollins 1991, p.15), design decisions will be better if designers understand the processes of work within a 'conceptual framework'. This conceptual framework is called a design process model.

Models of the product design process have been developed since the early 1960s, progressively offering systematic procedures that make the design process clearer and more effective. Academics have spent a great deal of time discussing and disagreeing about the various stages that are followed in design activity. Models can be found in many different versions. This section addresses five characteristic examples, from a "market-to-production" design process model to Jones' (1992) "three-stage" process. They represent the most complex model to the simplest model.

The first model is an overall process from market to production. Its design code is: market, specification, concept design, detail design, manufacture and sell. The second model has a similar process to the first model. It proceeds from the product idea to disposal of the product, but it has a separate phase for design. The only difference between these two models is the terminology used. In addition, they are more like a product development process. The third and fourth models focus more on design activities. Again, the main difference between these models is the terminology used. The final model is by Jones and it summarizes the design process simply into three stages. The first two models have been recognized by standard associations and the second two have been practiced by the design teams of Motorola and Philips.

2.1.1.1 Pugh's design activity model

The design model shown in Figure 2.1-01 is a later version of one which has been developed by Pugh since 1976. It has been adopted by an increasing number of bodies (e.g. The Institution of Production Engineers' *A Guide to the Management of Design*, 1989). This model envelops the whole system of artefact production—from the market (the initial need) to selling to the customer, and includes the manufacturing function. It provides the framework to which the designed product must relate, and demonstrates the design process for almost all products (Hollins and Pugh 1990).

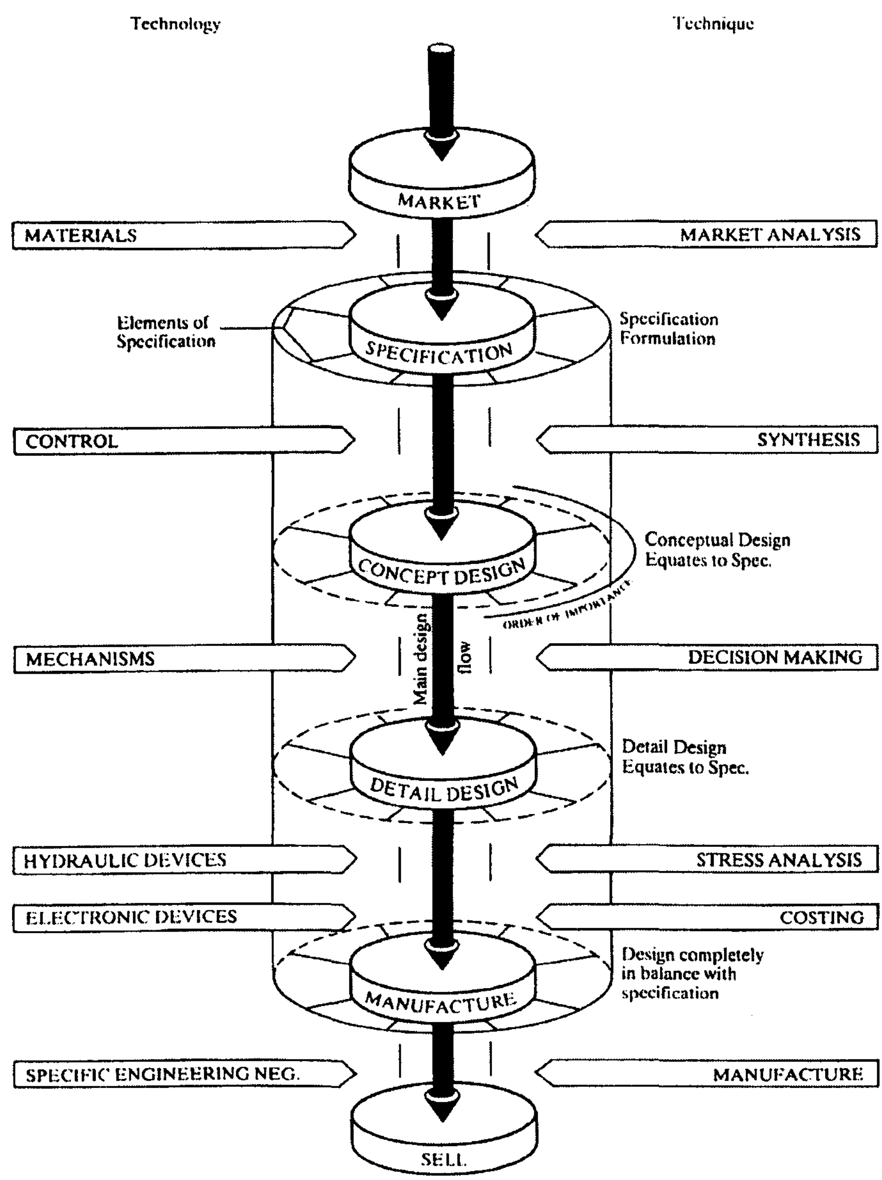


Figure 2.1-01:Product Design Activity Model.
Source: Hollins and Pugh 1990, p.51

2.1.1.2 British standard model

The design process model, as shown in Figure 2.1-02, is included in the 1989 British Standard *A Guide to Managing Product Design-BS 7000.* It takes the process from concept, through production, to product disposal; design is separate, being only part of the process. Within the design phase, there are four procedures: conceptual design, embodiment design, detail design and design for manufacture.

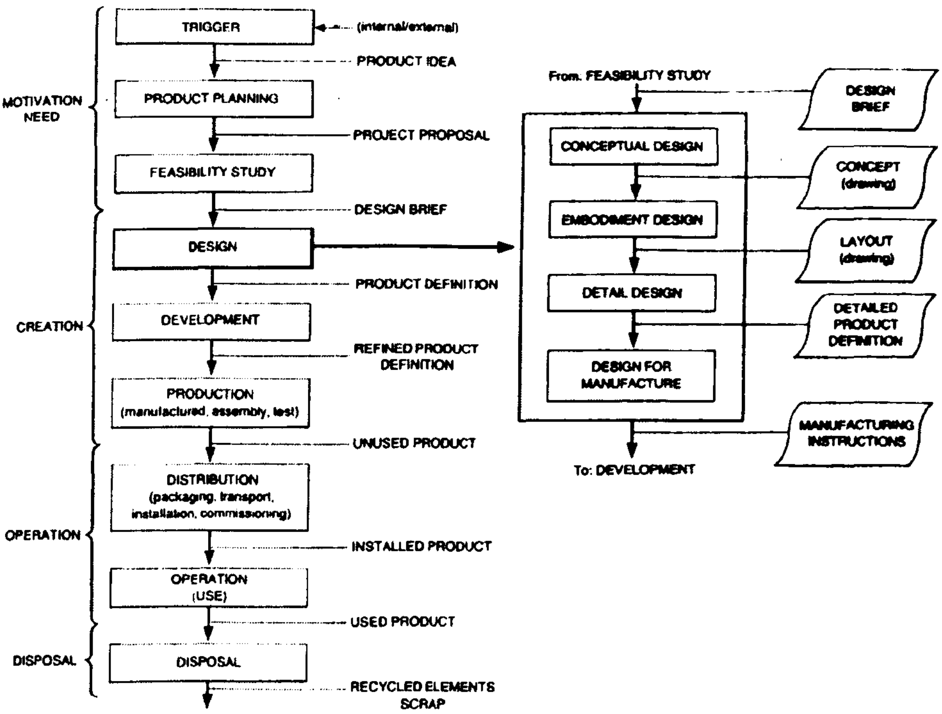


Figure 2.1-02. This model is included in the British Standard *A Guide to Managing Product Design-BS 7000*
Source: Hollins and Hollins 1991, pp.17-18

This model and Pugh's design activity model are more like product development process models. Wright (1998) explained that product development is the period between investigation into a new product and launching the product onto the market. The product development process includes the costly activities of market research, technological research, design, prototype testing, and preparation for manufacture, as the two models show. Although designers' actions are only involved in part of these models, they are closely related to other professional tasks e.g. engineering design. Design actions are given clearly defined roles in Eppinger and Ulrich's process (Section 2.1.1.3, p.12) and Phillips's process (Section 2.1.1.4, p.13).

2.1.1.3 Eppinger and Ulrich's process

Eppinger and Ulrich (1995) have given us a more understandable abstract; that within the design process the input to the process is a mission statement and the output of the process is the product launch. The mission statement identifies the target market for the product, the functional description of the product, etc., in order to identify customer needs. It is made up of the following phases, which have been practised by Motorola:

1. Investigation of customer needs
2. Conceptualisation
3. Preliminary refinement
4. Further refinement and final concept selection
5. Control drawing
6. Coordination with engineering, manufacturing, and vendors

(Eppinger and Ulrich 1995)

2.1.1.4 The Philips Design Track

Heskett (1989) introduced the Philips Design Track (see Figure 2.1-03) which was established by Knut Yran, director of Concern Industrial Design Centre (Philips industrial design centre), and used by Philips design teams. It begins with briefing the product characteristics and specifications (BRIEFING), then proceeds through information research (CREATING), sketches and renderings (DESIGNING), model work and modifications (PRESENTING), to delivery and testing (DRAWING).

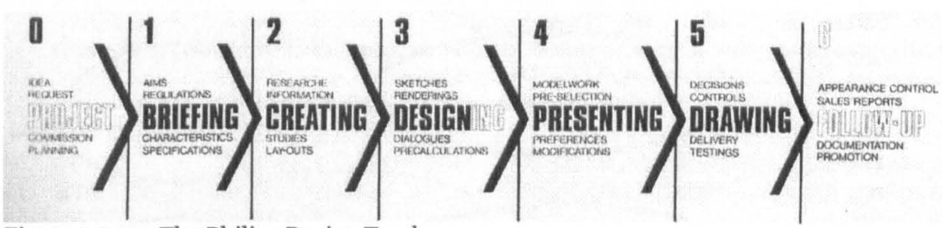


Figure 2.1-03: The Philips Design Track.
Source: Heskett 1989, p.25

Yran suggested that design is really problem-solving, and that the definition of the design problem is half of the design work (Heskett 1989). He also emphasised that a formal written brief is important because the brief affects the successive stages in the process.

2.1.1.5 The three-stage process

The simplest design process model, with which many writers agree, is designing as a **three-stage process** (Jones 1992): analysis, synthesis and evaluation. Analysis involves the breaking up of the problem into pieces, synthesis is the putting together of the pieces in a new way, and evaluation equates to testing to discover the consequences of putting the new arrangement into practice (Jones 1992). The design process models addressed before could all be condensed into the three-stage process. Because design activities have been influenced by social and environmental changes (e.g. economic, technology) the considerations of design are much more complicated. Therefore, the three-stage process could cover the entire design process, and could also be applied within each stage of the design model. Each stage would cover all the procedures of analysis, synthesis, and evaluation. For example, Eppinger and Ulrich's process can be presented with three-stage process as Figure 2.1-04.

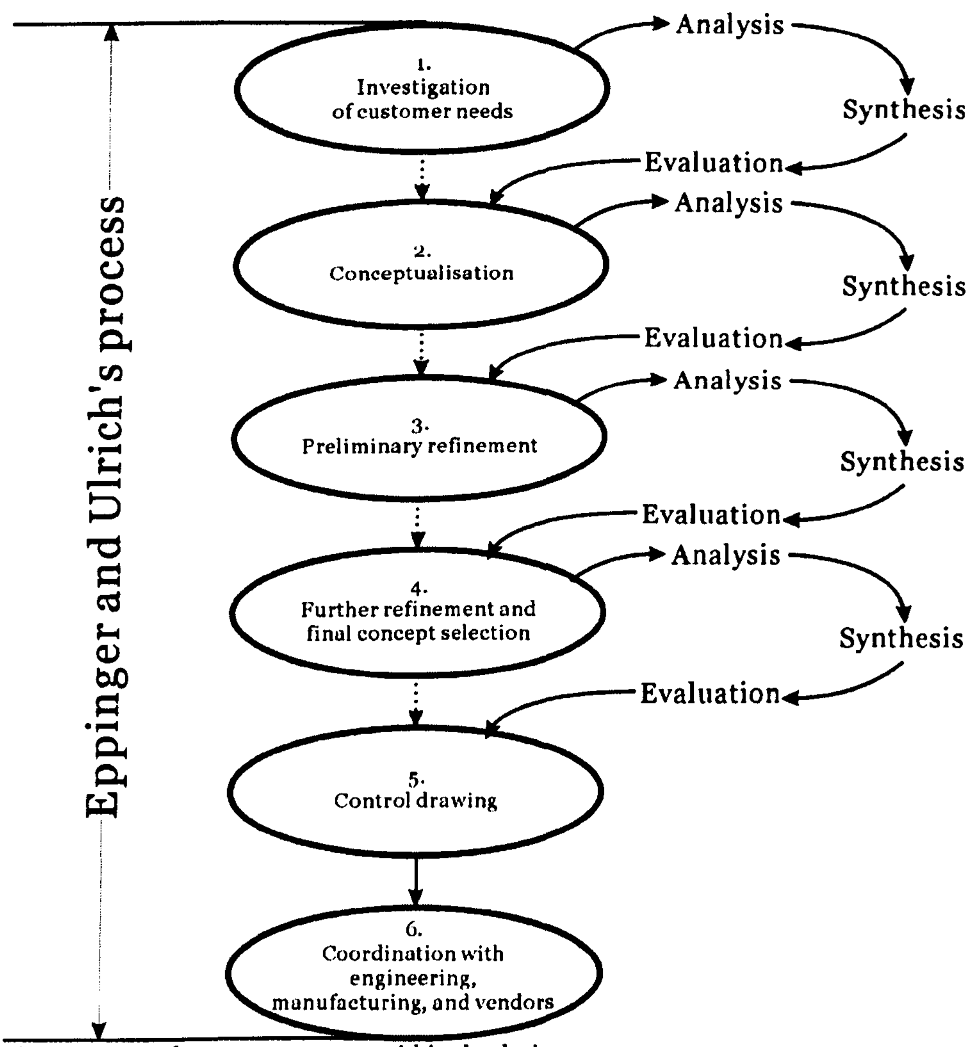


Figure 2.1-04: Three-stage process within the design process

2.1.1.6 Summary

To sum up, the design process could generally be divided into three phases: conceptual design, embodiment design and detail design. (Baxter 1995, Eekels and Roozenburg 1995, and Eppinger and Ulrich 1995)

a). Conceptual Design

The conceptual design phase starts with identifying the needs of the target market and determining the overall function and important sub-functions that are to be fulfilled. Next, alternative product concepts are generated and evaluated, and a single concept is selected for a suitable point of departure for embodiment design and detail design. A concept is a description of the form, function, and features of a product, and is usually accompanied by a set of specifications, analysis of competitive products, and an economic justification of the project.

Conceptual design and concept development are commonly the initial and critical stages of the design process. Decisions on a design *brief* made here will bear strongly upon all subsequent phases of the design process. This may include some of following information (Eppinger and Ulrich 1995):

- Brief description of the product
- Key business goals
- Target market(s) for the product
- Assumptions that constrain the development effort

b). Embodiment Design

In this phase the chosen concept is elaborated into the definition of the product architecture and the division of the product into subsystems and components (Eppinger and Ulrich 1995). The product's architecture is the functional and physical terms of the product (Otto and Wood 2001). The functional elements of a product are the individual operations and transformations that contribute to the overall performance of the product. The physical elements are the parts, comprising components and subassemblies, that ultimately implement the product's functions. In this phase the design is represented by layout drawings to scale showing important dimensions (and now 3D CAD models), and a preliminary functional specification for each of the product's subsystems, as shown in Figure 2.1-05.

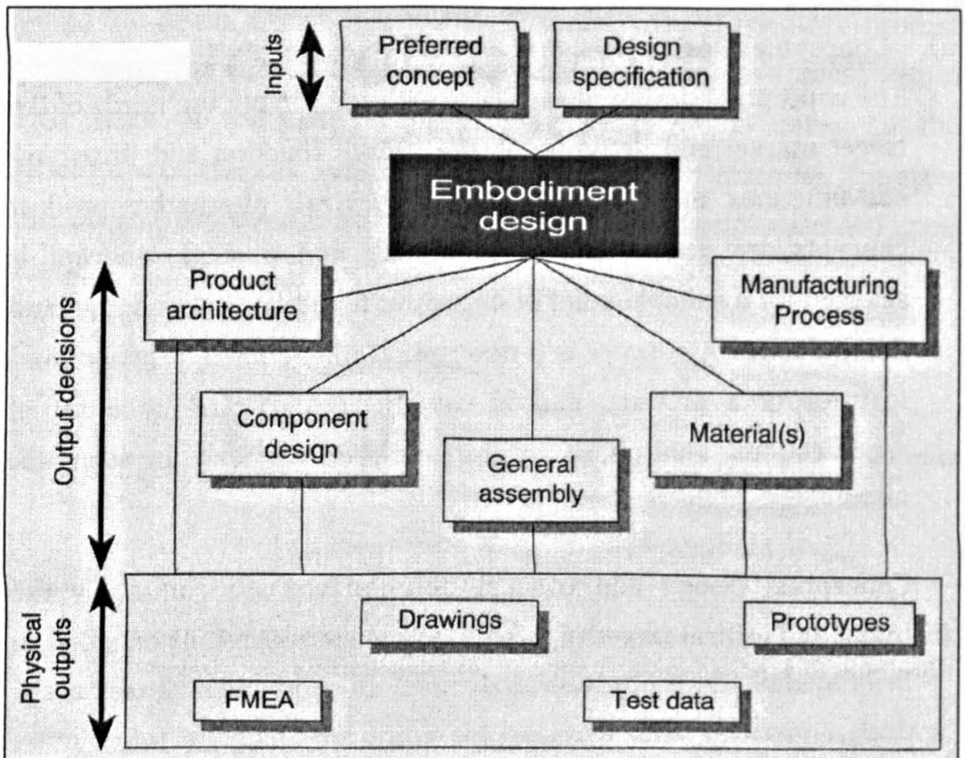


Figure 2.1-05: Inputs and outputs in the embodiment design process.
Source: Baxter 1995, p.272

c). Detail Design

The detail design phase includes the complete specification of the product's geometry, material, and tolerance of all of the unique parts in the product, specified in assembly drawings, detail drawings and parts lists. The output of this phase is the control documentation for the product—the drawings or computer files describing the geometry of each part and its production tooling, the specifications of the purchased parts, and the process plans for the fabrication and assembly of the product, as shown in Figure 2.1-06. The most important point is that the result has to meet the specification which was laid down in the conceptual design phase.

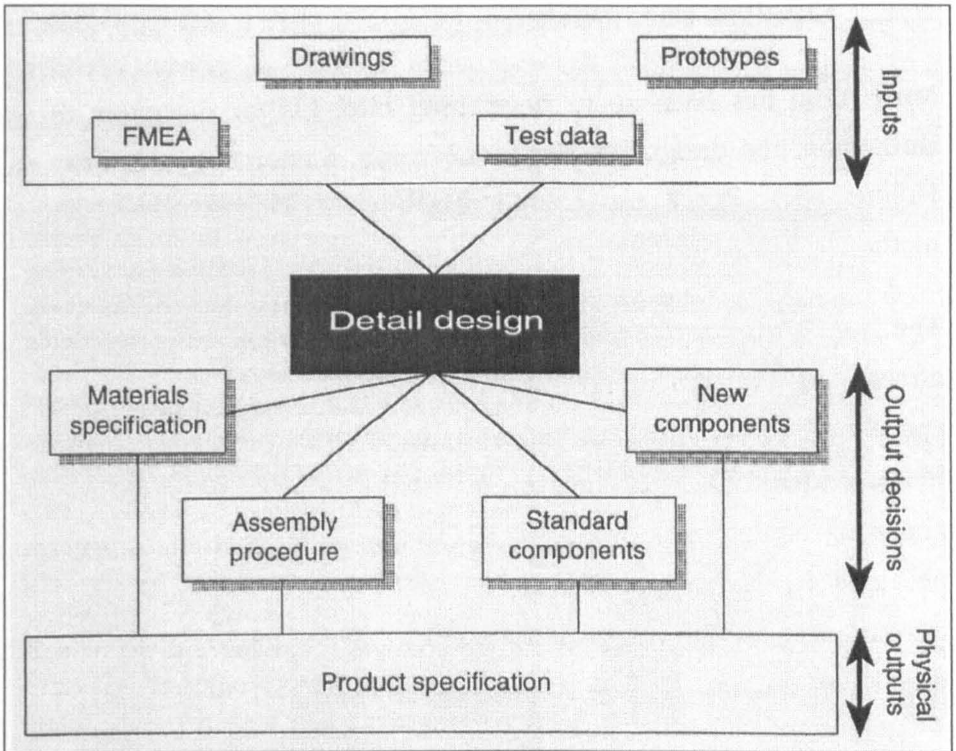


Figure 2.1-06: Inputs and outputs in the design process.
Source: Baxter 1995, p.273

Of these three phases, it can be seen that that conceptual design plays an important role. It determines the direction of the following two phases and is also where creative activities start.

2.1.2 Design methods

Much time has been spent developing methods for designers to use throughout the design process (Jones 1992, Baxter 1995, Hollins and Hollins 1991, Bruce and Cooper 2000 etc.). This section discusses methods applied during the front-end (conceptual design) stage.

The front-end phase of the design process is a critical stage because it affects the direction of the following phases. In this stage designers spend time researching and conceptualising design ideas. The activities include: identifying customer needs, establishing target specifications, analysing competitive products, and interpreting market information provided by the client. To conceptualise ideas, designers use this information to inform exploration of visual forms and research functional solutions.

Gillian Hollins and Bill Hollins (1991) suggest that there are several ways in which individuals can stimulate their creativity, such as 'Challenge', 'Visualisation', 'Brainstorming' and so on. The methods discussed here, however, relate only to using images.

Jones' (1992) 'The Visual Inconsistency Search' method proposes the use of samples and/or photographs of existing designs to find directions for design improvements. The aim is to identify design conflicts and compromises that may have been necessary in the past but may be avoidable in the future. It is assumed that such conflicts are bound to affect the appearance of a design, and that experience in looking at designed objects makes it possible to detect such conflicts quickly.

Another similar method is using visual references to assist designers' visual thinking in order to determine how the product fits into the symbolic expectations of the customer. It starts off with broad objectives and narrows them down to specific, tangible and manufacturable forms. Baxter (1995) observed that these visual image selections could be divided into lifestyle, mood, and theme boards. A Lifestyle board is one with an image of the target customers. These images should convey the customer's personal and social values. For example Figure 2.1-07 and 2.1-08 are lifestyle boards of mobile phones users. They are used to explore how the styling of mobile phones could be changed to match more closely the semantic and symbolic expectations of a diversified customer base (Baxter 1995).

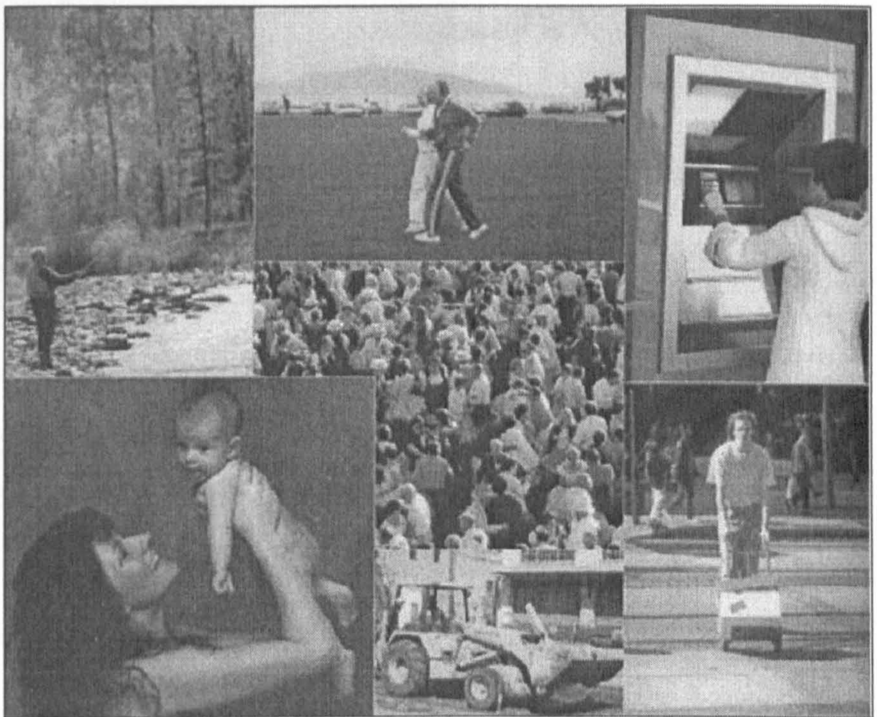


Figure 2.1-07: Lifestyles of the 'new' mobile phone user.
Source: Baxter 1995, p.224

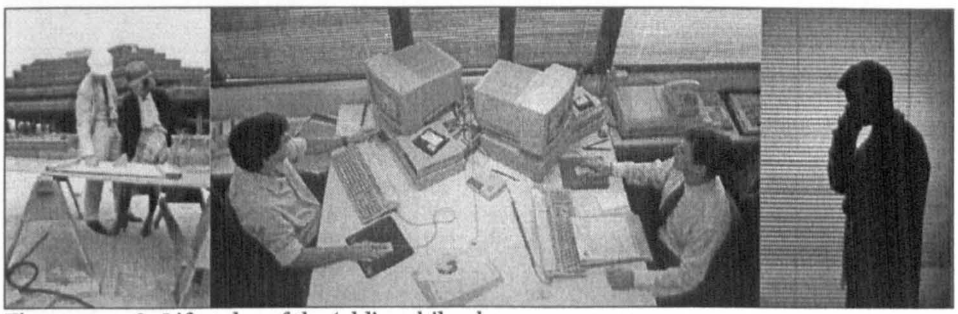


Figure 2.1-08: Lifestyles of the 'old' mobile phone user.
Source: Baxter 1995, p.224

A mood board projects a single expression of values for the product, which will appeal to customers with the identified lifestyles (Figure 2.1-09 and 2.1-10). The mood of a product is the sentiment, feeling, or emotion which the product engenders when first seen. Good mood boards capture images which do not reference specific product features.

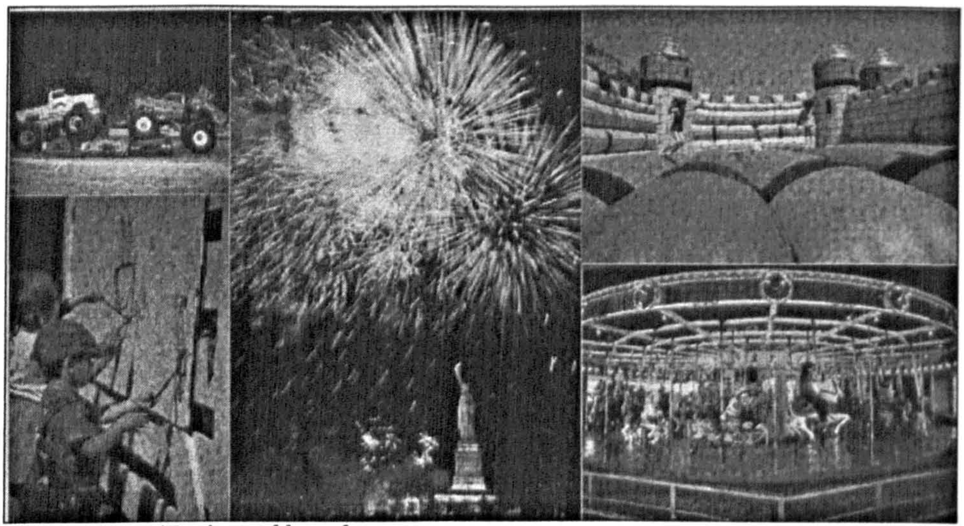


Figure 2.1-09: 'Fun' mood board.
Source: Baxter 1995, p.226

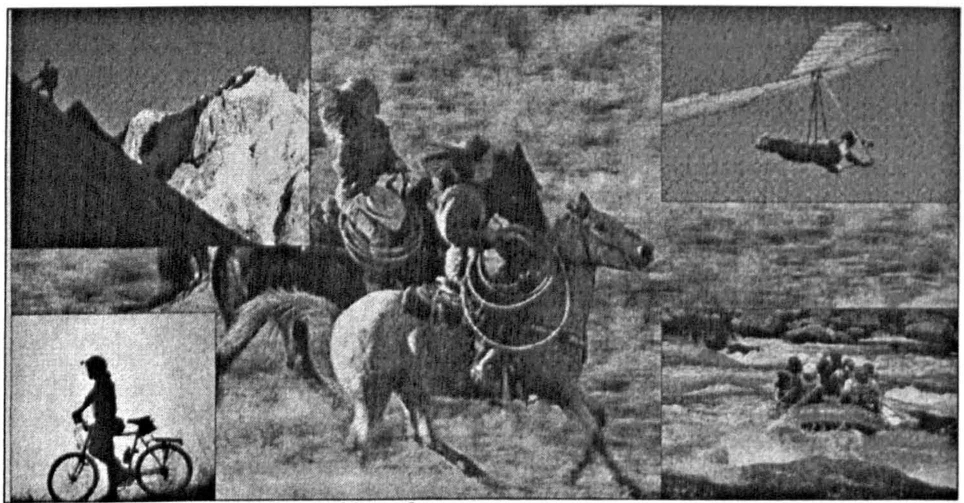


Figure 2.1-10: 'Adventure' mood board.
Source: Baxter 1995, p.226

Theme boards collect together images of products, materials or colour which manage to convey the target mood (Figure 2.1-11 and 2.1-12). These products can be from diverse market sectors and have widely different functions.

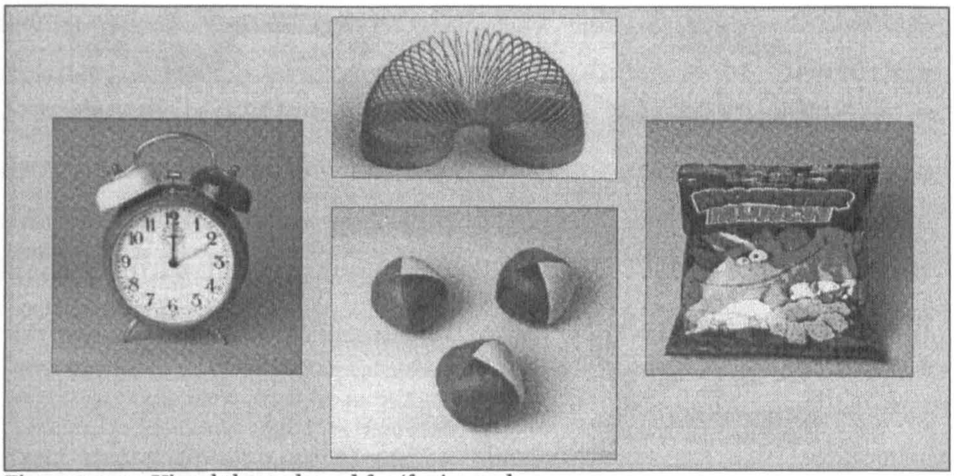


Figure 2.1-11: Visual theme board for 'fun' mood.
Source: Baxter 1995, p.227

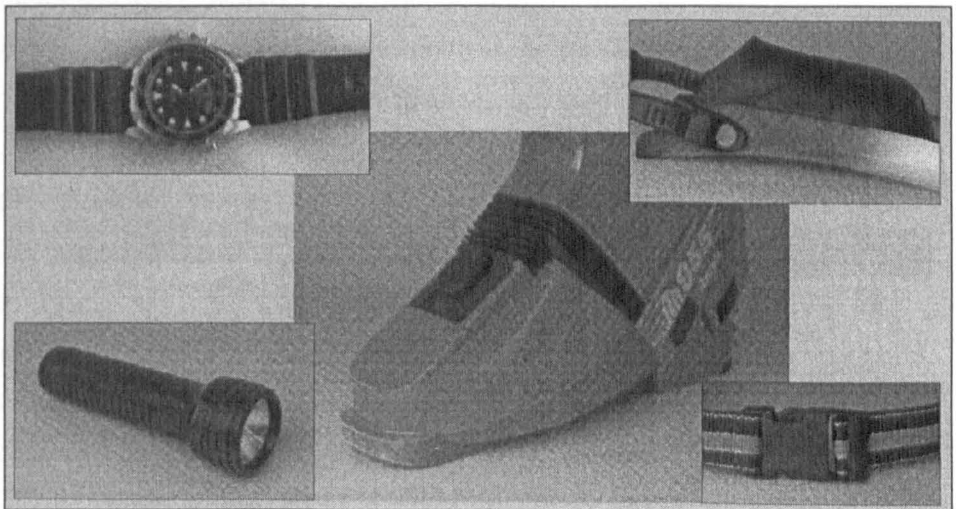


Figure 2.1-12: Visual theme board for 'adventure' mood.
Source: Baxter 1995, p.227

Theme boards are the most well know and popular way of using images to understand contexts and express ideas. Additionally, the use of images within the design process not only assists designers in generating concepts but also helps them to communicate with others (see Section 2.2.4, p.48).

The following methods are taken from 'RSA Inclusive Design Toolkit' (2004) which collected design relevant information, tools and techniques. There are two methods which use visual reference as a tool within design works.

1. Users photograph their lives, homes and work

Users' 'Photo diaries' allow designers to enter the users' world with a small expenditure of time and effort. Users take pictures of their environment, tools, social network etc. Depending on the focus of the design process, they then make an album of the photographs. They are interviewed about the content and meaning of the pictures and the overall structure of the album. This method was contributed by Anu Makela of the Helsinki University of Technology, Finland, in Methods Lab: User Research for Design.

2. People pictures as creativity catalysts

This method uses a collection of photographs that show aspects of people in some part of their daily lives. They are not a substitute for engaging with real users but might be used as a catalyst. They are meant to act as stimuli for idea exploration and as reminders that some people are different from those involved in the design team.

Images help designers to focus their thoughts. Beyer and Holtzbiatt (1998) suggested that using language could help to focus thought, and graphical languages give a whole picture. However, the graphical languages are not images; they are symbols which convey concepts. Graphical languages reveal more detail about work. Beyer and Holtzbiatt illustrated that a picture is a better external representation than a page of text because it is easier to see what designers are talking about.

This research tests the theory on use of images in design methods and develops understanding through interviews (see Section 4.1.3, p.104) to ensure a full range of possibilities for using images have been examined.

2.1.3 Innovation design

Since the emergence of industrial design, activities within the discipline have steadily changed and improved (Heskett 1980, Loewy 1979, Dormer 1993, Bevlin 1977 and Kunstsenter 1991). Technology has played an important part in the change of focus in the design process. Manufacturing concerns are not as important as before. Designers have more freedom in creating form, style and functions. Baxter (1995) noted that as manufactured products have become more global, the competitive pressures from overseas companies have increased substantially. The need for product innovation has grown because innovation is a centrepiece of corporate strategies and initiatives (Kelly and Littman 2002). This section focuses on understanding innovation design, and the factors and methods involved in creating a new product.

2.1.3.1 Types of innovation design

'Innovation design helps to develop tangible visions and possible short and long-term concepts and scenarios, supported by technology roadmaps, to generate innovative design and new value propositions. (Innovation design, 2004)' The difference between innovation and design is that design is a total activity which always considers function, form and many other attributes of the designed item (Heap 1989). Innovation is the creation of a novel product, or novel feature of an existing product. 'A designed product may or may not be the result of innovation (Heap 1989, p.4)'

According to Bruce and Cooper (2000), research by Tidd *et al* identified types of innovation (Table 2-01) each of which is classified by its strategic advantage. They suggest that new product development must be considered as a type of innovation by strategy advantage as in Table 2-01, in order that the right type of product may be developed for the target market.

Table 2-01. Type of innovation by strategic advantage

Type of innovation	Strategic advantage
Novelty	Offering something, that no-one else can
Competence shifting	Rewriting the rules of the competence game
Complexity	Difficulty of learning about technology keeps entry barrier high
Robust design	Basic model product or process can be stretched over an extended life, reducing overall cost
Continuous incremental innovation	Continuous movement of cost-performance frontier

Source: Tidd et al. 1997. Adapted from Bruce and Cooper 2000, p.7

Aiken's (1999) research claims there are only two approaches to innovation: Technology-driven innovation and Customer-driven innovation. The differences between 'Technology-driven' and 'Customer-driven' innovation are:

1. In Technology-driven innovation, new product ideas generally come

from designers and engineers. Aiken (1999, p.5) said 'this technology-driven innovation process was inefficient in that it frequently created a "solution looking for problems"—clever application of technology to nonexistent problems or designs that reflect what a designer can do, not what a consumer wants.'

2. The Customer-driven innovation process begins not with an invention or design, but with an understanding of the target market and consumer. Aiken (1999, p.5) said 'Understanding consumers and markets does not replace design or innovation, it informs innovation, giving it a direction and a focus on the consumer.' Aiken also emphasizes that customer-driven innovation requires not only a change in market research procedures, but a major change in the way product development and design are approached.

Innovation design plays an important role within a new product design development process. The international product design consultancy IDEO undertook research into why companies looked outside their organisations for product development. They found that there are four key reasons: Capacity (availability of more designers), Speed, Expertise and Innovation (Kelly and Littman 2002). For large companies with in-house design teams, innovation is frequently the reason for employing consultant designers. It is recognised that a fresh approach can identify new design solutions (Kelly and Littman 2002).

2.1.3.2 Idea generation

In the previous section different kinds of innovation design were introduced. According to the literature search, the processes of innovation design are the same as the design process demonstrated in Section 2.1.1. They all start from identifying the product market and users, and then end with a designed product. Therefore, this section is not about the design process. Instead it focuses on the idea generation techniques for innovation design.

Bruce and Cooper (2000) sum up the techniques for generating information, knowledge and ideas for innovation design, as shown in

Figure 2.1-13. They divide the techniques along two axes: On one axis, from "information generation focused activities" to "idea generation focused activities"; and on the other, from "exploratory techniques" to "confirmatory techniques". For example, 'brainstorming' falls into an area of idea generation focused activities and exploratory techniques.

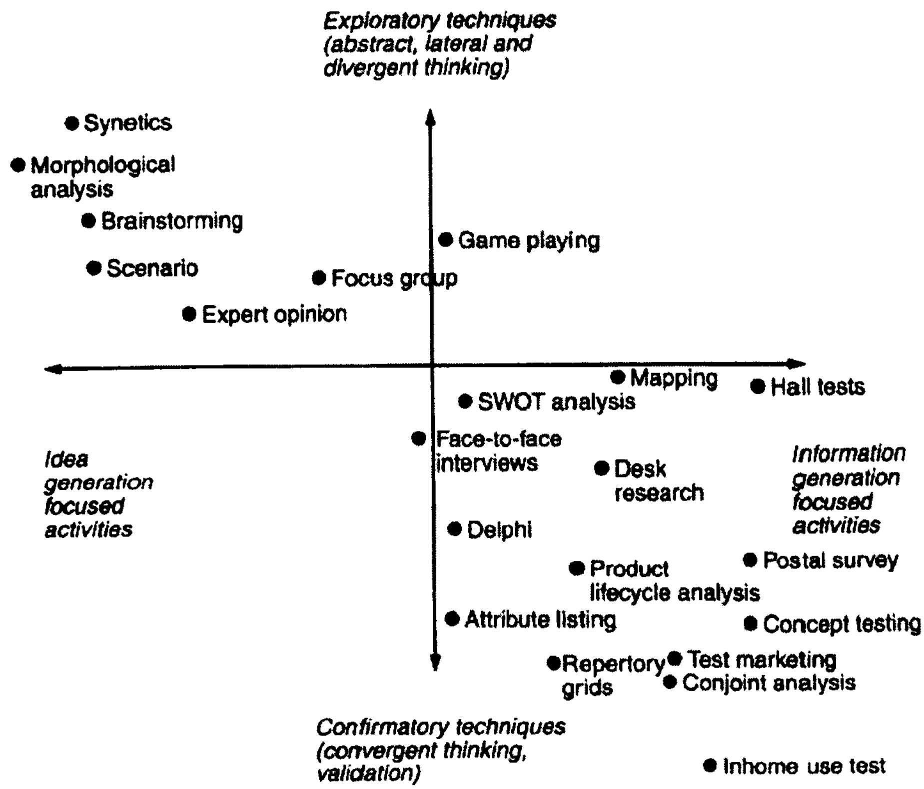


Figure 2.1-13: Techniques for generating information, knowledge and ideas
Source: Bruce and Cooper 2000, p35

Four product research techniques use by the Ford Motor Company (reported by Aiken 1999) are shown below. References to the Bruce and Cooper chart are shown in brackets.

1). *History*. Using the detailed information from present customers as a knowledge base. [Postal survey or face-to-face interviews]

2). *Futuring*. This includes the development of future scenarios, cohort analysis/demographics, and analysis of trends and values. [Scenario, Game play, Disk research, or Mapping]

3). *Customer Insight*. The techniques for generating insight include:

- Segmentation—based on consumer needs, not product categories. [Focus group]
- Idea generation—providing designers and engineers with the opportunity to interact directly with consumers. [Brainstorming]

- Ethnographics—understanding the consumer experience. How do people live and what do they value? How does the automobile fit into their lives?
- Observation—paying attention to what people do, not what they say, to inform design.
- Imaging—translating verbal information into design images.

4). *Testing of future products*

- Ethnography and product development

Ethnography scientifically evaluates and describes culture. In new product development, the more deeply researchers understand consumer experience; the more clearly they can envisage the future. Ethnography reveals insights into consumer perceptions, actions, and experiences. The application of this insight allows ethnographic research to become the future.

- A focus on experience

As the experience of the user becomes the new research focus, the intricate interactions of needs, attitudes, and demographics become less relevant. It focuses on what consumers 'think' about a product and what consumers 'do'. The perceptions surrounding experience reveal valuable insights. Valuable knowledge can be gained from the investigation of actions. Finally, it will increase the understandings of consumer behaviour by looking at how people 'use' various products. [Inhome use test]

At IDEO, a five-stage idea generation technique is used (Kelly and Littman 2002):

1). Understand: understand the markets, clients, technology, and problems.
2). Observe real people: observe real people in real-life situations.
3). Visualise: visualise new-to-the-world concepts and the customers who will use them.
4). Evaluate: evaluate and refine the prototypes.
5). Implement: implement the new concept for commercialisation.

Again there are similarities with other techniques. At the Ford Motor Company, for example, 'Customer Insight' matches 'observe real people' and 'Testing of future product' is the same as 'evaluate and refine the prototypes'.

All the above techniques show that no matter whether they use observation, visualization or imagination, they all end up using images to emphasize their target. For example, images are used to support the understanding of markets and users, images are used to record the observation of real people, or images are used to demonstrate the visualization of new concepts.

2.1.4 Design emotion

The literature search was focused on the search of the context a product conveys to the users. The issue of users' emotional responses toward a product was raised after the interview survey with design professionals. Therefore a study of the emotional feelings are aroused by products was carried out as follow.

2.1.4.1 What is emotion?

Desmet (2002) expressed the view that the design of products and their use involves, evokes and influences the user's moods, feelings and emotions in many different ways. But what is the difference between moods, feelings and emotions? Desmet suggests that the affective states[1] which are aroused by objects are emotions, moods, emotional traits and sentiments (Table 2-02). Feeling is not included, because it is not considered to be a distinct affective state. He explained the affective states by dividing them into:

a). Whether the state involves a relation between the person and an object (i.e. intentional or non-intentional)

b). The duration of a state's existence (i.e. acute or dispositional)

States that involve a relationship between the person and a particular object are intentional, e.g. emotion, whereas those not involving such a

1 The term "affective state" is used to cover phenomena such as passions, sentiments, temperament and moods.

relationship are non-intentional, e.g. mood. Table 2-02 shows the classification of the four states.

Table 2-02. Differentiating affective states

	Intentional	Non-intentional
Acute	Emotion (Short limit of time duration)	Mood (Long limit of time duration)
Dispositional	Sentiments	Emotional traits

Source: Desmet 2002, p.4

1) **Emotion:**

   Emotions imply and involve a relationship between the person experiencing them and a particular object, such as when one is afraid of something, proud of something, in love with something, and so on.

2) **Moods:**

   The main difference between moods and emotions is that moods are essentially non-intentional; for example one is not sad or cheerful at something. Moods are not directed at a particular object but rather at the surroundings in general (Frijda 1994). This is how Mood Boards are used to generate a phenomenon.

3) **Emotional traits:**

   Emotional traits can be interpreted as moods that are characteristic for a certain person.

4) **Sentiments:**

   Sentiments are dispositional states that may persist throughout a lifetime, and involve a person-object relationship (e.g. like and dislike).

A product can be the object of one's emotion; sometimes the product is the cause. Although emotions are influenced by moods, the focus of this section is the role emotion plays in the design process. Therefore, the next section examines emotional responses to products.

2.1.4.2 Product emotions

Cupchik (1999) proposed that three kinds of meaning which can be attached to industrially designed objects are: sensory/aesthetic, cognitive/behavioural, and personal/symbolic. "Sensory/aesthetic meaning would be primary in a decorative context, while cognitive/behavioural meanings would be central in a purely instrumental context, and personal/symbolic meaning would be critical when the object has social value (Cupchik 1999, p77)." They are related to two contrasting emotional processes associated with action and reaction.

He also suggested that sensory qualities could have an immediate and direct effect on experience through brain activity (e.g. the colour red elicits a feeling of approaching warmth, while blue evokes a feeling of receding coolness). "They can metaphorically foreshadow the cognitive meaning of a designed object (as when a coarse texture evokes a sense of ruggedness in an outdoor product)" (Cupchik 1999, p76)".

Cupchik (1999) explained that personal/symbolic meanings relate to self-concept and dynamic processes affecting both a person's motivation for engaging with an industrially designed object and how it is interpreted. These motivations can lead a person to project supplementary meanings onto objects which may not be directly related to their functions or appearances. At the most superficial level, an object can be seen by the user to resonate with, and be symbolic of, the self. Thus, perceiving oneself as rich and powerful might lead to conspicuous consumption, such as owning a luxury car or wearing designer apparel.

Cupchik's explanations also reflect on Desmet's (2002) study that product emotions are: first, between those expressed by products and those elicited by products; second, those that people experience towards products. This indicates that designers would have emotional responses to the images' aesthetic, behavioural and symbolic meanings, because images of objects already have some interpretation attached to them in the way they have been created (Eckert and Stacey 2000). Cupchik also indicated that product emotions are personal, temporal and mixed. Therefore, each designer's emotional reaction would be very different.

How many emotions could be elicited by products? In Desmet's (2002) study the product relevant emotions were divided into eight categories: Pleasant Excited, Pleasant Average, Pleasant Calm, Neutral Calm, Unpleasant Calm, Unpleasant Average, Unpleasant Excited and Neutral Excited. In his study he used words which came from the Davitz's (1969)

347 emotion words, which he reduced to 69 product-relevant emotion words and classified under the eight categories (see Figure 2.1-14). Desmet then reduced these 69 to a set of 25 emotions which are elicited by product's appearance and eliminated 9 of these words, because of similarities between them, the degree of relevance to product appearance, practical considerations and his empirical findings (see Figure 2.1-14).

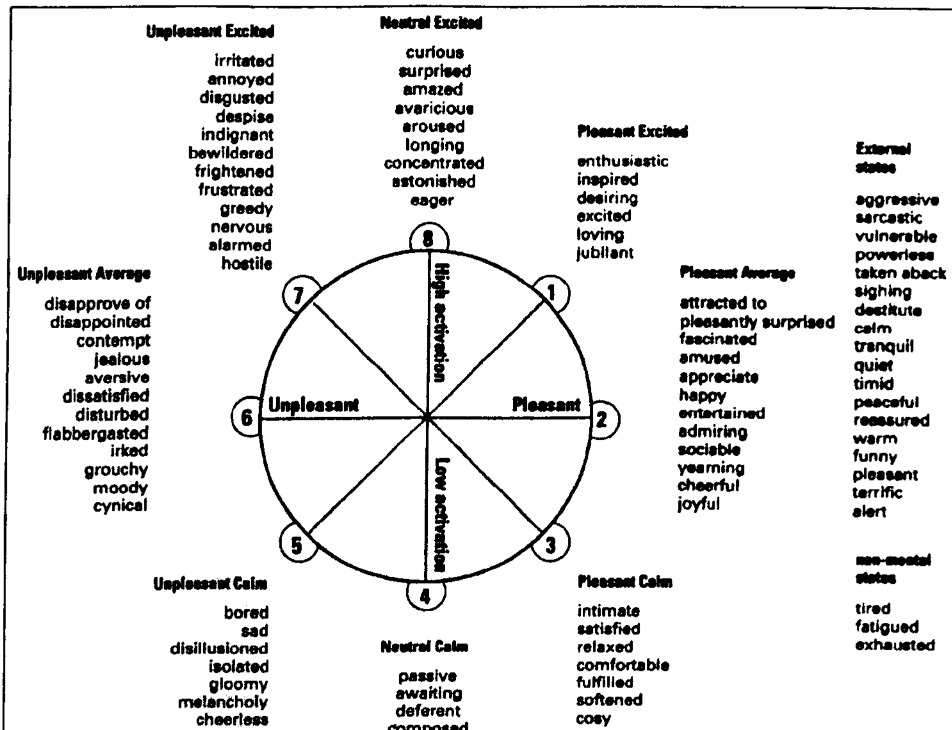


Figure 2.1-14: 69 product-relevant emotions.
Source: Desmet 2002, p.27

He thus produced 14 words which express emotional reactions to product (see Figure 2.1-15):
Disgust, Indignation, Contempt, Unpleasant surprise, Dissatisfaction, Disappointment, Boredom, Inspired, Desire, Pleasant surprise, Amusement, Admiration, Satisfaction, and Fascination.

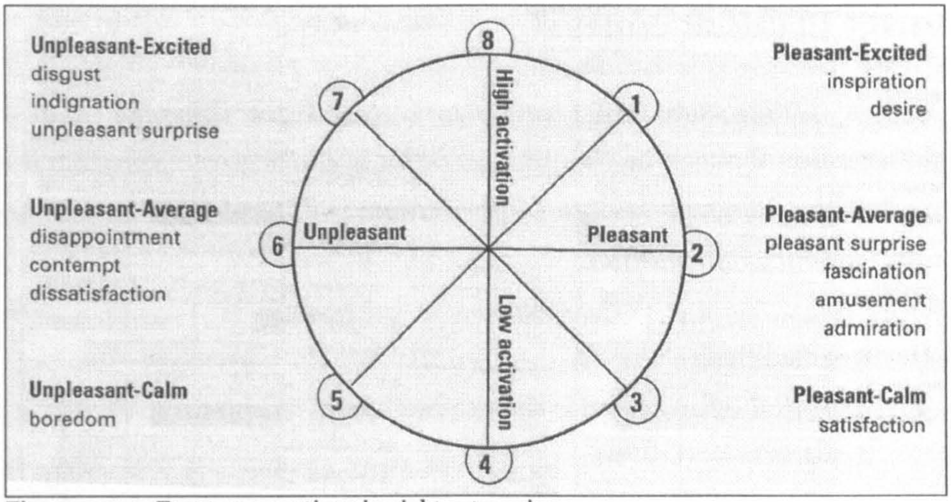


Figure 2.1-15: Fourteen emotions in eight categories.
Source: Desmet 2002, p.69

Desmet's work involved several experiments which used photos to examine participants' responses, and some experiments also involved using instruments to measure emotions. It is of direct relevance to this study in the way it focuses on the context which images can convey, and consequently the 14 emotional reaction descriptors were adopted as keywords within the divisions of information used in the database (see Section 5.3.2, p.149).

2.1.5 Product context

Coates (2002) stated that products convey three different kinds of information that can be classified in order of the degree of freedom they permit the designer: *essential information*, *collateral information*, and *discretionary information*.

He explained that:

- *Essential information* is the product's very reason for existence, e.g. a watch indicates time.
- *Collateral information* exists alongside essential information to supplement it. It is always optional. Coates indicated that the designer has more discretion in shaping sources of collateral information, as long as it does not hinder the effectiveness of any essential information, e.g. the numbers on a watch face.
- *Discretionary information* refers to the designer's freedom to have a product created. Coates indicated that whether or not a product conveys essential or collateral information, it always conveys discretionary information. Discretionary information in a product is a means of broadcasting personal values, beliefs and attitudes, e.g. iMac conveys a brand value more than its essential information.

'*Discretionary information*' is the important information conveyed by products which represent brand names and the visual image of a corporation. Mooij (1998) describes elements of a product's 'association network' which relates to:

- The brand name and the brand's visual image (e.g. packages, logo, brand properties, etc.);
- Attributes: what the product is or has (characteristics)
- Users
- Place, occasions, moments, moods when using the product
- Value

All of which are related by the product's '*Discretionary information*'.

Mooij (1998, p.95) explained that 'Values have cognitive, affective, and behavioural components. A value is a preference for one mode of behaviour over another mode of behaviour.' He also indicated that values guide and determine social attitudes and behaviour, and are linked to a product's attributes. The oldest value research used for marketing is the VALS (Value and Lifestyles) framework, and it sorts respondents into: Actualizers, Fullfillers, Achievers, Experiencers, Believers, Strivers, Makers, and Strugglers (Kotler 2000).

When it came to identifying a product's customer, Williams (1998) thought that this could be achieved by defining customers demographically and psychographically. Demographic considerations include age, sex, income level, marital status, ethnicity, geography and education; psychographic (or lifestyle) considerations include a person's activities, interests and options.

According to Kotler (2000), demographic variables are the most popular bases for distinguishing customer groups. They divide the market into groups using variables such as age, family size, family life cycle, gender, income, occupation, education, religion, race, generation, nationality and social class. Table 2-03 shows Kotler's classifications of age, gender, and social class.

Table 2-03. Classification of age, gender, and social class from Kotler (2000)

Category	Members
Age	Under 6, 6-11, 12-19, 20-34, 35-49, 50-64, 65+
Gender	Male, female
Social class	Lower lowers, upper lowers, working class, middle class, upper middles, lower uppers, upper uppers

Mooij, Williams and Kotler all provided very detailed categories to help define the users of a product. However, the work of Packard (1959), Saunders (1990), and Wynne (1998) suggests that users could be simply defined by their age, gender and social class, because social class could represent the income, occupation and education.

The understanding of a product's context helps to analyse an image's context and this can be taken as one approach to establish the categorisations for the storage of images.

2.1.6 Summary

The product design process can be simply divided into three phases: Conceptual Design, Embodiment Design, and Detail Design (see Section 2.1.1.6, p.15). The decisions made during the Conceptual Design phase will effect the successive activities.

Product design literature shows that images are an essential part of a design method and, most importantly, are used in the concept design stage. Images are used to:

a). Understand target users—using lifestyle boards,

b). Analyse existing products—'The Visual Inconsistency Search' method,

c). Express a concept as a theme board—using mood and theme boards.

This survey identified that products can evoke one's emotions, and Desmet (2002) had refined these to 14 words.

A product conveys essential information, described as *'Discretionary information'*, which represents its product characteristics, users, the place where it will be used, its value and the visual image of a corporation.

2.2
Language

A general definition of language is a system of communication which consists of a set of sounds and written symbols; nowadays, it is more widely used to describe different communication forms such as sign language, programming language, or visual language (Dinneen 1967 and Crystal 1997). Communication is important in the design process and the use of images is also important in communicating with others. Therefore, it is essential to understand the forms of communication and what words mean. In this section, language is discussed in a range of contexts as below.

Section 2.2.1 introduces the meaning of words and how linguists categorise words. A categorisation theory is introduced in order to assist in classifying keywords for the development of a system.
Section 2.2.2 focuses on understanding the elements of visual language.
Section 2.2.3 discusses the theory of product semantics in order to understand how it affects designers' thinking.
Section 2.2.4 is about the language used in design communication. It focuses on verbal and visual communication in the design process.

2.2.1 Linguistics—the meaning of a word

Linguistics is the study of how language works and the meanings it can convey. This section focuses on understanding the meaning of words. This aims to assist in classifying keywords used by product designers to express or describe ideas.

According to Crystal (1997), there are six models of language structure in the study of linguistics (see Figure 2.2-01). The simplest model recognizes only two basic levels: the set of physical forms (sounds, letters, signs, words) contained in a language, and the range of abstract meanings conveyed by these forms. The three-level model includes pronunciation (phonology), grammar (syntax), and meaning (semantics), as shown in Figure 2.2-01.

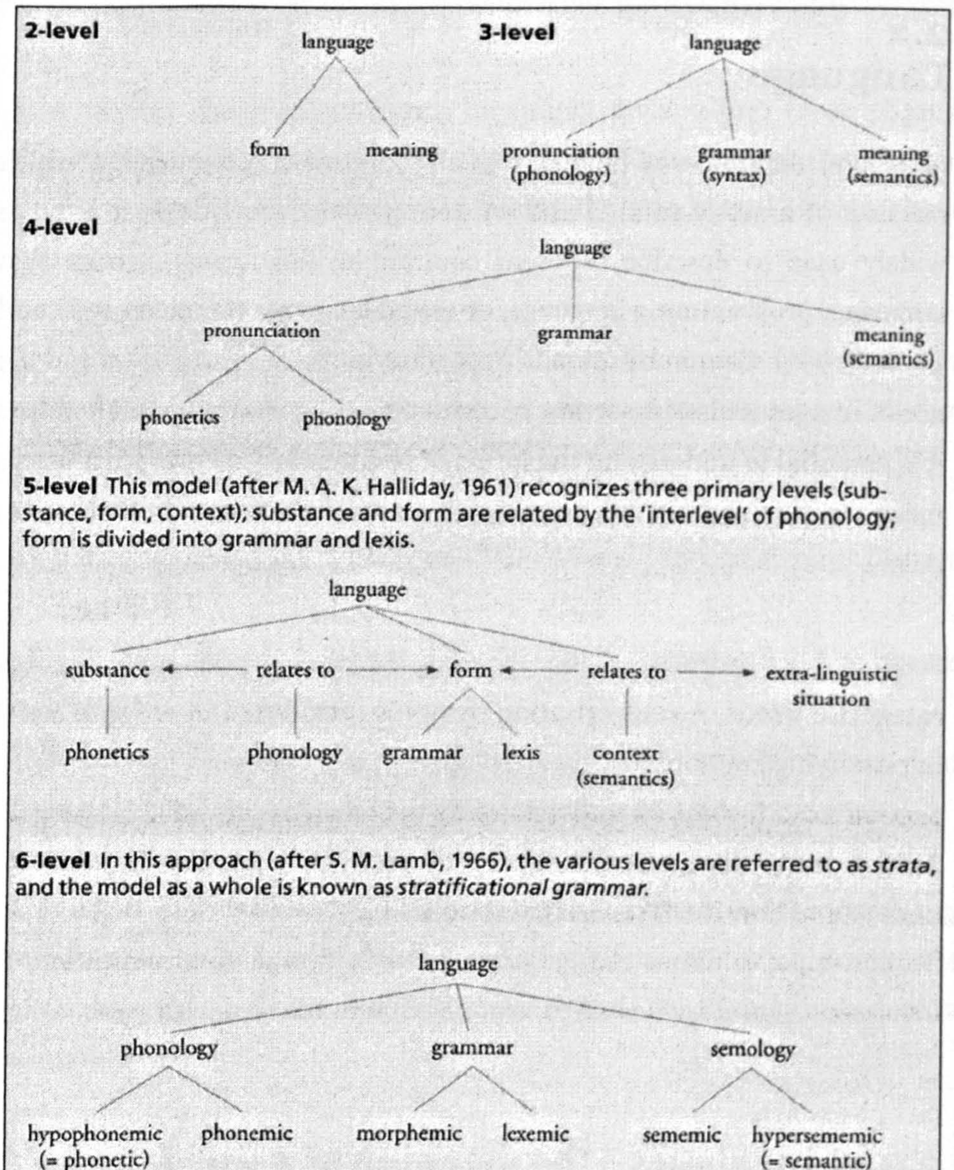


Figure 2.2-01: Models of language.
Source: Crystal 1997, p.83

Four-level models of language (phonetics/ phonology/ grammar/ semantics) are among the most widely used. The processes of articulation, acoustic transmission and audition, are considered to be the subject of *phonetics*. *Phonology* is the way different languages organize sounds to convey differences of meaning. The study of the way meaningful units are brought into sequence to convey wider and more varied patterns of meaning is the province of *grammar*. The term *semantics* is used for the study of meaning. Five-level and six-level models have further divisions within and between these levels, see Figure 2.2-01 for the relationship.

In addition, Dinneen (1967) stated that, essentially, linguistic studies are divided into phonology, grammar, and meaning. In the light of Crystal and Dinneen's work, it shows the direction for this research should focus on semantics, the study of meaning.

2.2.1.1 Meanings are concepts

The meaning of words in Crystal's (1997) three conceptions of meaning are:

1). Words → things

Words 'name' or 'refer to' things. However, the majority of words seem unable to be related to things. For example, adjectives such as *difficult* cannot be seen.

2). Words → concepts → things

This view argues that the relationship can be made only through the use of one's mind. For every word, there is an associated concept.

3). Stimuli → words → responses

This is the view of meaning proposed by the behaviourist Leonard Bloomfield, in his book *Language* (1933) and adopted by Crystal: meaning is something that can be deduced solely for a study of the situation in which speech is used – the stimulus that leads someone to speak, and the response that results from this speech.

In reviewing the basics of linguistic studies, the popular view is that meanings are concepts. For example, according to Hudson (1995), a word and its meaning are **concepts.**

Löbner (2002, p.20) used the example of a *dog*. He explained what the word *dog* means: "you would probably say that dogs are a certain kind of medium-sized animal with four legs and a tail, that they are often kept as pets, and that they bark, etc." He said this is an adequate reaction; that giving a description of dogs may well count as an explanation of the meaning of *dog*. However, the word does not carry this description with it. The recognition of a word is something residing in one's mind.

Therefore meaning is a mental description called a concept. Löbner (2002, p.20) explained that "A concept for a kind, or category, of entities is information in the mind that allows us to discriminate entities of the kind from entities of other kinds." For example, 'intelligent' and 'bright' have the same concept of "intelligent" or 'water' and 'mountain' have the same concept of "nature". He emphasised that a concept should not be equated with a mental visual image. For example, verbs such as *ask* or *find*; adjectives such as *traditional* or *productive*; nouns such as *consistency* or *efficiency* are unable to have a visual image.

One of best-known formulations of words as concepts is the 'semiotic triangle'. The original one is by Ogden and Richards (1923) (adapted from Crystal 1997, p.101), as shown in Figure 2.2-02. Löbner's (2002) version of the semiotic triangle is the relationship between a word, its meaning and its denotation, as shown in Figure 2.2-03.

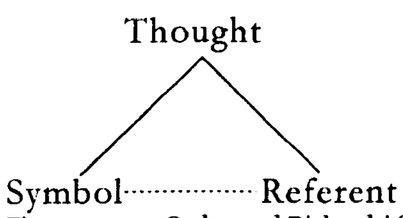


Figure 2.2-02: Ogden and Richards' (1923) semiotic triangle.

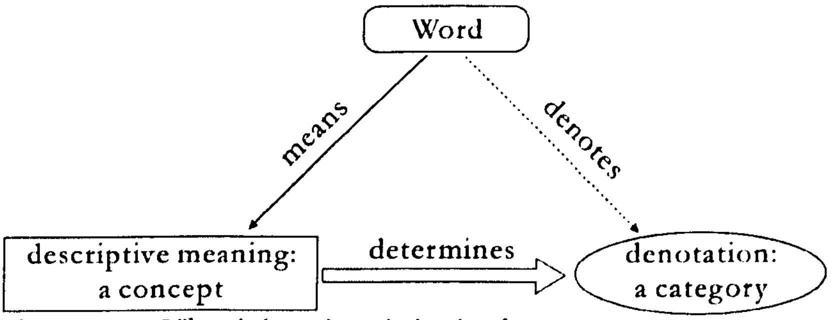


Figure 2.2-03: Löbner's (2002) semiotic triangle.

To sum up, the meaning of a word is a concept that provides a mental description of a certain kind of category.

2.2.1.2 Categories and concepts

As described above, a concept determines a category. The single entities that belong to a category are called **exemplars** or **members** of the category. A category is developed by categorization theory. Categorization is the practice of sorting things. The traditional view of categorization is that it is shaped by a list of necessary and sufficient features. This categorization model is named NSC (necessary and sufficient conditions) model for short. For example, if the category *man* is defined by the three conditions of being human, male and adult, each one is necessary. If someone is neither human nor male or not adult, he or she is not a man.

However, in 1969 Berlin and Kay found that colour terms (colour categorization) did not seem to fit the NSC model. Based on the analyses of colour terms, it was found that similarity is a matter of degree. For example, the categories *red* and *brown* intuitively overlap. Brownish red is red but still more or less brown, and reddish brown is vice versa (Löbner 2002).

Prototype theory was the result of the investigation for gathering similar phenomena. The evidence for this theory was proposed in 1978 by Eleanor Rosch. The Prototype theory of categorization suggested that instead of the NSC analysis method, categorizing could be achieved by using a "prototype," an 'ideal' image of the perfect member of that category. For example, in a category of *bird* a chicken is a bird, but a prototypical bird is not a chicken, an owl or a penguin. Entities such as birds seem to share the same features such as 'animal', 'feathers', 'wings', 'laying eggs', and so forth.

Löbner (2002) summarized the characteristics of the prototype model of categorization as follows:

- **Graded structure**. The members of a category are not of equal status.
- **Prototypes are best examples**. There are prototypical members that are consistently considered the best examples of the category.
- **No set of necessary conditions**. Category membership is not a matter of a fixed set of necessary conditions. The prototype of a category may be defined by properties absent in less typical examples.
- **Family resemblance**. Category members are connected by family resemblance.
- **Prototypes are reference points**. Prototypes serve as reference

points for categorization. Category membership is a matter of similarity to the prototype.

- **Graded membership**. Category membership is a matter of degree.
- **Fuzzy boundaries**. Categories have fuzzy boundaries. This is because of variation of word meanings within a language community, partial knowledge of word meanings, etc.

Giannakopoulou (2003) emphasised that prototype theory is considered as having a supplementary role to word meanings. He emphasized the essence of the prototypical conception of the structures of categories; people create categories of things and assign the same name (or label) to things that are not exactly the same but similar.

Consequently, the 'prototype theory' only really applies consistently to categories which are a matter of degree: for example the category 'happy'. It would be difficult to build up a list of features for this category; however prototype theory makes it easier to categorize. Therefore, prototype theory can be used to classify descriptive words.

2.2.2 Basic language of design—visual language

Visual language is the basis of design creation. Visual language is similar to verbal language in that it has a structure and rules. Visual language uses elements of colour, shape, layout, composition and illustrations to convey meaning.

Bonnici (1999) suggests that anyone who cares about meaning as well as form should be interested in visual language, as a powerful medium of non-verbal communication. Visual language is essential to designers as a method of visual communication through the choice of colour and composition. Wong (1993) states that a designer can work without conscious knowledge of visual language, because his personal taste and sensitivity to visual relationships are much more important, but a thorough understanding of visual language would definitely enhance his capability in visual organisation.

There are also many principles of visual language related to design, e.g. red and yellow are warm colours, an ergonomic shape is smoother, etc. The focus of this section is to understand the relevant elements, not the principles. It aims to assist in the understanding of the elements of the designer's work.

Visual elements include shape, colour, texture and material.

2.2.2.1 Form/shape

Wong (1993, p.138) explained that 'the terms *shape* and *form* are often used synonymously, but their meanings are not the same. A shape is an area easily defined with an outline. A shape that is a given volume and thickness and that can exhibit different views becomes a form. Forms display some depth and volume—characteristics associated with three-dimensional figures, whereas shapes are forms depicted at particular angles, from particular distances. A form therefore has many shapes.' Although this research focuses on two-dimensional images, the content of most images is three-dimensional objects.

There are a lot of studies about design elements, however, only a few are about the categorization of design elements. Wong has the most comprehensive introductions to forms and shapes. He classified forms into: *representational and non-representational* forms. He suggested that a form that contains a recognisable subject communicates with viewers in more than purely visual terms and is called a *representational* form. Representational forms can be further classified into: *natural, man-made, verbal,* and *abstract* forms, as shown in Figure 2.2-04.

Figure 2.2-04: Form classification.
Source: Wong 1993, pp.146-147

Wong (1993) has also classified shapes into three types: *calligraphic, organic,* and *geometric* shapes. *Calligraphic* shapes are generated by hand, drawing tools or medium. Bevlin (1977) divided shapes into four categories: *geometric, natural, abstract and nonobjective.* Bevlin defined an 'abstract' shape as being when a natural shape is distorted in such a way as to reduce it to its essence.

This research suggests that for the visual database, form/shape may be classified into: *natural/organic, man-made, verbal, geometric, calligraphic* and *abstract.*

2.2.2.2 Colour

Colour conveys many emotions and messages. Feisner (2001) felt that colour must have a purpose within any project, and choice of colour is the primary method of conveying one's message. He stated that colour could reflect mood, emotion and time frame, and provide symbolism. Colour, therefore, has attributes and characteristics.

The most widely used colour specification system is the Munsell (Whitfield and Wiltshire 1983). There are 10 hue categories in this system, as shown in Figure 2.2-05. However, the whole system is more complex, and the specification of colour is based on hue, value and chroma, as shown in Figure 2.2-06. Despite this, based on the Munsell system, colours could also be classified into: violet, blue, blue-green, green, yellow, orange, red, brown, pink, white, off-white, grey, black and grey tints (Danger 1987).

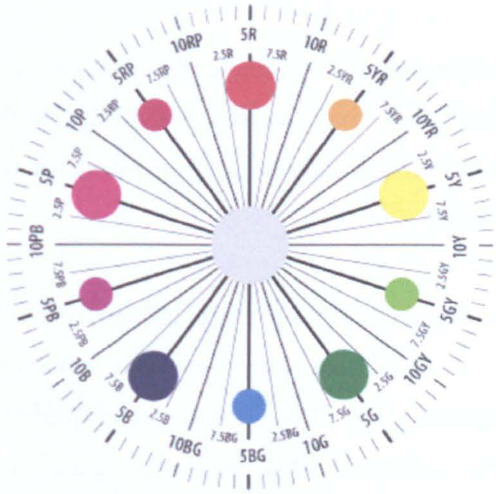


Figure 2.2-05: Colour circle of Munsell system.

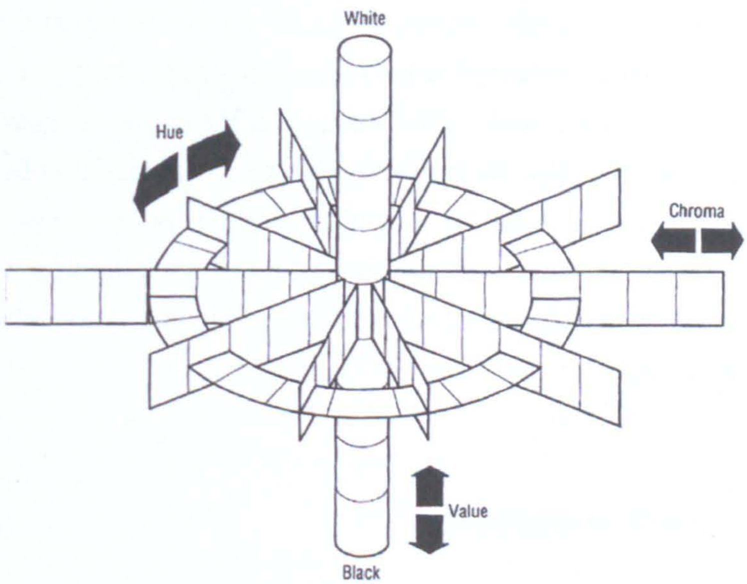


Figure 2.2-06: Colour space of Munsell system.

2.2.2.3 Texture

Texture refers to the surface characteristics of a shape. It may be plain or decorated, smooth or rough, etc. Lindbeck (1994) named this 'surface quality'. He indicated that the surface qualities could add interest or emphasis to a design and they generally contribute to appearance. There are two kinds of texture: tactile textures and visual textures (Bevlin 1977). Bevlin indicated that every work of art could be characterized by its textural quality, whether tactile or visual. It could be smooth, coarse, regular, uneven, harsh or sensuous.

2.2.2.4 Material

Material provides the solid surface of an object. "The act of designing is complex, involving designers in both intuitive and rational judgements. The choice of materials is basic, and can provide a starting point for the rest of the design. (Kirkbride 1983, p.175)"

This leaves no doubt as to the importance of material qualities in allowing a designer to fulfil a brief. People have unconscious relationships with materials. Designers understand the material qualities which produce these reactions, so materials fulfil both functional and emotional needs. However, images rarely convey detailed information about materials so their subtle qualities need not be identified by a visual database which can simply record material types. There are many different collections of material lists (Flurscheim 1983, Manzini 1986, Gasson 1974, Bevlin 1977, and Lefteri 2001), but the contents show little variation between each list. By combining them, the material collection selected for the visual database includes: Copper-based alloys, Zinc alloys, Steel, Stainless steels, Aluminium and its alloys, Titanium, Glass, Rubber, Wood, Plastics, Ceramics, Clothing material, and Composite and compound materials.

2.2.3 Product semantics

'Products which move fast should look sleek and streamlined. Products which are durable and hard-wearing should look robust and rugged. Products which are fun should look bright and happy, whereas products used for serious work should look sombre and efficient. This is the essence of product semantics. (Baxter 1995, p.218)'

Product semantics is a term that has been widely used by industrial designers' since the mid-1980s. It is derived from the semiological discussion developed by philosophers, such as the Frenchman, Roland Barthes. It is a development from the 20th century philosophical writing, extending the notion of meaning from written and spoken language to the language of objects and images, which not only signifies their basic function, but also carries a 'meta-meaning. In addition objects and images operate, due to their wider associations, as signs (Julier 1993).

Designers' interest in semiotics and semiotic applications began in the 1950s at the Uim school, a theory of linking an aesthetic design concept to the semiotic which stated that a design product has four dimensions—material dimension, syntactic dimension (the dimension of technique and construction), semantic dimension (the dimension of technical product form), and pragmatics dimension (the dimension of use) (Viham 1995), as shown in Figure 2.2-07.

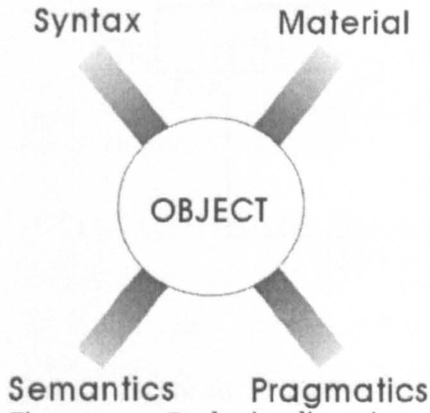


Figure 2.2-07: Product's 4 dimensions.
Source: Viham 1995, p.50

The emergence of product semantics in the early to mid 1980s required designers to look beyond the merely functional aspects of an object and consider its social, symbolic and historical qualities, as well as the psychological and sensual aspects of interaction. It was hoped that consumers could enjoy meaningful personal involvement with the products they used and designers would be granted more freedom of expression in the design process.

There are a lot of studies on product semantics, but only a few main sources of information specifically detail the various theoretical principles of product semantics. In line with the aim of this research this section is focused on the cognitive process of product semantics, and how to interpret the meaning of products.

Krippendorff (1989a, p.11) noted that 'A suitable starting point for product semantics is the experiential fact that people surround themselves with objects that make sense to them, they can identify what they are, when, how, for what, and in which context they may be used.'

As shown in Figure 2.2-08, form and meaning are intricately related. Form is related with context and context is cognitively constructed by the viewer/user, meaning therefore becomes a cognitively constructed relationship between designers, users and objects (artefact).

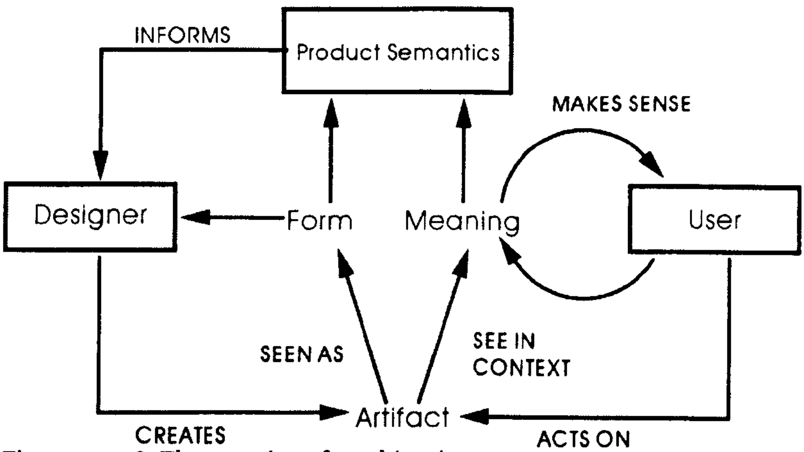


Figure 2.2-08: The meaning of an object in context.
Source: Krippendorff 1989a

Krippendorff (1989b) proposes that the meaning of products may be understood according to four contexts. These he terms the contexts of use, language, genesis and ecology. The 'use' implies psychological contexts which refer to the meaning of an object for a user in its everyday use. The 'language' is the socio-linguistic context however, which is founded upon the experiential fact that people discuss everyday objects in natural language and consequently the described objects play a mediating role in linguistic-based social interaction. Within this context Krippendorff (1989b) suggests that products can become conventional symbols of social differentiation, integration or status, individual identity, material support to social relationships and content of communication. Figure 2.2-09 demonstrates the relationship between use and language and shows the roles of genesis and ecology.

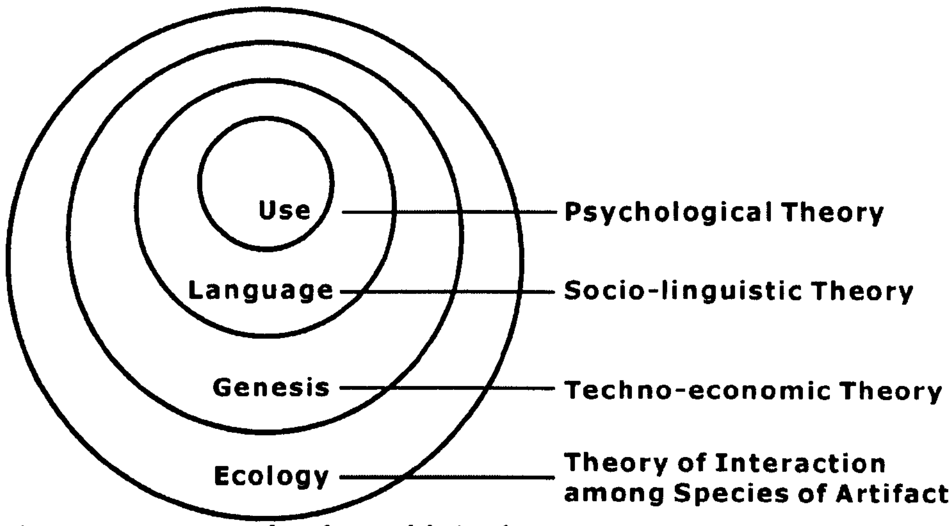


Figure 2.2-09: Context of artefacts and design theories.
Source: Krippendorff 1989b, p.a11

Krippendorff indicated that people select material objects to create their own personal identity and then locate that identity within the symbolic fabric of society by establishing relationships with the complex of objects with which they surround themselves. Consequently, people deliberately use material objects as symbols to express individuality or different social wealth and status. People also by necessity use the same symbols to mediate this, and denote a generally held desire for belongingness to the same society as those they seek to differentiate themselves from. Krippendorff used socio-linguistic theory and observation of social relationships to suggest that, as a result of the interchange of material goods within society, industrially designed objects play an important role in establishing, maintaining and changing social relationships between individuals.

As a result, product semantics helps in understanding the relationship between the relevant design elements (e.g. material, form, colour and texture) and people. It also helps in understanding the relationship between designers and objects which leads to them being designed to express their context. Because of this a study of the context of objects is needed in order to comprehend designers' views and inform the development of the image database (See Section 2.1.5, p.32).

2.2.4 Language of design communication

Sources of inspiration, visual references, are a very important element for designers when it comes to the design process, both in defining the context for new designs and in informing the creation of individual designs. Previous design concepts and other sources of ideas furnish a vocabulary for both thinking about new designs, and for describing designs to others. Product semantics and visual language are two well-known theories about how products or visual materials are interpreted by human beings. However, this section focuses on verbal and visual communication in the design process.

Eckert and Stacey (2000) indicated that the structure of language of sources of inspiration (source-language) within the design activities are (taking into account that, their study was based on knitwear design):

a). The syntax

Descriptions of design in source-language typically comprise references to objects, images and sometimes to abstractions such as moods e.g. 'playful', or cultures such as 'Arabic'. The sources themselves have the character of **nouns**, while the modifications have the character of **adjectives**. These modifications can change any describable characteristic of the source. For example a designer might say 'this shape is fun' (Figure 2.2-10) or 'this lamp is cool' (Figure 2.2-11). The range of available nouns is large and open-ended, while the range of adjectives is comparatively small.

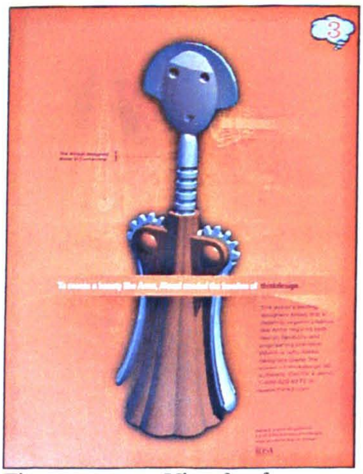


Figure 2.2-10: Visual reference example 1.
Source: I.D. magazine June 2001, p.10

Figure 2.2-11: Visual reference example 2.
Source: Lefteri 2001, p.126

According to Eckert and Stacey's study there are no verbs used in knitwear design practice. However, product designers use verbs, such as 'it looks like', 'I feel', 'the surface shows' etc., in product design.

b). The semantics

Verbal and visual communication in source-language defines locations within the space of all possible designs of a type of artefact. The locations of individual designs are defined through a single set of complementary source-features. The user recreates the design from the description, so communication depends on the recipient sharing the speaker's mapping of terms to meanings.

By referring to sources of inspiration designers can convey concepts very concisely: a key image or a mood board can express and elaborate a set of cultural references; and a brief description can express a complex design. It is not the design itself that is communicated, but information about a range of alternative designs. The listener mentally redesigns the design, influenced by a different set of preferences and procedures.

Eckert and Stacey (2000) also discuss the idea that conceiving and communicating designs by reference to images also assists the explanation of design activities. It works differently for different recipients who have different amounts of knowledge of the designer's sources. The recipients include:

1. **Oneself:** the sources of inspiration function similarly to sketches, as facilitators of reinterpretation when the context has changed, and as memory aids.
2. **Fellow specialists:** designers exchange ideas with people who share similar knowledge, expertise and frames of reference. Reference to sources of inspiration provides a powerful, effective and efficient means of communication when exactness is not required.
3. **Complementary colleagues:** who have different concerns, expertise, mental representations of the designs, and frames of reference, but who share the same objectives.
4. **Superiors:** such as project managers
5. **Customers:** refers to clients commissioning design
6. **Unknown:** refers to users or others

Their work shows the importance of images for design communication and provides a valuable foundation for this research's fieldwork.

2.2.5 Summary

The study of linguistics shows that the meanings of words are concepts and these can be used to classify the descriptive words which will be used in the database. The classification process should adopt 'prototype theory' to achieve better categorization.

The essential visual language of design is constructed from form, colour, texture, and material. These are the fundamental elements of the relationship between the designers and objects.

Product semantics provides a tool which helps in examining the contexts of objects.

2.3
Images

Visualisation is part of the creative process, many designers use images of previous designs in the form of pictures, photographs and graphics, as well as objects and other visual information from the real world, such as product images, images of certain environments, images of target users, images of colours and so on (see Section 2.1.2, p.18) to provide inspiration and to visualise the end product. Furthermore, images are also used as a tool to improve communication between people (see Section 2.2.4, p.48). The following sections focus on a survey of existing image data management systems, image databases and archives.

2.3.1 Image data management

Eakins and Graham (1999) said that the need to find a desired image from a collection is shared by many professional groups, including journalists, design engineers and art historians. This comment indicated the need for a well-organised database. However, the requirements of image users can vary considerably, and Eakins and Graham suggested that images could be characterised into three levels of abstraction:

a). *primitive* features such as colour or shape,
b). *logical* features such as the identity of objects shown,
c). *abstract* attributes such as the significance of the scenes depicted.

Eakins and Graham's report shows that current indexing practice for images relies largely on text descriptors or classification codes.

Content-based image retrieval (CBIR) is a technique for retrieving images on the basis of automatically-derived features, such as colour, texture and shape. Since 1992 it has been widely discussed as a process of retrieving desired images from a large collection, and it remains a lively research topic (Eakins and Graham 1999).

Convera's Visual RetrievalWare is one of the commercial CBIR systems available (Figure 2.3-01).

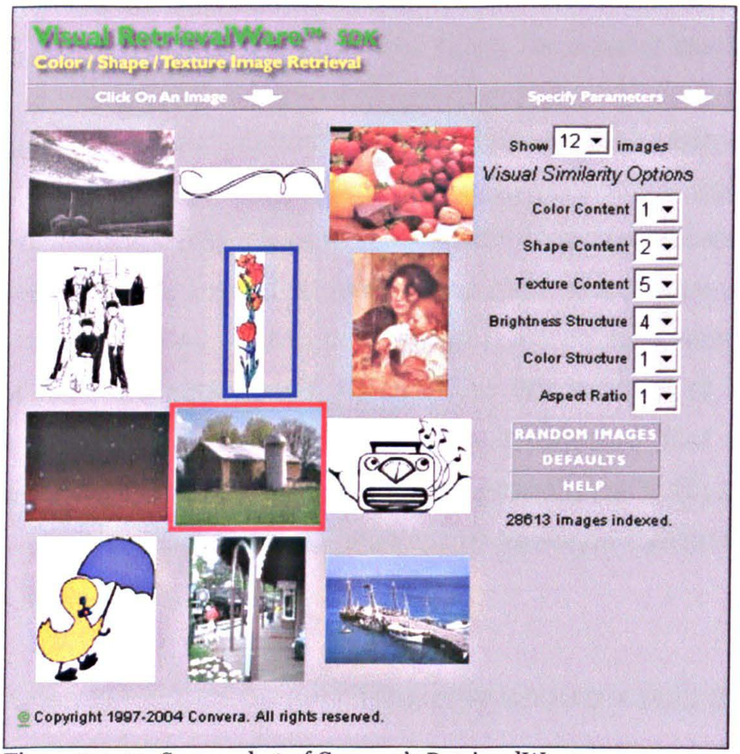


Figure 2.3-01: Screen shot of Convera's RetrievalWare.
Available from: <http://vrw.convera.com:8015/cst> [June 2004]

The results of searching for similar images "with a blue stroke" are shown in Figure 2.3-02, and the results of search for similar images with "red a stroke" are shown in Figure 2.3-03.

Figure 2.3-02: Screen shot of search result 1

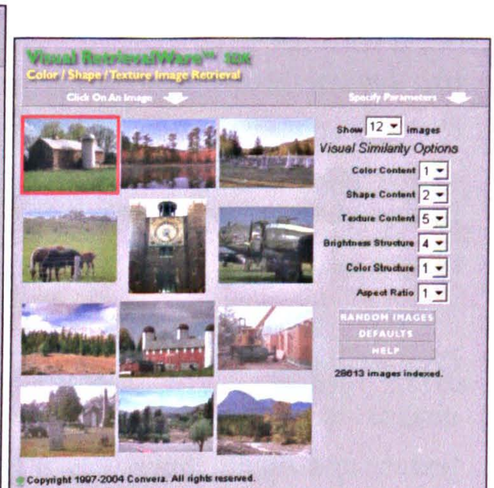


Figure 2.3-03: Screen shot of search result 2

However, while the results of CBIR's searches may be appropriate for professionals such as journalists and art historians, they do not fit the product designer's expectations. This is because its search aims to find images which have a similar colour and shape to the original image. The author's own experience and the survey results (see Chapter 4, p.100) when product designers search by colour and shape, they require more information on the image's context. Text descriptors or classification codes are a better way to assist product designers to search for images.

To access a desired image from a repository might thus involve a search for images depicting specific subjects. Research and development into image processing and information retrieval should cover topics like:

- Understanding image users' needs and information-seeking behaviour;
- Identification of a suitable way of describing image content (Eakins and Graham 1999).

Eakins and Graham also reported that images have many types of attribute which could be used for retrieval, including:

- The presence of a particular combination of colour, texture or shape features (e.g. green stars);
- The presence or arrangement of specific types of object (e.g. chairs around a table);
- The depiction of a particular type of event (e.g. a football match);
- The presence of named individuals, locations or events (e.g. the Queen greeting a crowd);
- Subjective emotions one might associate with the image (e.g. happiness);
- Metadata such as who created the image, where and when.

There are some commercial image data management systems, such as *iBase* (http://www.ibase.com/) (Figure 2.3-04), *Digital Catalogue* (http://www.imageres.com/), *FotoWare* (http://www.fotoware.com/) and *Signpost* (http://www.signpost.com/). They are all similar to Figure 2.3-04 (iBase), and the information is mostly based on the image's content (physical properties), such as filename, object name, headline, source and so on. Although users can still index images by using a note field to key-in their feeling or descriptions of image quality, this function will not encourage users to look at images in depth. Therefore, the image database as Figure 2.3-04 assists in the storage of images, but it does not facilitate searching for images as designers would want.

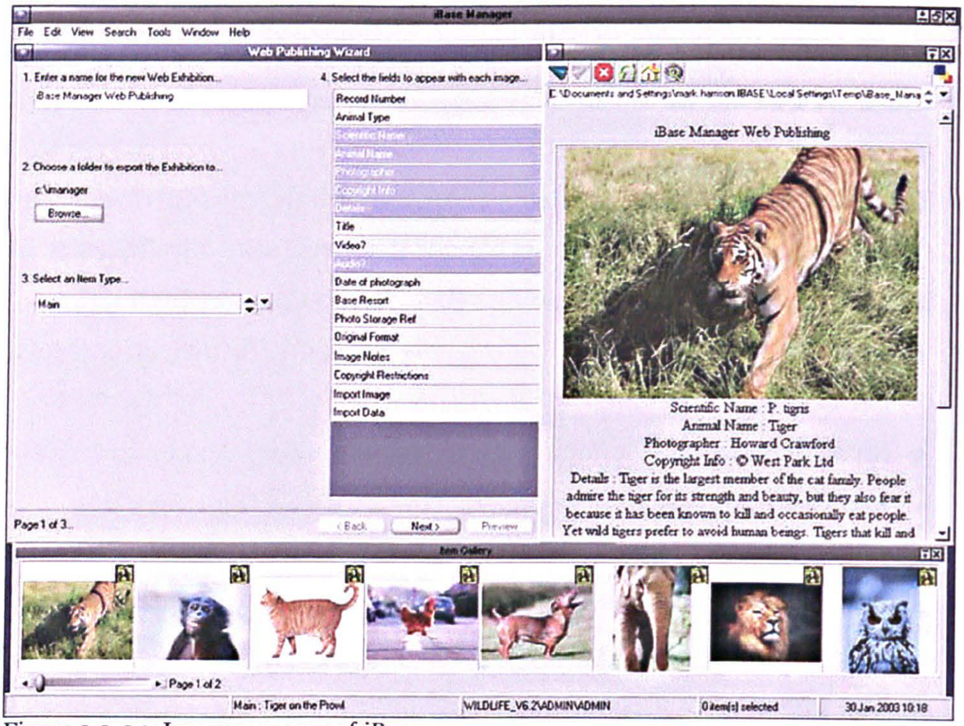


Figure 2.3-04: Image manager of *iBase*.
Available from: <http://www.ibase.com/manager.html> [12 August 2004]

2.3.2 Existing image database survey

Picture research has become a skilled profession since online access developed. There are many thousands of images online, but these are not referenced in a way which assists product design. Understanding existing approaches to finding images online or understanding how the image providers organise their image collections will help to avoid mistakes in developing an image database for product design professional.

The existing image databases which assist product designers can be divided into three different groups:

(1) Design related image archives

(2) Commercial image providers

(3) Internet search engines

2.3.2.1 Design related image archives

Many publicly funded design organisations have their own design collections, and normally they are free for the general public to inspect. However, they generally catalogue the images by the name of the image subject, designer/creator, the time of publishing, etc. For example Austen (1978) noted that the Design Council then had the Design Index, a record of some 7,000 well-designed British consumer goods. It comprised a photographic record of selected products, together with their specifications, costs, and name of designer and manufacturer, etc. The Design Index (see Figure 2.3-05) was moved to the Design History Research Centre at the University of Brighton in 1994 where it provides one of severalvital tools for understanding the activities and operation of the Council of Industrial Design from 1944 to 1971 and the Design Council from 1972 to the present day (Moriarty 2000).

Two image data services have grown from the Design Council archives:

The Design History Research Centre Archives (DHRCA)

Originating with the acquisition of the Design Council Archive in 1994, the DHRC Archives now include additional major holdings along with several other related collections (Figure 2.3-05). Further information is available from:

http://www.dhrc.brighton.ac.uk/dca_web_site/default.htm

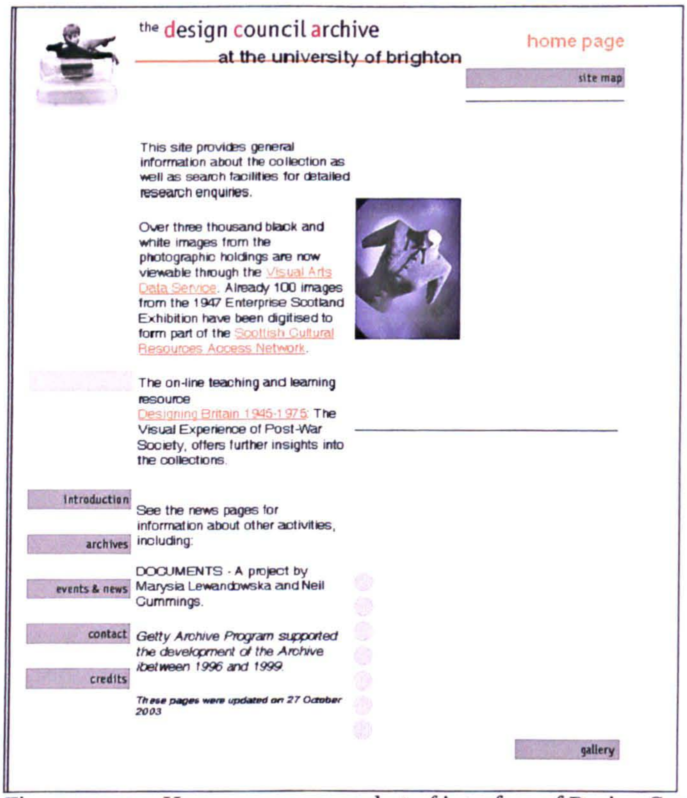


Figure 2.3-05: Home page screen shot of interface of Design Council Archive. Available from: <http://www.dhrc.brighton.ac.uk/dca_web_site/default.htm> [November 2003]

AHDS Visual Arts (formally Visual Art Data Service)

The Design Council Slide Collection was transferred to the Department of History of Art and Design at Manchester Metropolitan University from the Design Centre, London, in 1995. The collection comprises almost 22,500 images and covers most areas of design. The majority of slides showing products of various kinds (including tableware, furniture, lighting, toys, domestic appliances, textiles and wallpapers), but other areas of design such as architecture, town planning, interior design, graphic design, and corporate identity are also included. The emphasis is mainly upon British design in the post war period up to 1990, but there are also many images illustrating examples of design from other countries and earlier periods.

AHDS Visual Arts (Figure 2.3-06, 07, 08 and 09) grew out of the Design Council collection and is an integrated online interface of 14 image collections in the UK run by AHRB (Arts and Humanities Research Board) and JISC (Joint Information Systems Committee). The collections cover a broad range and can be seen in the screenshot Figure

2.3-07. Information about images is recorded in may fields including title, type, date, decoration, descriptions, subject, measurements, materials, culture, ID number and rights.

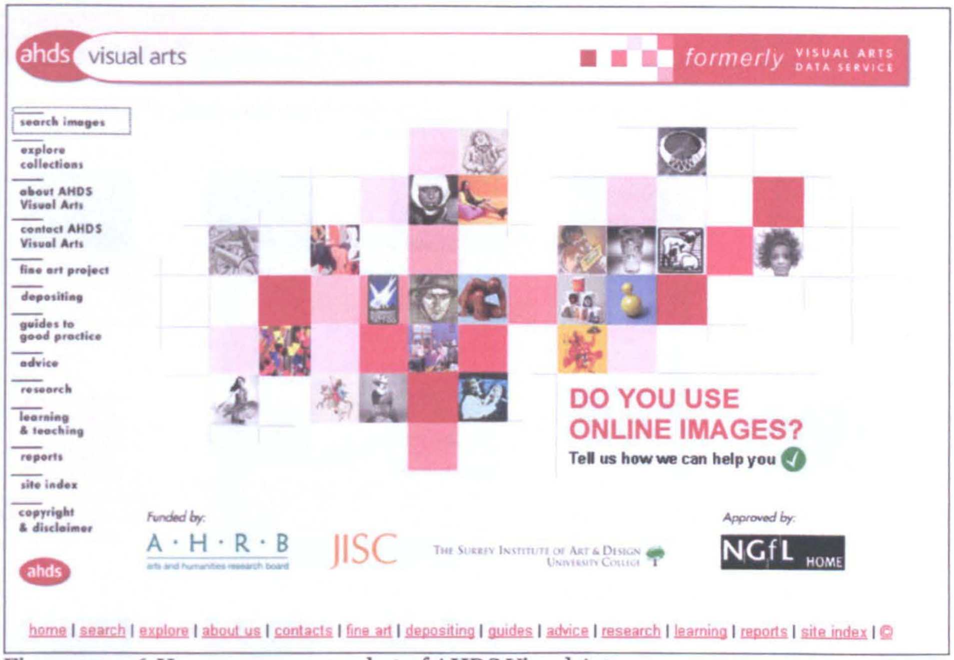


Figure 2.3-06:Home page screen shot of AHDS Visual Arts.
Available form: < http://vads.ahds.ac.uk/index.html > [11 Dec 2003]

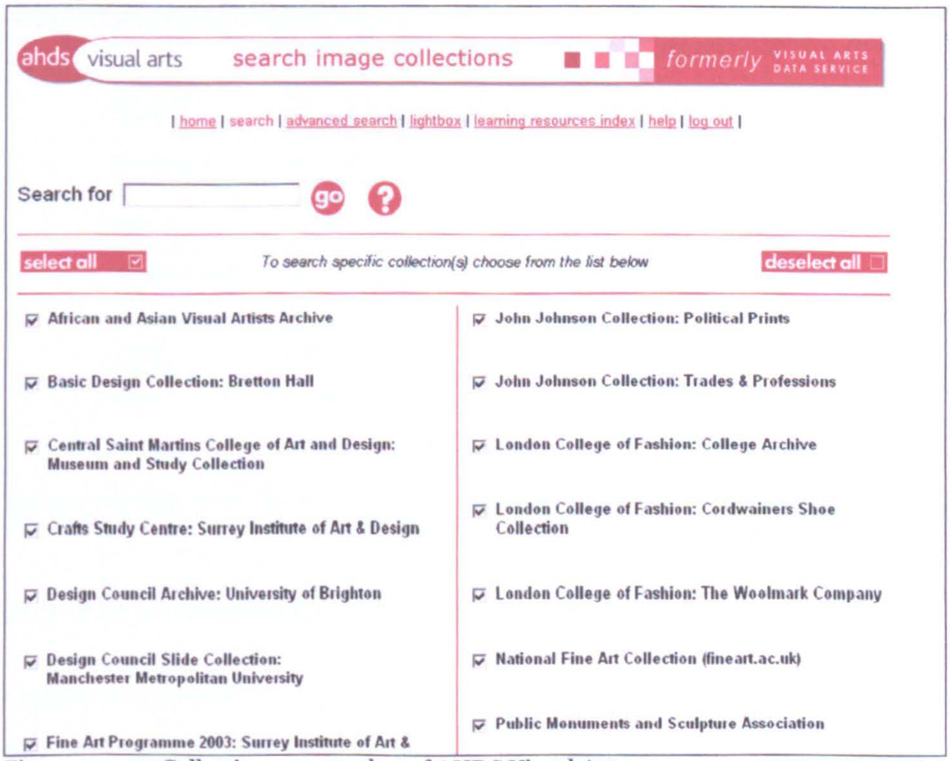


Figure 2.3-07: Collections screen shot of AHDS Visual Arts.

A search for 'red' produced 1711 records (Figure 2.3-08). However, the results are not clear, for example there is no keyword of 'red' and no 'red' on the image in Figure 2.3-09. Therefore, it is not a very helpful archive.

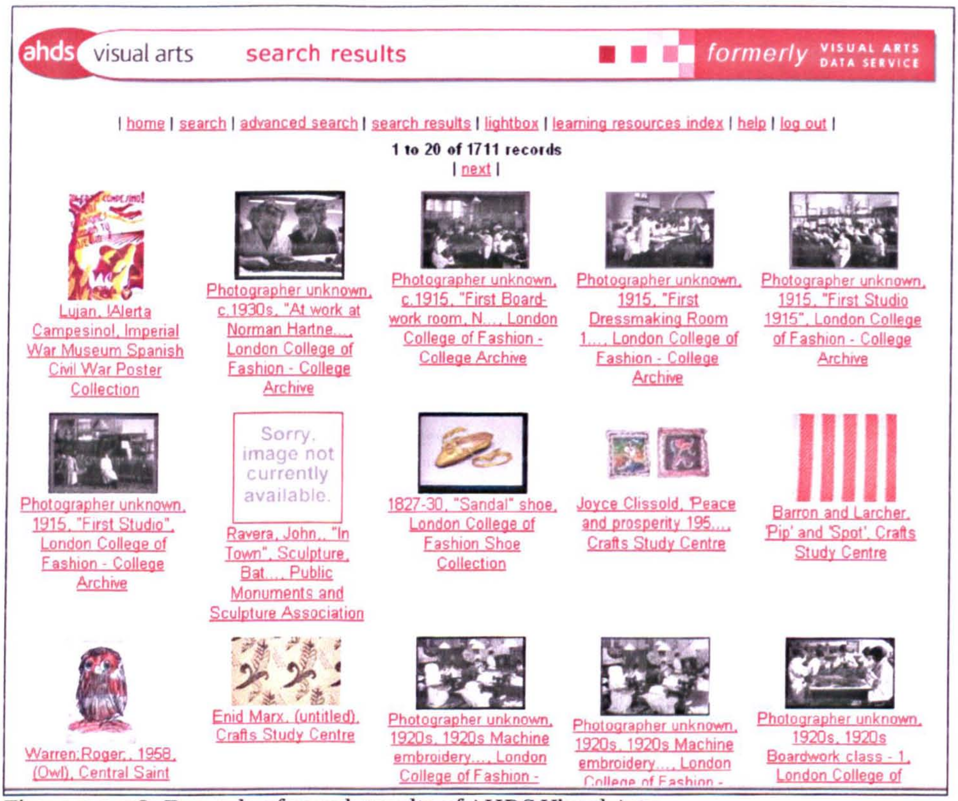


Figure 2.3-08: Example of search results of AHDS Visual Arts.

Details of "sample" from previous screenshot:

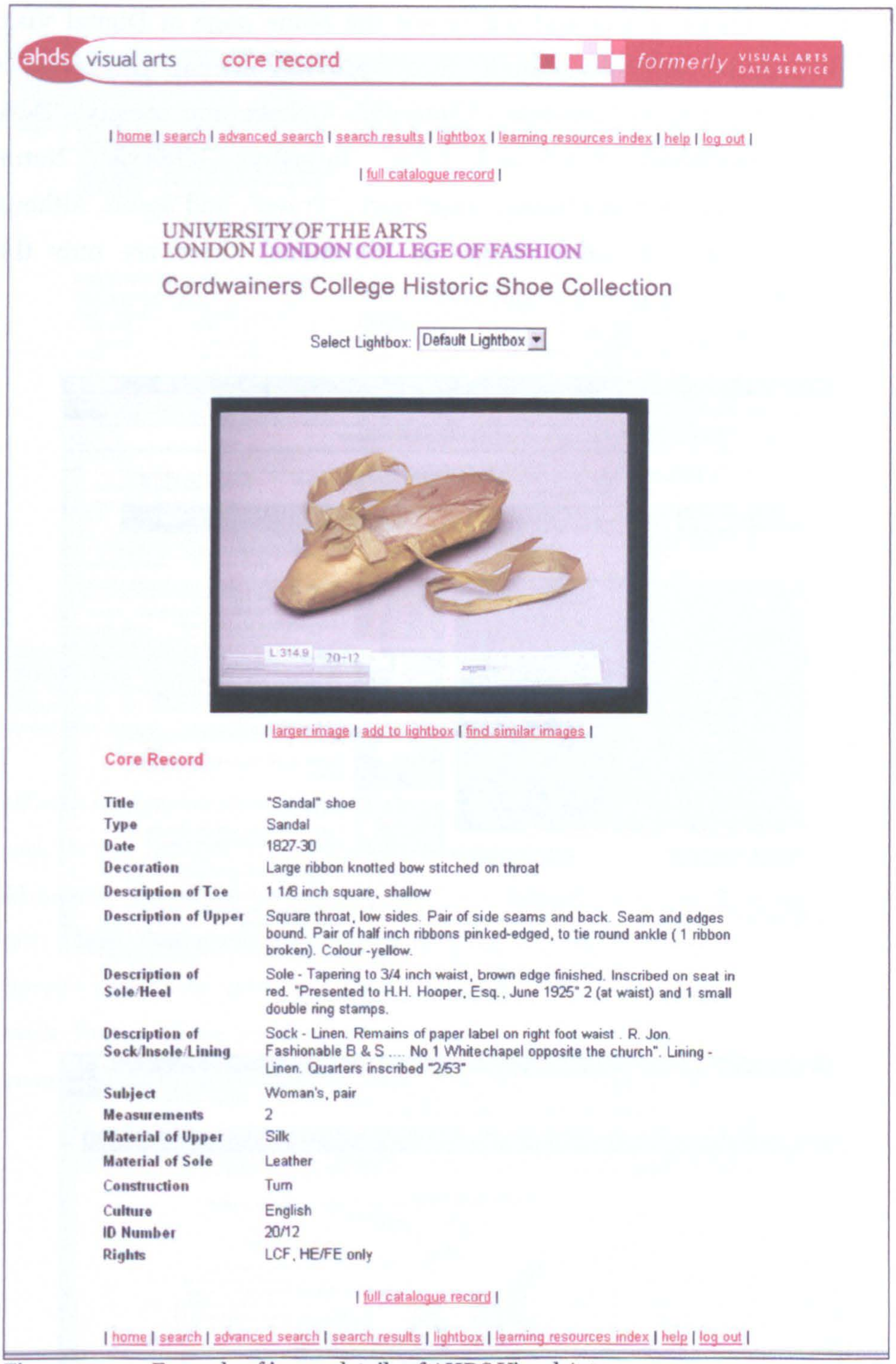


Figure 2.3-09: Example of image details of AHDS Visual Arts.

2.3.2.2 Commercial image providers

Online commercial image providers, such as Digital Vision, Wonderfile and Fotosearch, all provide categories with keyword searching. (See following figures captured in March 2003)

Figure 2.3-10, 2.3-11 and 2.2-12 are the home page of Digital Vision, Wonderfile, and Fotosearch. They provide similar categories for browsing such as 'Business', 'Concepts', 'Culture and society', 'Design and background', 'Food and drink', 'Industry', 'Lifestyle', 'Nature', 'Science', 'Sport and fitness', 'Transport', 'Travel', and so on. Although, Digital Vision provides images of 'Emotions', there are only three subcategories: anger, joy, and love.

Figure 2.3-10: Home page of Digital Vision.
Available from: <www.digitalvision.com> [March 2003]

Figure 2.3-11: Home page of Wonderfile.
Available from: <www.wonderfile.com> [March 2003]

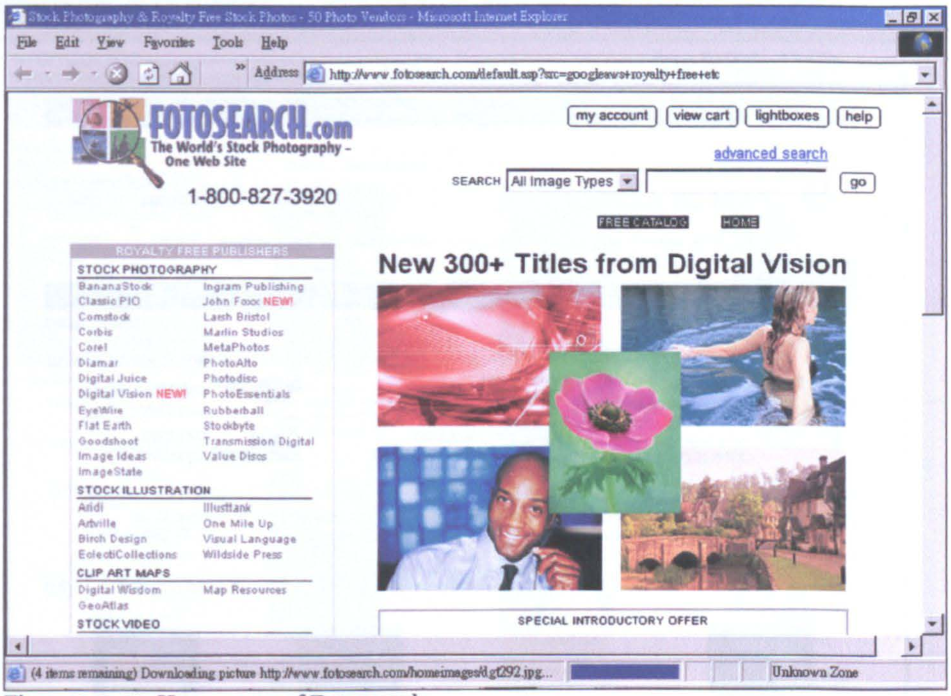


Figure 2.3-12: Home page of Fotosearch.
Available from: <www.fotosearch.co.uk> [March 2003]

When designers use tangible terms, such as the name of product, to search for images, they would expect images to match their enquiry. However, this kind of result is difficult to find from commercial image providers. For example, Figure 2.3-13, 2.3-14, and 2.3-15 show the search results of 'mobile phone'. Although over two thousands images were found, there are few which show only the mobile phone. Similar results were in searching for 'table', 'car' and 'lamp'.

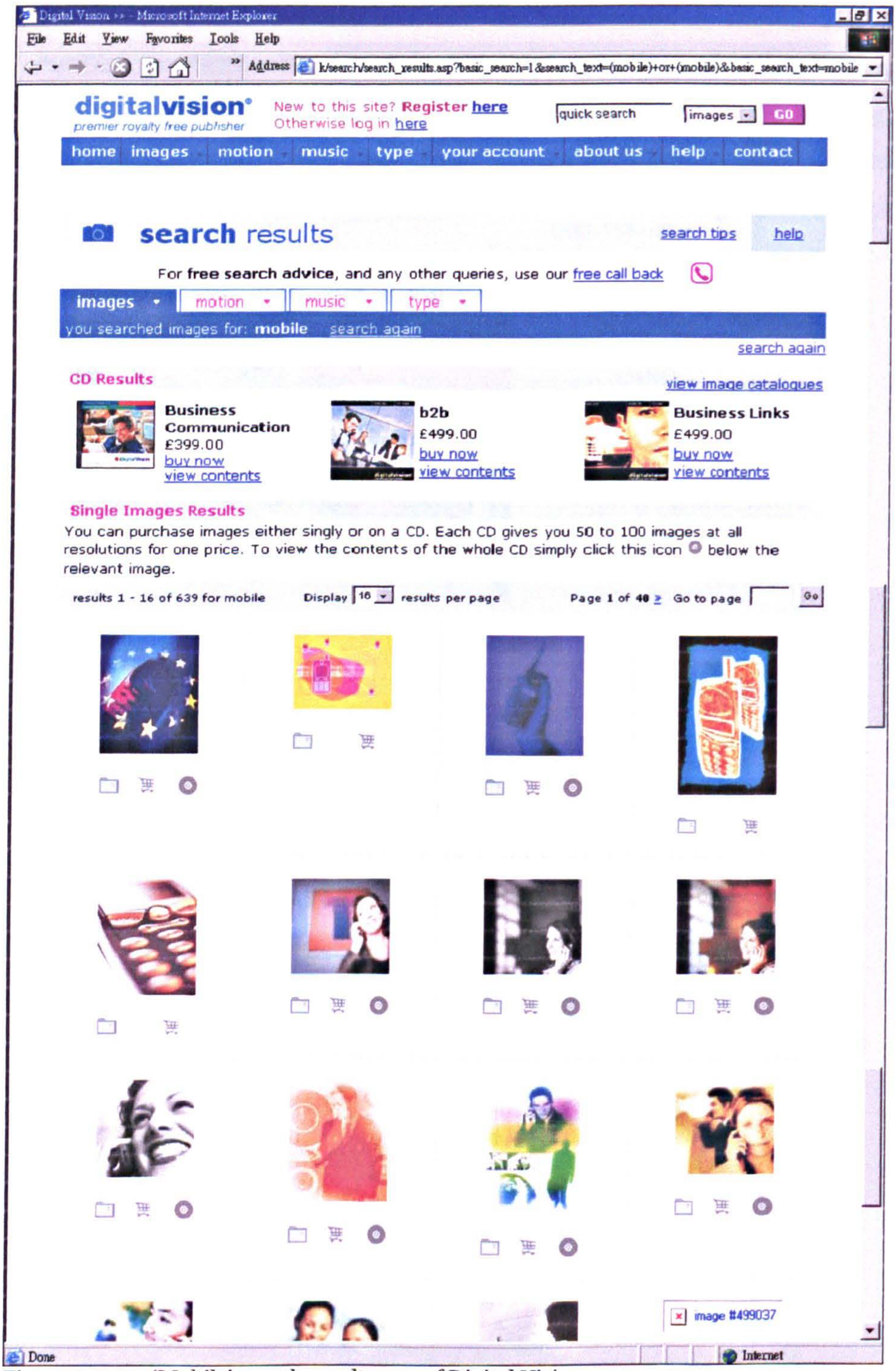


Figure 2.3-13: 'Mobile' search result page of Digital Vision.
Available from: <www.digitalvision.com> [March 2003]

Figure 2.3-14: 'Mobile' search result page of Wonderfile.
Available from: <www.wonderfile.com> [March 2003]

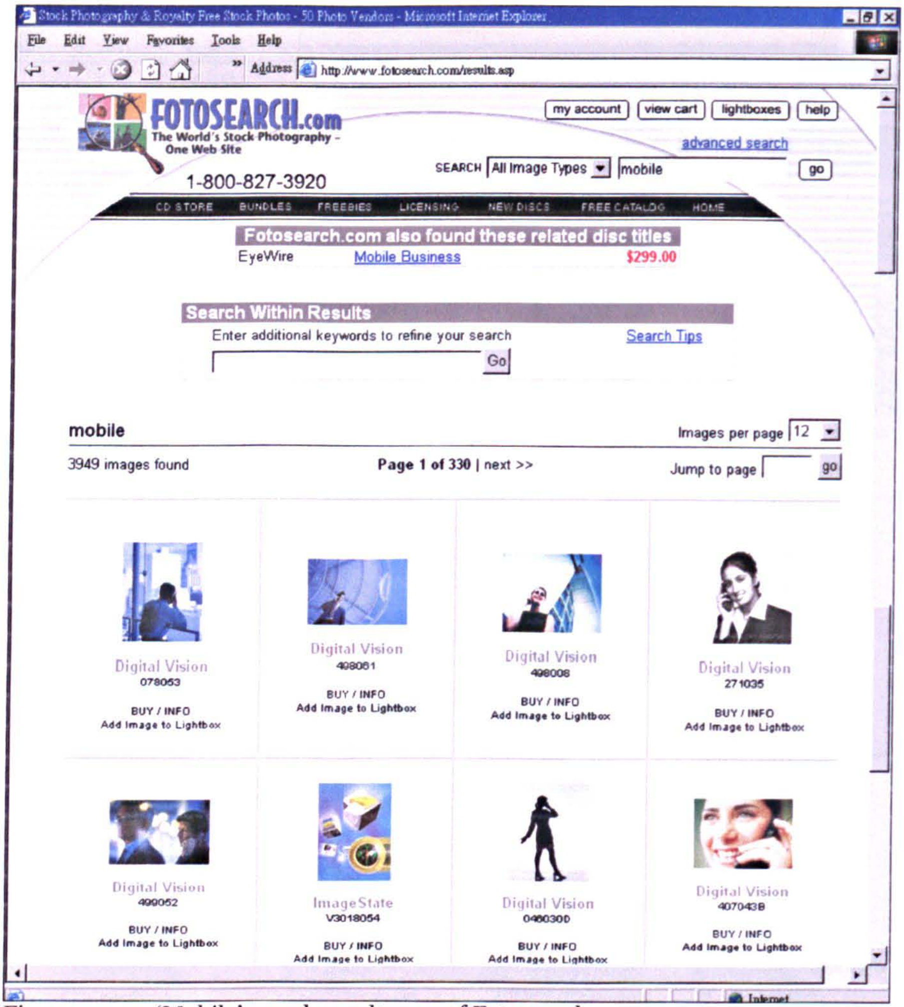


Figure 2.3-15: 'Mobile' search result page of Fotosearch.
Available from: <www.fotosearch.co.uk> [March 2003]

Although images from image providers provide a wide range of image selections, their target users are in adverting, graphics, web design and so on. Bevlin (1977) indicated that industrial design, and other areas are in the gap between the producer and the consumer. Product designers are closer to consumers than other design activities, such as graphic design, because their work is the result of observing the consumer's need. Within the product design process, a product designer would therefore need to involve users with their design work, more so than with other design activities. This requirement must be accommodated in the visual database.

2.3.2.3 Internet search engines

Paula Berinstein (1996) pointed out that to find images, one has to be able to describe them accurately and in detail. She gave a good explanation of the difference between images and text, pointing out that:

a). Images are representations of things found in the real word, but text consists of symbols for things that might or might not be found in the real world.

b). One does not have to learn to read to comprehend an image, but one does have to learn language and reading to understand text.

c). Perceptions are direct and cannot be completely communicated through symbols; text, on the other hand, can be reproduced and communicated exactly.

These differences indicated that images are easy to perceive but extremely difficult to describe. Therefore, when searching for images, it requires the images to be stored with consistent image attributes, such as composition, perspective, proportion, pattern, style, subject, etc. This information might be found attached to images provided by image providers, however, images from the search engines on the Internet do not normally have this information.

Google is the world's most popular search engine and its search criteria are representative of others. It has a separate section for image searching which provides keyword searches (Figure2.3-16) and advanced image searches (Figure2.3-17).

Figure2.3-16: Home page of Google Image.

In the advanced image search page, it provides for rules to limit searching by words and it also provides options of size, file types, colouration, domain and safe search (Figure2.3-17).

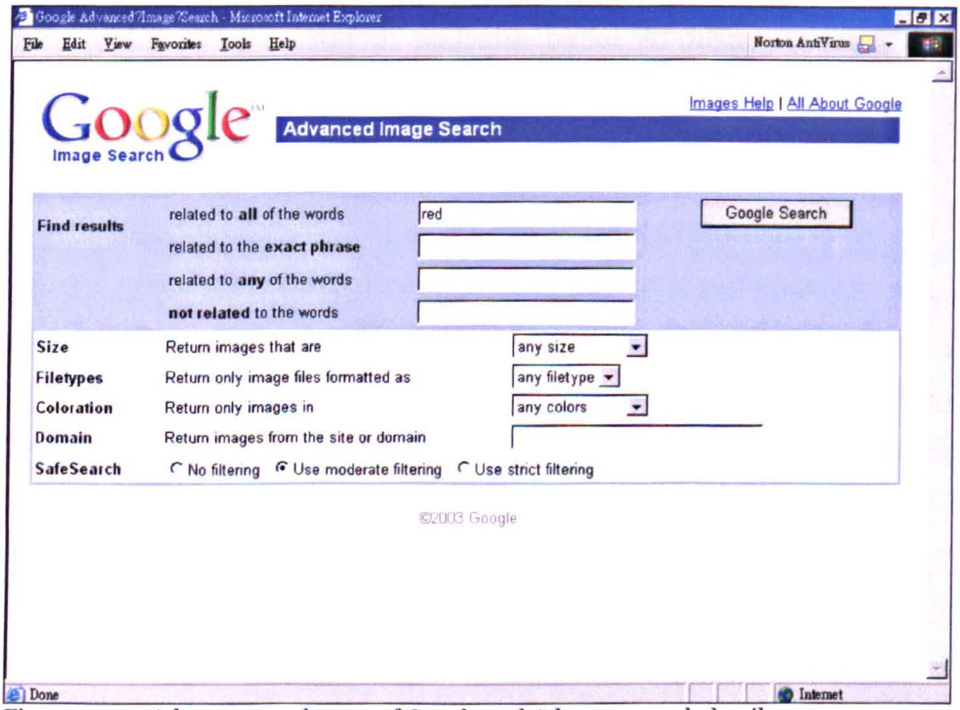


Figure2.3-17: Advance search page of Google and Advance search details.

However, the search results do not differ much between keyword searches and advanced image searches. Because search results are based only on the match of the keywords with the file name of images, the search results hardly fit designers' needs. For example, searching for "mobile phone", provided 8,600 images which match the keywords (Figure2.3-18), so, if one web page can display 20 images, there are still 430 pages to go through. Also, the results are not just mobile phone images but include all sorts of images which have mobile phones within the file name, such as "mobile phone report.jpg" (Figure2.3-19).

Figure2.3-18: Results of search for mobile phone for Google. [March 2003]

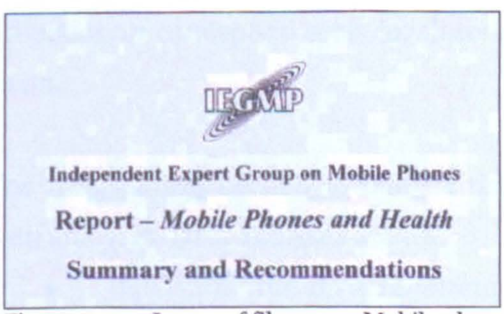


Figure2.3-19: Image of file name: Mobile phone report.jpg [March 2003]

There is an advantage in searching images in this way as designers may find some inspiration from the range of results. The disadvantage is that it takes time to go through the search result pages and is therefore not an effective tool.

2.3.3 Summary

This section showed that the existing image databases retrieve images in various way. However, they use words which describe tangible features of the image contents. For product designers, such image databases do not provide sufficient functions and information. The proposed image database would fulfil these needs, and unlike a search engine such as Google, the results it produced will be directly relevant to the designers' needs.

2.4
Database and interaction design

This section includes an introduction to databases, principles of interface design and how a usability test should be carried out. This is intended to assist in the work on the database development process and to understand how to evaluate the database.

2.4.1 Understanding Databases

Harvey and Press (1996, p22) explained 'a database is a collection of interrelated data organised in a pre-determined model according to a set of logical rules, which is structured to reflect the natural relationships of the data and the uses to which they will be put, rather than reflecting the demands of the hardware and software.'

They stated that the logical structure of a database is of great importance, and is the responsibility of the researcher or database designer; he/she does not need to be concerned with the way in which the data is physically stored.

Database design involves the two related stages of ***data analysis*** and ***data modelling*** essential to the creation of correctly structured databases (Harvey and Press 1996). The procedures are to define the aim of the project, to define the database specification and selection of software, the design of the database, and implementation of the database. Data classification is the main part of this research, and its methods or techniques depend on the context of the data. Data models are a collection of conceptual tools for describing data, data relationships and so on.

The information needed to build a data model is gathered during the data analysis. Data analyses are to:

- determine the data requirements of the database in terms of primitive objects;
- classify and describe the information about these objects;

- identify and classify the relationship among the objects.

Zaïane (1995) indicated that there are three different groups of data model:

1. Object-based Logical Models

They are characterized by the fact that they provide fairly flexible structuring capabilities and allow data constraints to be specified explicitly.

2. Record-based Logical Models

In contrast to object-based data models, they are used both to specify the overall logical structure of the database and to provide a view level description of the implementation.

3. Physical Data Models

Physical data models are used to describe data at the physical level.

As describe above, Object-based Logical Models are the models direct relate with viewers and Record-based Logical Models and Physical Data Models are invisible structure of how data stored. Also it was mentioned before that the researcher does not need to be concerned with the way in which the data is physically stored (Harvey and Press 1996). Therefore, Record-based Logical Models and Physical Data Models would not be taking further.

There are two main types of Object-based Logical Models:

- The Entity-Relationship Model

  The entity-relationship model is based on a perception of the world as consisting of a collection of basic objects (entities) and relationships among these objects. (See Figure 2.4-01)

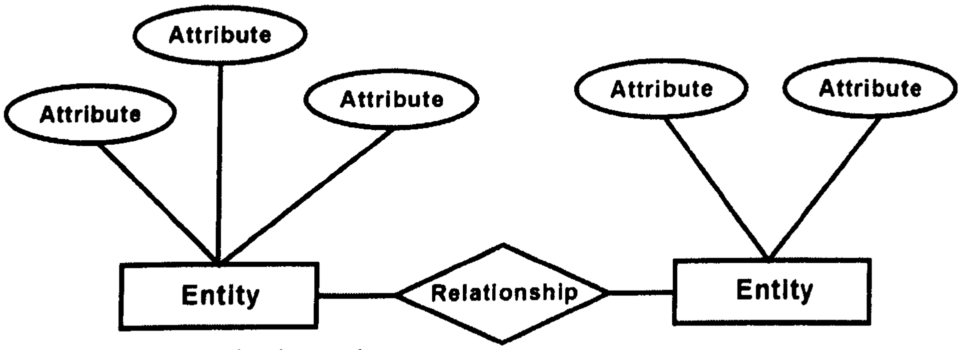


Figure 2.4-01: A sample of ERM diagram.

- The Object-Oriented Model
  A collection of objects which each object has its own unique identity, independent of the values it contains. An object also contains bodies of code that operate on the object. (See Figure 2.4-02)

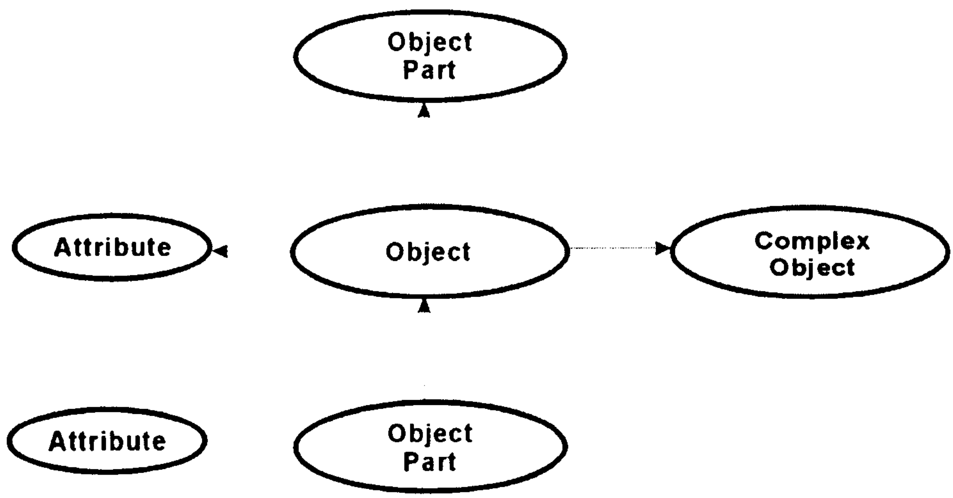


Figure 2.4-02: Semantic model for Object-Oriented database

For this research, the complexity of an Object-Oriented database with multiple categories of information is not required. The simpler Entity-Relationship Model better meets the needs of an image database. This conceptual model is described in terms of logical components known as *entities*, *attributes* and *relationships*. An **entity** is a distinguishable object that exists and each entity has associated with it a set of **attributes** describing it. **Relationships** exist between entities. Figure 2.4-03 is Harvey and Press's (1996) six-stage approach to entity-relationship modelling.

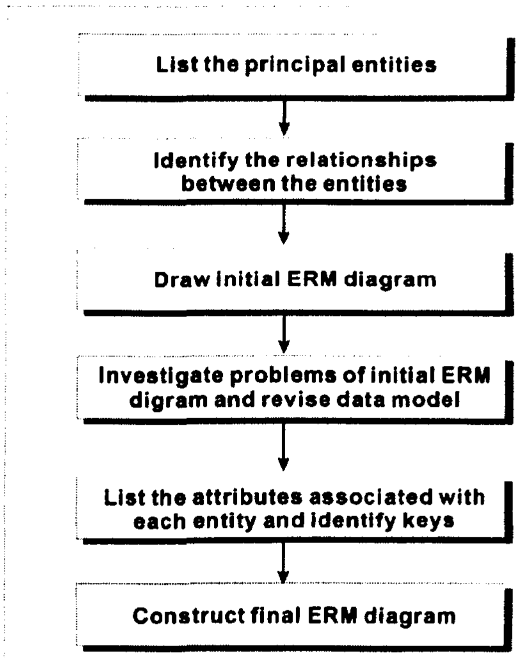


Figure 2.4-03: Six-stage approach to entity-relationship modelling.
Source: Harvey & Press 1996, p.109

2.4.2 Design principles

The system to be developed in this research will be a web-based database (see Chapter 6, p.157). The following are processes and principles for developing a website. During the literature review, most of the web design principles were found to be very similar. According to Lynch (2001), user-centred design of web interface design should focus on:

(1.) Clear navigation aids
Clear, consistent icons, graphic identity schemes, and graphic or text-based overview and summary screens can give the user confidence that they can find what they are looking for without wasting time.

(2.) No dead-end pages
Make sure all pages have *at minimum* a link back to the main "home" page or a home page link along with links to the other sections of the site.

(3.) Direct access
Users want to get information in the fewest possible steps. This means that it needs to be designed with an efficient hierarchy of information to

minimize steps through menu pages. Studies have shown that users prefer menus that present at least five to seven links and that they prefer a few very dense screens of choices to many layers of simplified menus. The following table demonstrates that there is no need for many levels of menus to incorporate lots of choices:

	Number of menu items listed			
Number of nested menus	6	7	8	9
1	6	7	8	9
2	36	49	64	81
3	216	343	512	729

(4.) Bandwidth and interaction

Research has shown that for most computing tasks the threshold of frustration is about ten seconds. Web page designs that are not well "tuned" to the network access speed of typical users will only frustrate them.

(5.) Simplicity and consistency

Users are not impressed with complexity that seems gratuitous, especially those users who may be depending on the site for timely and accurate work-related information.

For maximum functionality and legibility, the design should be built on a consistent pattern of modular units that all share the same basic layout grids, graphic themes, editorial conventions, and hierarchies of organization. The goal is to be consistent and predictable.

(6.) Design integrity and stability

Functional stability in any Web design means keeping the interactive elements of the site working reliably. Functional stability has two components: getting things right the first time, and then keeping things functioning smoothly over time.

These guidelines particularly focus on structural issues. Considering individual web pages, Tetrarch (2002, p.55) said " The key to good usability is differentiation. Each element on the screen should be clearly differentiated so that users know what it is, what to expect and where it will lead them. Differentiating items include colours, contrast, percentage of screen area used, relative size, screen location and typographic style."

Galitz (2002) emphasised that Colour can be used as a formatting aid to assist in formatting a screen and a visual code to identify components or information. This research aims to provide clear information for product designers' use. Usability is as important as the appearance so the use of colour will be very important for the development of the system.

According to the literature research, the principles of colour use include:

a). White or very pale colours provide the best backgrounds for legibility and to display graphics (Tetrarch 2002).

b). To draw attention to or to emphasize elements, use bright or highlighted colours. To de-emphasize elements, use less bright colours (Galitz 2002).

c). To convey similarity, use similar colours (Galitz 2002).

And for fonts:

d). The choice of serif or sans serif font is principally one which suits the look and feel required for the site (Tetrarch 2002; Lynch 2001).

e). Avoid using text all in upper case, as it requires 10% longer to read then lower case text (Tetrarch 2002).

Galitz (2002) suggested that presenting information simply and meaningfully should:

a). Provide legibility—information is noticeable and distinguishable

b). Provide readability—information is identifiable, interpretable, and attractive

c). Present information in usable form—translations, transpositions, and references to documentation should not be required to interpret and understand information.

d). Utilize contrasting display features—to attract and call attention to different screen elements

e). Create visual lines—implicit and explicit, to guide the eye

f). Be consistent—in appearance and procedural usage

The above design principles will be applied during the development of the system and be combined with web site development principles by Lynch (2001).

2.4.3 Usability test and expert review

Extensive testing is a necessity for interaction design. Shneiderman (1998) stated that the evaluation could happen in different stages of design and it needs to include expected users. Generally, evaluation methods include expert reviews, usability testing and laboratories, surveys, or classic experiments.

Expert review is an effective method (Shneiderman 1998, Galitz 2002). Shneiderman (1998) indicated that there are a variety of expert-review methods including:

1). Heuristic evaluation: the expert reviewers critique an interface to determine conformance with a short list of design heuristics;
2). Guidelines review: the interface is checked for conformance with organizational or other guideline documents;
3). Consistency inspection: the experts verify consistency across a family of interfaces, checking for consistency of terminology, colour, layout, input and output formats and so on;
4). Cognitive walkthrough: the experts simulate users walking through the interface to carry out typical tasks;
5). Formal usability inspection: the experts hold a courtroom-style meeting, with a moderator or judge, to present the interface and to discuss its merits and weaknesses.

The cognitive walkthrough method is more appropriate for this study. Other methods are performed by checking the interface against a short list of design principles. In the cognitive walkthrough method, experts simulate users "walking through" the interface to carry out typical tasks (Shneiderman 1998). This method allows the experts to have real experience of the system and the evaluation results are more accurate.

Web design for business (2001) suggests that testing the system in development should be done by a representative group, to understand how they use it and what problems need to be addressed. Usability testing can help inform the designer of features that might be added, because users find elements of the site difficult to use, or confusing. Web design for business (2001) suggests that a usability test needs between five and ten people who are representative of intended users of the site (and are not familiar with the project) for an hour. These users should be asked to try to achieve certain goals which are typical of the user goals the site has been designed to facilitate.

The results of user testing need to be collected along with any suggestions about how to solve the problems identified. The designer would need to prioritise those aspects that are critical to the project and then consider how to address these findings, and consider any solutions proposed.

2.4.4 Summary

This section has described different database models, guidelines for interaction design, and methods for usability testing. According to the review, the Entity-Relationship Model is suitable for the development of the image database in this study. The database development will also follow interaction design principles and the database evaluation will be carried out by means of usability tests.

2.5
Perception and thinking in action

Understanding the psychology of perception is fundamental to understanding how designers think and how they perceive images. This knowledge helps to analyse the designer's reactions, and this section focuses on what kind of factors affect people's perception and how designers knowledge reflect in their action.

2.5.1 Perception

McKellar (1957) stated that there are two kind of perception called 'primary perception' and 'secondary perception'. Primary perception is the instance seeing of a table, hearing a bomb fall, and feeling the pain of being stung by a bee. Secondary perception is the corresponding of seeing a picture of a table, hearing a sound recording of a bomb falling, and listening to a description of the event by one who has been stung. Either perception provides the raw material of the form of thought.

In addiction, Vernon (1962) stated that people notice and perceive differently; not only are there differences between the perceptions of different people, but also between the perceptions of the same person at different times. In Vernon's view visual perception, learning, memory, attention, emotion and personality have different levels of effect on people's cognition, and it affects the language used. Vernon indicated that when people cannot identify objects easily, they might think about their experience in words. Vernon demonstrated that the naming of an object, even in rather a loose and superficial manner, might affect the way in which it is perceived at the moment and recollected in the future.

Figure 2.5-01 shows the results of Vernon's experiment on the effect of naming on perception. In the tests, the first group were shown the images which had been given one set of names (e.g. Curtain in a window, Bottle, etc.), while the second group had the same images with another a second set of names (e.g. Diamond in a rectangle, Stirrup, etc.). They were then asked to draw the images from memory and as can be seen the reproductions were different.

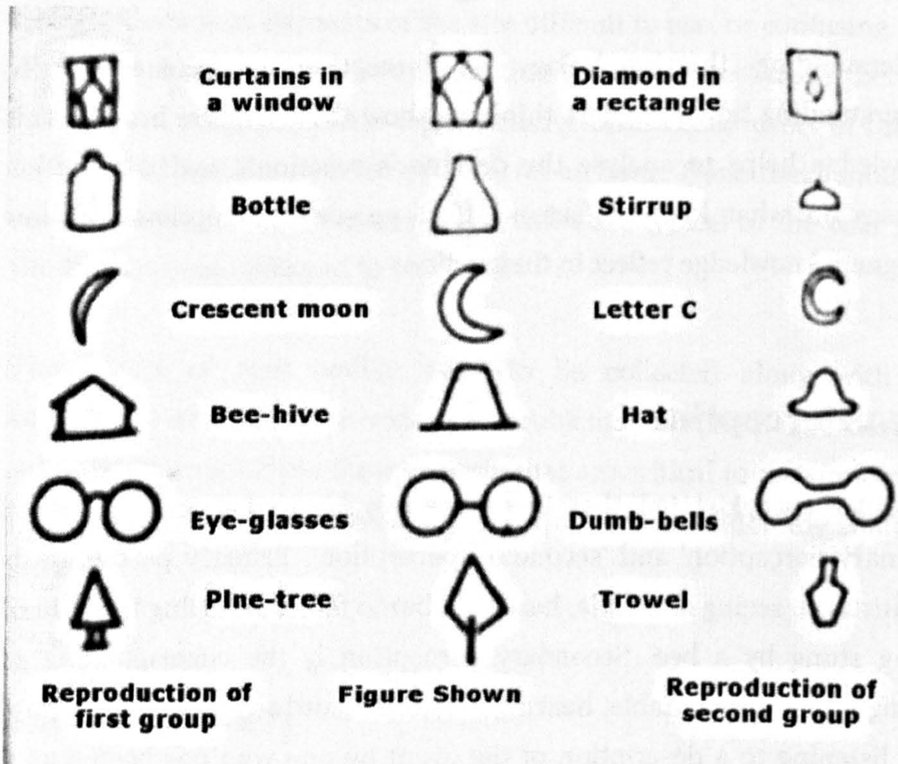


Figure 2.5-01: Effect of naming on reproduction of shapes.
Source: Vernon 1962, p.37

Carroll (1964) achieved the same experiment results as Vernon and thought that people vary in the degree to which they notice and concern themselves with the various kinds of attributes that characterize the things and events of the environment.

Vernon and Carroll's experiments demonstrated the importance of the words identifying an image in order to reduce perception differences. They also indicated the possibility of various keywords for the same concept. These examples show that perception varies among people, even when they have similar knowledge and experience.

As Carroll (1964) indicated, individual differences in verbal abilities are attributed to environmental influences—differential opportunities to learn language behaviour, and differential conditions of motivational arousal and reinforcement. He explained that individual differences in verbal knowledge are clearly related to socio-economic status, amount of schooling, parents' occupation, and other variables which can indirectly measure opportunity and motivation to learn language.

Language plays a large role in thinking, by facilitating it, allowing it to be more complex, efficient, and accurate (Carroll 1964). Carroll defined a concept as an internal representation of a class of experiences.

'People vary in the degree to which they notice and concern themselves with the various kinds of attributes that characterise the things and events of the environment. A forester will be more ready than the average person to notice differences among various kinds of trees. (Carroll 1964, p. 97)'

Trask (1995) also indicated that variation in language includes geographical variation, community variation, studying variation, and sex and gender, which affect the use of vocabularies.

To sum up, perceptions vary between people and the use of language also affects the result of people's perception.

2.5.2 Thinking in action

"The ancient Greeks divided thinking into two classes: one, the result of reflection, episteme; the other one, a result of daily living, doxa." (Narváez 2000, p36)

This section focuses on the influence of perception on thinking as well as its relation to one's action.

Thinking in general is the result of previous perceptual impressions organized into arrangements, and the form of these arrangements is provided either by the original perceptual content or by relationships abstracted from other perceptual contents (McKellar 1957).

Narváez (2000) proposed that design thinking is a holistic, synergetic, and continuous whole, shaped according to the designer's personality and social influence, which also relies directly on the sensible, expressive, or communicative abilities required to accomplish an idea. Not only that, Mackellar suggested that even secondary perception is important in that it extends substantially an individual's range of sense experience and thus permits thought and imagination to be cumulative.

Unlike other fields of knowledge, design is, as Michael Polanyi stated, the practice process of unconscious trial and error to success and may continue to improve without specifiably knowing (Cornock 1986). The entire process is combination of Schön's (1985) knowing-in-action and reflection-in-action.

He indicated that the work of the professional practitioner reveals in its recognition, judgments and skill, a pattern of tacit knowing-in-action. Knowing is ordinarily tacit, implicit in the patterns of action and in the feel for the involved events. Reflection-in-action is the unexpected outcomes of knowing-in-action and is a subconscious result. Usually reflection on knowing-in-action goes together with reflection on the understanding which have been implicit in the action.

Schön (1991) also stated that in professional practice, as a practice becomes more repetitive and routine, and as knowing-in-practice (knowing-in-action) become increasingly tacit and spontaneous, the practitioner may become 'over-learned' and miss opportunities to think about what he is doing. However, a practitioner's reflection can serve as a corrective to over-learning; through reflection they think back on a project they have undertaken and can make new sense of the situation.

Schön's theory reflects Mckellar's statements that secondary perception provides a vase enrichment of perceptual possibilities, and thus ultimately of the form and content of human thinking (knowing) and enables an individual to have perceptual experience (reflection) of objects and events that are remote in space and time.

2.5.3 Summary

In this section, the many factors which effect people's perception have been reviewed and this has indicated that the work of professional practitioners reflects their knowledge and sometimes their subconscious responses. These findings suggest that analysis of fieldwork (interviews and workshop) hold the potential to be highly complex. This will be resolved by seeking out consistencies in responses which identify directions and answers.

2.6 Conclusions

According to the literature review, within the design process, images are used:

- To find directions for design improvements. (Jones 1992)
- To assist designers' visual thinking. (Baxter 1995)
- To act as stimuli for idea exploration and as reminders about people. (RSA Inclusive Design Toolkit 2004)
- To communicate with others (Section 2.24)

These points will assist this research in the analysis of interviews with designers in relation to how images are currently used (see Section 4.1.3.1, p.107).

The elements of the messages conveyed by a product include its brand's visual image, the product's characteristic, its users, the place & occasions when it is used, and its value (Mooij 1998). The visual elements include form, size, colour, texture and material (see Section 2.2.2, p.40). These elements provide the basic information types which can be used to develop the proposed database.

Vernon (1962) and Carroll's (1964) experiments in visual perception show the importance of the association of images with words. The research into linguistic theory shows the most efficient way of categorization is prototype theory which is considered as having a supplementary role to word meanings. Therefore, prototype theory will be used to assist in classifying descriptive words in the database.

Other findings to be used in this research are:

- Interface design principles (Section 2.4.2, p.72):
    1. Clear navigation aids
    2. No dead-end pages
    3. Direct access
    4. Bandwidth and interaction
    5. Simplicity and consistency
    6. Design integrity and stability

- Perception differences: people notice and perceive differently; not only the differences between the perceptions of different people, but also between the perceptions of the same person at different times will be taken into account (Vernon 1962).

These will be used as principles and supports for the system development. The advantages and the disadvantages identified in the survey of current databases will be used to compare them with the system to be developed.

Chapter 3
Research methodology

The term 'methodology' identifies a general approach to a study topic; 'method' refers to a specific research technique (Willig 2001). It is fundamental to understand the available approaches and methods before the research taken in action.

Section 3.1 reviews the different research approaches and methods available in the field. The plan of this research and the choice of research strategy and methods are explained in Section 3.2; a detailed explanation of the research methods adopted is given in Section 3.3.

3.1
Review of research methodology

3.1.1 Types of research

Generally there are two different way of classifying types of research. The first is by whether the research information sought is qualitative or quantitative. The quantitative-qualitative classification is dependent on the purpose of the study, how the variables are measured, and how the information is analysed. Quantitative research is that which examines phenomenon through the numerical representation of observations and statistical analysis. Qualitative includes any kind of research that produces findings not arrived at by means of statistical analysis (Corbin 1990). Qualitative research tends to be associated with words used as the unit of analysis and there is a strong tendency for qualitative research to be relatively focused in terms of the scope of the study and to involve relatively few people or situations. It reflects the preference for depth of study and the associated 'thick description' which only becomes possible in relation to limited numbers (Denscombe 2003).

The second is classified by the research strategy adopted (Willig 2001 and Densombe 2003):

Surveys:

Surveys provide empirical research of how things are at the specific time at which data is collected. The emphasis is on breadth of coverage and representativeness of the population being studied in order to give credibility to any generalisations made on the basis of the research.

Case studies:

Case studies focus on one or a very limited number of instances or examples of a particular phenomenon in order to construct an in-depth account of what happens or happened during that instance. The emphasis is on depth rather than breadth of study.

Experiments:

Experiments occur when the subjects (people or social systems) and conditions (events or situations) to be studied are manipulated by the investigator. The emphasis is on observation and measurement of changes and effects, identifying the causal factors and controlling the factors which might otherwise interfere in the identification of the cause and effect chain.

Action research:

Action research is designed to deal with a particular problem in a specific setting. Its purpose is to improve through change. The key elements are practitioners as researchers, researching their own practice and introducing and evaluating changes in that practice in a cyclical process of intervention (or action), evaluation of its impact, revisions to the intervention, further evaluation, further revisions, and so on until the practitioner is satisfied with the improvements that have been introduced

Phenomenology:

Phenomenology is concerned with the ways in which human beings gain knowledge of the world around them. It identifies different approaches to human understanding and provides detailed guidance as to how such superior forms of knowing may be achieved. It is less concerned with collecting data to enable the researcher to interpret what is happening and more concerned with describing how the events get interpreted by those who are directly involved.

Grounded theory:

Grounded theory is inductively derived from the study of the phenomenon it represents. It is discovered, developed, and provisionally verified through systematic data collection and analysis of data pertaining to that phenomenon. Therefore, data collection analysis and theory stand in a reciprocal relationship with each other.

These approaches to research are strategic. They are not research methods. They could be used for either quantitative or qualitative research depending on the applied research methods and data. Each strategy could use a number of different research methods such as questionnaires, interviews, and observations.

3.1.2 Methods of research

The range of basic research methods was surveyed in order to evaluate the best approach for this project. There are many methods for collecting data such as the literature review, observation, interviews, questionnaires, diaries etc (Stone and Harris 1984, Willig 2001, Denscombe 2003, Kumar 1999, and Leedy 1989).

Literature review

Data comes from different forms of documents, such as books, journals, the Internet, newspapers, magazines, records, letters, memos, dairies or government publications and official statistics. It is an easy, generally inexpensive and essential method.

Observation:

This technique involves watching and recording phenomena as they occur. Its characteristic is that the information required by the investigator is obtained directly. It can be used to collect information about people's behaviour but it is not suitable for finding out people's attitudes and opinions (Stone and Harris 1984).

Interview:

Interviews involve direct questioning of an individual or group of individuals. They provide information which is varied, in-depth and rich (Denscombe 2003).

Questionnaires:

There are many types of questionnaires. To qualify as research questionnaires, they should be designed to collect information which can be used subsequently as data for analysis, consist of a written list of questions, and gather information by asking people directly about the point concerned with the research (Denscombe 2003). Questions generally are divided into 'open-end' and 'closed' questions. 'Open-end' questions are those in which the question itself is standardised but the response is freely worded; 'closed' questions structure the answers by allowing only answers which fit into categories that have been established in advance by the research (Heather & Stone 1984, Denscombe 2003)

Diaries:

Diaries can provide rich subjective date but are not widely used because the method constitutes a challenge in effort for both researcher and participants who need to maintain a record over an extended period of time (Willig 2001).

Willig (2001) pointed out that there are no 'right' or ' wrong' data collection methods. A good research design is one where the data analysis is appropriate to the research question and where the method of data collection generates data that is appropriate to the analysis.

3.1.3 Selection of research samples

Leedy (1989) indicated that the results of a search are no more trustworthy than the quality of the population or the representativeness of the sample. Sampling procedures are of paramount importance and become critical as factors in the success of the study.

Basically, there are two kinds of sampling techniques: 'probability' and 'non-probability'. Probability sampling is when the research can specify in advance that each segment of the population will be represented in the sample. Non-probability sampling is conducted without such knowledge. (Denscombe 2003, Kumar 1999, and Leedy 1989)

Probability sampling

1. Random sampling

   This approach to sampling involves the selection of people or events literally 'at random'.

2. Systematic sampling

   It is a variant of random sampling. It operates on the same principles but introduces some system into the selection. For example, the selection is made by choosing every fifth member within the population.
3. Stratified sampling

   It adheres to the principle of randomness, however, it adds some boundaries to the process of selection and applies the principle of randomness within these boundaries. For example, the selection is made within different categories, such as, sex and age.
4. Quota sampling

   It establishes certain categories which are considered to be vital for inclusion in the sample, and also seeks to fill these categories in proportion to their existence in the population. Quota sampling has very similar principles to stratified sampling. The difference is quota sampling does not need to be strictly random.
5. Cluster sampling

   The samples are obtained by focusing on naturally occurring clusters of the particular thing that the research wishes to study.
6. Multi-stage sampling

   This involves selecting samples from samples.

Non-probability sampling

1. Purposive sampling

   The primary consideration is the researcher already knows who can provide the best information to achieve the objectives of the study.
2. Snowball sampling

   It is the process of selecting a sample using networks of respondents.
3. Theoretical sampling

   The selection of instances follows a route of discovery based on the development of a theory.
4. Convenience sampling

   It is built upon selections which suit the convenience of the researcher and which are 'first to hand'

The review of research methods for this research (Leedy 1989, Robson

1993, and Oppenheim 1992) show that the sample size for a survey is hard to determine. Oppenheim (1992) states that the size of a sample is not very important; a sample's accuracy is more important than its size. Denscombe (2003) quoted that 'in practice, the complexity of the competing factors of resources and accuracy means that the decision on a sample size tends to be based on experience and good judgement rather than relying on a strict mathematical formula (Hoinville et al. 1978).' To achieve greater accuracy, the general rule is the larger the sample size, the more accurate it will be. The cost will reflect the chosen size of the sample and this means that there is a general tendency to choose the minimum sample size that is feasible in light of the level of accuracy demanded of the finding, usually between 30 and 250 cases.

However, in the case of qualitative research there is a different logic for the size of the sample and the selection of cases to be included. Qualitative research tends to work with relatively small numbers of participants; this is due to the time-consuming and labour-intensive nature of qualitative data collection and analysis (Willig 2001). In addition, qualitative research relies upon representative samples.

The nature of the research method for this research is described in Section 3.2.

3.2 The research strategy applied

The aim of this study is to develop a collection of key descriptive words and construct a prototype electronic image database for product professional's use.

The literature review showed that:

- to develop an image database there is a need to understand the image users' requirements and information-seeking behaviours, and to identify a suitable way of describing image content (Eakins and Graham 1999).
- to build a data model there is a need to determine the information requirements of the database in terms of primitive objects, to classify and describe the information about these objects, and to identify and classify relationships between the objects (Harvey and Press 1996).

Therefore, the objectives to achieve the aim of this research were:

- to understand the reasons why designers use images
- to understand how designers store and access images
- to understand the words designers use in describing visual features
- to collect the words used and create key descriptive word
- to understand and apply semantics methods in classifying these words
- to design and evaluate a prototype image database

According to the nature of the research problem, this research may be described as 'qualitative research'. To meet the aim, this research involved the process of:

1. Stating the problem (phase 1);
2. Identifying the information needed to solve the problem (phase 1);
3. Selecting the methods for gathering the information (phase 1);
4. Collecting the information (phase 2);
5. Analysing the information (phase 2);
6. Generalising the database (phase 2);
7. Evaluation (phase 3).

The research was planned with a three-phase structure as shown in Figure 3.2-01.

Phase1: Research background

During this phase the research problems were identified, a literature review conducted and a survey on the present situation of how images play a role within the design process carried out (Chapters 1-4).

Phase 2: System development

During this phase the data collected was analysed, an image and word classification system developed and the database built (Chapters 5-6).

Phase 3: Research evaluation

During this phase the system was tested and the research reviewed (Chapters 7-8).

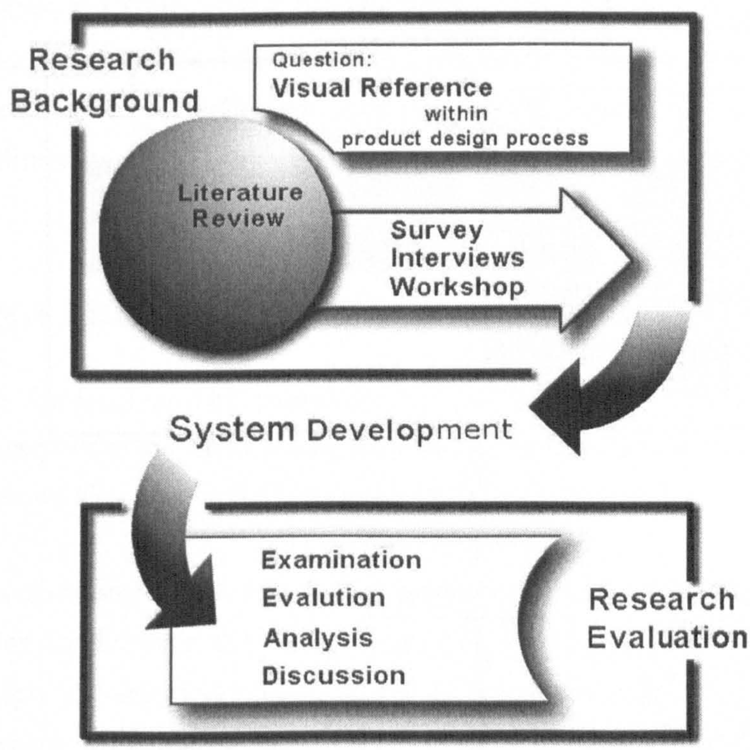


Figure 3.2-01: Research structure.

The choice of research strategy is depended on the nature of the research problem (Willig 2001 and Denscombe 2003). The first stage of this research was to obtain as much insight as possible into the role images play within the product design process. A survey based research strategy was chosen and the literature review, interviews, and questionnaires were selected as research methods to collect data. A combination of 'purposive sampling', 'snowballing sampling' and 'theoretical sampling' techniques was used to select the participants. The review of research methodology indicated that a small-scale sample size was acceptable as long as the result is consistent. Therefore the size of the sample in this research followed this principle.

The diagram in Figure 3.2-02 demonstrates the process of this research. It starts with a literature review and survey of current image database, to provide a knowledge base for planning the interviews and a workshop. The data from these is analysed and discussed. The results are then used to develop the image database system for product designers. Finally, this is evaluated to assess responses to the system.

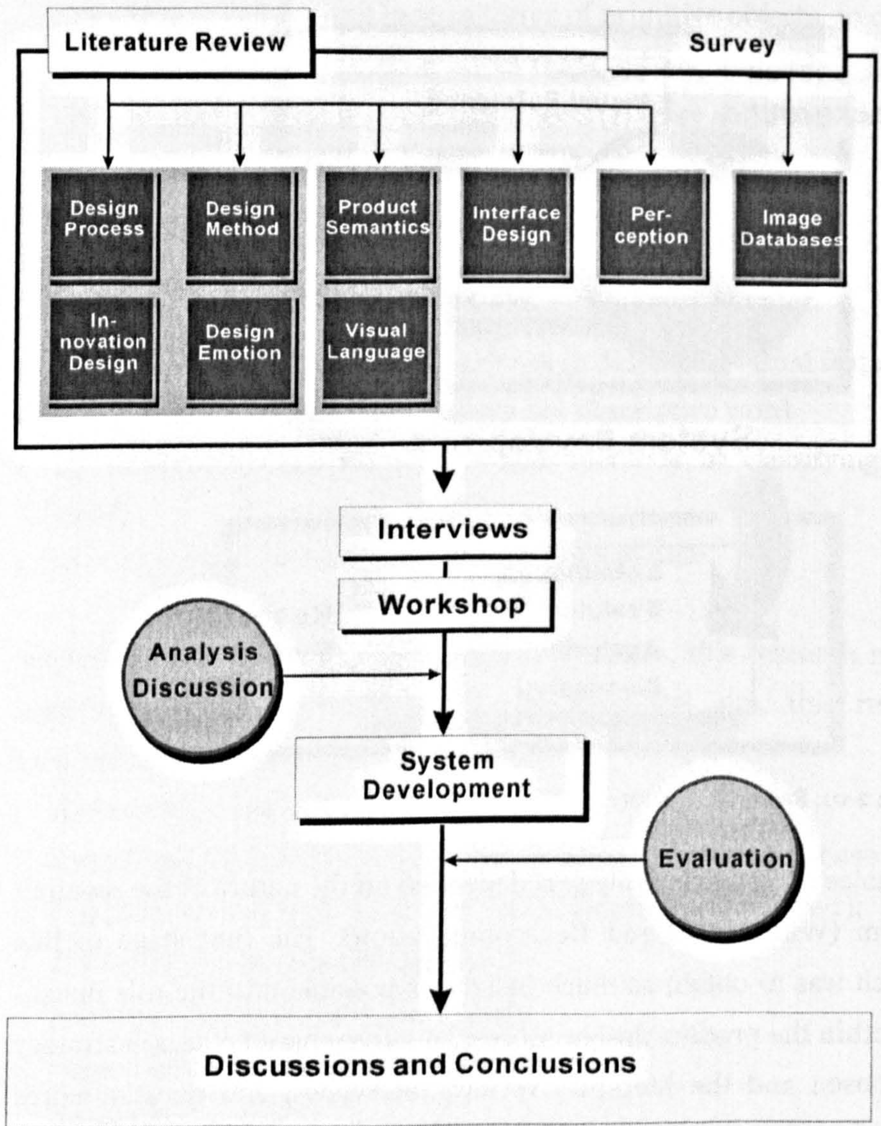


Figure 3.2-02: Research process.

3.3
The research methods in detail

The core methodology involved in this research is determined by the aim of the research. It focuses on defining the role images play within the design process that the designers use to realize their ideas. Firstly, a literature study was carried out and a survey made of existing image databases. Secondly, a series of interviews with product designers was carried out in order to provide empirical information. A collection of keywords was selected from the interview scripts. These selected keywords were classified and their classifications were tested against another collection of keywords before the system was developed.

Section 3.3.1 introduces the elements of the literature review; Section 3.3.2 presents the interviews and workshop plan; Section 3.3.3 is an introduction to collecting and classifying keywords; Section 3.3.4 outlines the system development and evaluations.

3.3.1 Literature review (see Chapter 2)

The libraries of The University of the Arts, London and the British Library were the main places for conducting the literature research. The Internet also provided a source for the latest information.

A preliminary review was focused on general product design activities in order to discover the main purposes for using images. The product design process and design methods were the starting point of this research. Subsidiary areas were also investigated in order to supply relevant information (e.g. visual language, interactive design, etc.)

The literature research essentially includes:

1. The Product Design Process: to understand the existing process and the design activities
2. Design Methods: focusing on methods of using visual material to generate concepts
3. Product Semantics: because product semantics is a theory of how

people interpret a product's form and function. Therefore, it is part of the designers' tool kit of translating visual knowledge.

4. Visual Language: is used widely in different design disciplines, so it is important to find the relevant area and define its meaning for this research.
5. Other relevant studies, such as image data management, perception and interactive design.

3.3.2 Interviews and workshop (see Chapter 4)

3.3.2.1 Interviews

In order to gain a full understanding of how images are involved within the design process directly and influence design work, interviews were considered as the best data collect method. They provide an in-depth insight into the topic.

There are three types of interview: structured, semi-structured and unstructured. Structured interviews involve tight control over the format of the questions and answers. Unstructured interviews closely resemble natural conversation; neither the question nor the responses are predetermined. Semi-structured interviews use a clear list of issues to be addressed and questions to be answered and interviewees speak more widely on the issues raised. (Stone and Harris 1984, Kumar 1999, Willig 2001 and Denscombe 2003)

Semi-structured interviews were selected to carry the survey in order to collect enough data in an organised way. There are two main types of semi-structured interview (Stone and Harris 1984):

1. Interview guide approach

   An interview is conducted by having a list of topics with the interviewer having the freedom to select questions from these topics.
2. Standardised open-end interview

   The interviewer uses a set of questions which are determined in advance but the respondent replies in his own terms.

With the 'interview guide' approach, questions are asked in different ways, and the information gathered is not standardised. This reduces the comparability of responses. So the decision was made for this research to use interviews which were partially structured, so that consistent data could be collected, but at the same time open questions were also used to allow unanticipated information to arise. Therefore standardised open-end interview were conducted to do the survey. Although, open-ended responses are difficult to analyse, this technique is more flexible in that there is a greater opportunity to explain the purpose of the project, to gain people's confidence and interest and, within limits, it can be arranged at a time which is convenient (Stone and Harris 1984).

Phase 1: The questions

The wording of the questions needed to be unmistakably clear. A preliminary pilot interview was necessary to rehearse and experience people's comments. The questions were modified for a second set of pilot interviews before being finalised. These pilot interviews were conducted with CSM MA Industrial Design students who had at least one year's professional experience. (See Section 4.1.1, p100)

Phase 2: The interviewees

In order to meet the aim of the research, suitable candidates for interview were expert product designers. According to a study by Kavakli and Bero (2002), the expert designers' cognitive activity and productivity in the design process was three times as high as the novice's. The list of interviewees was based on their 'representativeness' in order to avoid unsuitable candidates.

The interviewees had to be practicing professionally. A sample size of twenty design professionals was proposed, and a list of twenty designers names was suggested by supervisors and advisors. In the end, seventeen designers participated in this survey.

Phase 3: The interviews

Before the interviews took place, the following strategy was instigated:

1. A telephone enquiry was made to identify the appropriate people to

whom an introductory letter (Appendix A, p.234) could be sent;

2. An introductory letter which explained the purpose of the research study was sent to the candidates;
3. A telephone enquiry was made again to determine the candidates' intention, and schedule an interview.

The interviews were tape-recorded in full for further analysis. After the interviews had taken place, the interviewees were sent a letter of thanks.

Phase 4: Analysis

A standardised open-end interview tries to gain as much information as possible; therefore, analysis was most easily and clearly achieved by using an organized data pattern (Stone 1984). A table of which recorded all the responses to the request for comments on products and images taken to the interviews, was essential.

3.3.2.2 Workshop

In order to test the transferability of the image description words derived from the interviews, a workshop was carried out with CSM MA Industrial Design students. The pilot interviews with this group had shown their responses to the products and images they were shown was similar to that of the professional designers. Consequently they provided a readily available user evaluation group.

An experiment is to isolate individual factors and observe their effect in detail to discover new relationships or properties associated with the materials being investigated, or to test exiting theories (Denscombe 2003). The workshop was conducted to confirm whether the information categories, identified from the interviews analysis, were understandable by the designers and covered all stages of the design process. The purpose of the workshop was also to improve the researcher's understanding of what sort of information an image could deliver (see Section 4.2, p.120).

3.3.3 Collecting and classifying keywords

Keywords were collected and classified from the analysis of the interviews, workshop, and existing research on designers' thinking, perception, product semantics, and linguistic theory. Two strategies were planned to classify this keyword collection. Firstly a theoretical approach using a thesaurus and secondly asking people to analyse words into groups on a table. These strategies proved unable to provide usable classifications and it was decided to explore the potential of linguistic theory (See Appendix C, p.256). Help was sought from a senior linguistic lecturer at the School of Social Sciences, Humanities and Languages, University of Westminster.

According to the interview and workshop analyses, images may be divided into PRODUCT and NON-PRODUCT images by image content. The analyses also show images convey tangible and conceptual information which may be organised into three information divisions: SPECIFICATION, EMOTION, and CHARACTERISTIC (see Chapter 5, p.138).

SPECIFICATION division

Keywords for this division are collected from the product's physical properties and its tangible context. The relevant information is discussed in Section 2.1.6 (p.34) and 2.2.2 (p.40).

EMOTION division

There are a number of studies of words describing emotions (e.g. Davitz 1969 and Niemeier and Dirven 1997). There are also studies of relevant product emotions (Cupchik 1999 and Desmet 2002). Comparing those studies, their classification of emotions, and the words used to express those same emotions were not very different. Desmet's 'Designing Emotions' gives the most relevant results because it was a study discussing the emotions elicited by products. As this research focused on descriptive keywords, it was decided not to carry out similar research to decide the keywords. As a result, the keywords in this division adopt Desmet's (2002) study (see Section 2.1.4.2, p.28) of product emotions.

CHARACTERISTIC division

Keywords were collected from the interviews with designers (see Appendix D, p.258). They are classified and associated using linguistic theory. The results are tested against another collection of keywords which was taken from Kuno's (1999) Colours In Context list of "Image words" (see Section 5.3.3, p.150).

3.3.4 Database system development and evaluation

The database system, ImageNexus, was developed around the three information divisions. Functions are provided to define images, search images and set-up keywords (see Chapter 6, p.157). The development model was based on the Entity-Relationship Model (see Section 2.4.1, p.69) which provides a relevant structure to record the information of images. The evaluation (see Chapter 7, p.172) was carried out using the principle of expert review and usability tests (see Section 2.4.3, p.75) and analysed through use of case studies.

The case study is characterized by its focus upon a particular unit of analysis: the case (Willig 2001). A case study is used when the phenomenon under study is not readily distinguishable from its context; such a phenomenon may be a project or program in an evaluation study (Yin 1993).

Case study can be based on single or multiple-case studies and a case study can be exploratory, descriptive, or explanatory (Yin 1993, Willig 2001, and Denscombe 2003). An exploratory case study is aimed at defining the questions and hypotheses of a subsequent study or determining the feasibility of the desired research procedures. A descriptive case study presents a complete description of a phenomenon within its context. An explanatory case study presents data bearing on cause-effect relationships, explaining which causes produced which effects.

The evaluation of ImageNexus used exploratory case study. The evaluation was carried out with eight MA student (who had at least one-year experience) and five design professionals. The students were included because the pilot survey had shown that their working process is the same as professional and also because they were available and accessible.

Chapter 4
Interviews and workshop

This chapter discusses the two surveys included in the research, their methods and results. The surveys were designed to understand the user's needs and information seeking behaviour (Eakins and Graham 1999) in the context of images, and to collect information to inform the construction of a model which assists designers in defining images.

Interviews were used firstly, to learn how designers use images and understand what sort of images they are and, secondly, to know how designers interpret the images in order to understand what sort of information they need from the images. The survey therefore aimed to reveal the information conveyed by images.

A workshop was conducted as a second survey to establish if the information classifications defined from the interview results were appropriate, and also to understand the range of information an image could deliver.

4.1
Interviews

A semi-structured interview method was selected as a data collection method (see Chapter 3, p.84). The semi-structured interview provides an opportunity for the participants to talk and allows collection of comprehensive data. To increase the comparability of responses, a standardised open-end interview strategy was applied (Stone and Harris, 1984).

4.1.1 The questions

The survey was based on an investigation of how product designers discuss and categorise visual design sources. It also sought to comprehend the role visual material currently plays in the design process.

The interview focused on understanding the following 4 points:

1. The status of images within the design process;
2. How designers store and access these images;
3. The status of product semantics in the practical field;
4. The words designers use in describing visual features.

A standardised open-end interview takes of a set of questions asked in the same order. To meet these objectives, each interviewee was asked 11 questions (Table 4-01). The first 7 questions focus on the status of the images within the design process. These were followed by a question on image storage and access and another on product semantics. Finally the interviewees were asked to talk about some images and products they were shown.

The questionnaire was piloted with 9 second-year MA Industrial Design students at Central Saint Martins. They came from different undergraduate schools, but the similarity in their responses indicated that extending the questionnaire to a large number of interviewees was not necessary.

Table 4-01. The questionnaire and the aims of the interview.

The status of images within the design process	
1	When you are given a design briefing, how would you describe the design process from start to finish?
2	What sort of resources do you use at different stages in the design process?
3	What kind of information do you look for within the resources you use?
4	Are there any specific resources you use to help stimulate ideas?
5	Do you use images, and if so, at which point in the process?
6	When you have all the design requirements, do you have a mental image in mind, and if so, can you describe it?
7	Within the design process, at which points and with whom do you discuss your ideas? What is the emphasis within this discussion?
How they store and access these images	
8	Do you have a personal collection of visual material you use for inspiration, and if so, what sort of images are they? How do you store them? How do you classify them?
The status of product semantics in a practical field	
9	What is your understanding of product semantics? Do you use product semantics within the design process? Yes – can you describe how? No – why do you not use them?
The words they use when describing visual features.	
10	Questions about the images: What is your feeling and reaction?
11	Questions of the products: How would you describe the visual quality and property of this product?

As the interviews were recorded, the final questions formed part of a strategy to collect the key descriptive words designers use when describing visual features. The selected products were ones that were easy to carry to the interview and the images were selected from *New and notable product design: No. 2* (Blaich, 1995) and the image provider (Digital Vision).

In total, there were 4 products (Figure 4.1-01) and 5 images (Figure 4.1-02; two images were product images, the others were non-object photos). The products, as shown in Figure4.1-01 were a Mini Disk player by SHARP, two ball pens by Lamy, a cable tidy, and a portable alarm clock.

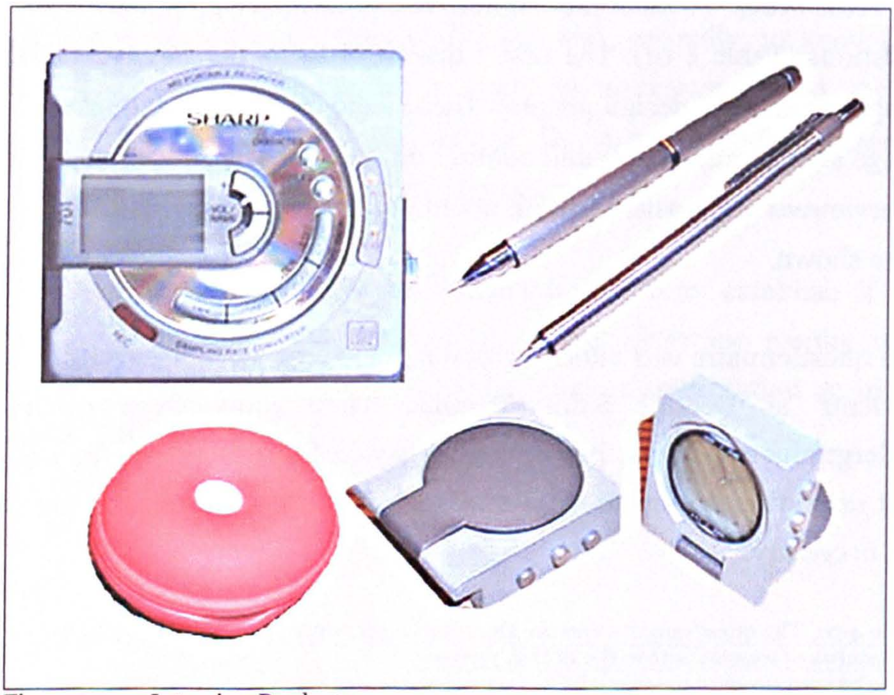


Figure4.1-01: Interview Products.

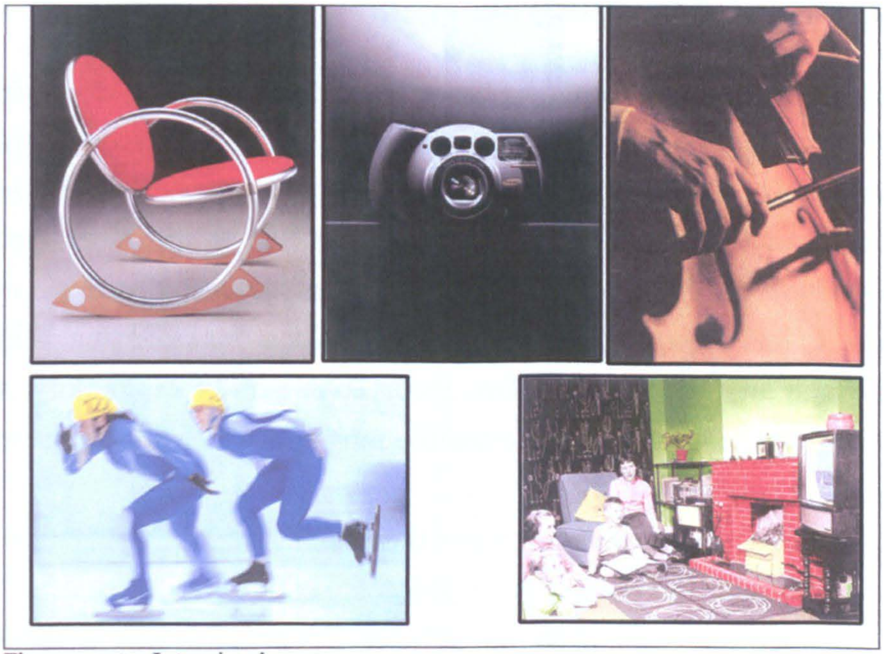


Figure4.1-02: Interview images.
Sources: *New and notable product design: No. 2* (Blaich, 1995) and Digital Vision.

4.1.2 The interviewees

The literature review has showed that images play an important role in the design process. The interview was planned to collect information from professional product designers with over 3 years experience in practice.

The question of what forms an adequate size for a sample does not lead to a correspondingly straightforward answer (see Section 3.1.3, p.87). Based upon the experiences of similar qualitative research, small-scale research is acceptable as long as the results meet the aim. Twenty introductory letters (see Appendix A, p.234) were sent out and 17 interviews were arranged by phone and conducted in the interviewees' work place. Their professional experience ranged from 3 years to 35 years.

4.1.3 Interview analysis

During interviews the designers became very involved in the discussion and made many comments. The average time taken to conduct an interview was around 90 minutes. But some of the interviews took more than the average time. As this survey set out to glean as much information from the design professionals as possible, they were not asked to cut short their answers. The reason for selecting semi-structured interviews was to allow the interviews to be exploratory. An opening statement was read before the interview which served several important purposes:

- to restate the aims and purpose of the interview
- to inform the interviewee of the procedure of the interview
- to gain the consent of the interviewee that the interview would be recorded
- to begin the formal conversation

The interviews were tape-recorded and transcribed. Table 4-02 shows the concise results of interviews and the question order is the same as in Table 4-01.

According to the objectives, the data analysis was divided into 4 phases.

1. The status of images within the design process
2. How designers store and access images
3. The status of product semantics in a practical field
4. The words designers use when describing visual features

Table 4-02. The concise results of interviews.

Interviewee	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
A	Depend on project, research, environment, technical drawing, prototyping	Magazine, don't specific do for project, library, observing people	Technical, social, trade	Magazine, take photo	Initial stage when you in concept generation, late stage as well, detail	Yes, the place of this project will be	After research, people around me	Put into file, art, design, architecture	In visual what product try to do; if it's happen, it happens by nature
B	Sketch, group meeting, decision, technician support	Material, style, colour,	Material, style, colour, fabric	Furniture fair, magazines	Research level	Not much, depends on project, till I look around	Managers, customers, from, colour, cost	Personal-books, studio-colour, material	Not much
C	Find a appropriate solution to archive the effect	Many thing, exhibitions, keep eye open	Depends, anything related	Not really, do some activity than read something	All the time	Yes, have to, because you have to thing about where your design may go	Talk to client early on, colleague	Yes, in my sketch book, very random	Very difficult, many thing to say
D	Exploring phase, development phase, realize phase	The flexibility in the initial field,	What people do within the product	Yes, maybe existing products	Very early on, video	May do, what it could be without really	Depends on,	Used to, put in box	Visual language, not come to me much
E	Search phase, concept generation, valuation phase, prototyping	Everything, trade show, shops, magazine, library, exhibition	Difficult to say, competitive analysis, colour trade	Not really	Any point, more at beginning	Sometimes, it would be change	A lot people at different time	Everything, picture from magazine, photo, in box	The language of product, yes, but not separate thing
F	Market research, manufacture cost, detail sketching, computer renderings, focus group, 3D engineering	Images,	Colour trend	Magazines, colleagues, trend fair	A lot, research stage	Wait until done research	Designers, colleagues	Yes, for projects	Subconsciously
G	Generate concept, specific develop detail, prototype	Material, material library, visual reference→ subconscious	Depends on project, understand manufacture process	No, if you do the design will be link to that specific things you found	No, the process itself is reference	Almost have a pilot image, what it will be	Art director, production manage, make decision	No, most are store in my head	Never knowingly use it
H	Product direction, front-end research	Digital photo, video, from magazine or take picture	Try to describe value, to explain the intangible	Magazine, surround things	A lot, for research and stimulate people	Maybe picture the value	Different level; all the time	CD, by project	Use it as experience
I	Depends of type of product, concept design, design development, detail design	Have numbers of difference disciplines: Engineers, economics	Customers	Internal thing, work in team, brainstorming section, discussion	Mood board, generate feeling	Not set out particular design style, after get the visual language right, we have a vision of what it is	Discuss all the time, it's a continue process, review	We create them, unique for the project, trend, market, open people's mind, form magazine, brochure, internet, take photo, 3D stuff	Is nature things to come out, we don't' tend to make a big issue about it, it's part of experience

Interviewee	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
J	We will ask involve with the briefing was written; we work for what is require, not the process	From report, culture, trend, gather information from consumers,	User, (attitude, what they wear) usage attribute and emotional value	Create mood board, mood movies	Early on, before our design work	You will have image of what you need	Knowledge of people within the team, professional body, clients	Video, magazine, books	Communication between user and product; every one use but different way
K	Research range, interested, research, concept, exhibition	Internet, visit expert, specialist, talk to people	Depends on project,	People, news paper for current issue	Not really use,	We have no client no brief, it's up to us to define everything	Among ourselves, manage the project, checking	-	Kind of related to semiotics, object communicate to visual code, in very functional way
L	Research problem	Something I like	Noting specific	No, it's something you built in your life	No	Impossible to describe	No	No	I don't know
M	Start with observation	Vary a lot, more literature reference	No	Not specifically		Yes, potentially, can't describe it	Don't usually discuss	Sense of space, sense of structure	The use of visual devices to give people way of visually reading, not really use it
N	Design concept, design development, technical drawing, production pieces	Most important resources is out brain, for WWW, store checking, magazine	Existing product within market, technique	The resources is your mind, imagination, everything through the eyes of designer	Yes, all the time, could be product, images, or painting	Yes	With everyone in the team	Kind of do, store them digitally, end up with particular project	The meaning of the product, not kind of separated idea, not conscious
O	Carefully plan the presentation to client,	Sketching, rendering, computer drawing	Colour, material, etc.	Everything	Yes	Sometimes	team-mates	Yes, not specific	Subconsciously
P	Research, more work in front-end	Sketching, modelling, CAD	Trend, stylish trend, lifestyle, technology	Go out to ask people	Mood board, useful to explain clients	Styling or technical? Yes, particular audience, size, shape, character, in the end is different	Everyone within project, clients, most of time, potential idea, make direction	Yes, sort of trend from magazine, internet; resort every time	A link to a culture, yes, styling association, functional
Q	Identify value; catch value; deliver back value	Human resource – designer, engineer; company resource – innovation approach	Consumer research, manufacture research	Not really	Yes, brand value	No	People in team	Yes, by packaging or material	Yes, use it decode the meaning of design

4.1.3.1 The status of images within the design process

Question:
When you are given a design briefing how would you describe the design process from start to finish?

Sample responses:
"there is a search phase followed by concept generation, then we have an evaluation phase, then go to prototyping"

"there are different ways; generating concept, ideas at the first stage, then we present products in many different forms from sketching to resulting technical dimension, or 3D visuals"

"the process we use we call product direction, a process we have been developing for several years which is to do with the front-end, early stage of the design process; that is the principle of the process we follow"

There are a number of design process models available, in order to make the design process more effective. However, when practised professionally the model usually changes with the time, area, and people. Therefore, this question tried to find out what sort of stages professional designers would really be concerned with, in order to comprehend the actual activities within the process.

According to the responses, they all reflected that generally the design process used would differ slightly depending on the projects or the clients. The result indicated that after the concept generating phase there is not such a big difference in activities within the design process, and these involved activities: such as sketching, technical drawing and prototyping. The main differences were the chosen activities within the front-end stages (same as Conceptual Design, see Section2.1.1.6, p.15). Some focussed on identifying the brand and product value. Others focussed on consumer group research in order to fulfil the consumers' need. For instance, one company divided their design process into three stages: identify value, catch value, and deliver back value. They start by doing research about the marketplace, consumers and the retail space, in order to understand the current product status and to find a gap in the market. There was one company who called their research phase "product direction." They started by identifying the brand value and product value of their client. The purpose of this stage - to try and identify the problem and find solutions - were almost the same.

Question:
What sort of resources do you use at different stages in the design process?

Sample responses:
"everything, we visit trade shows, shops, magazines, we go to the library, exhibitions, personally I don't just go to design exhibitions, I think fine art, sculpture is also quite a strong area for inspiration"

"depends on the project; in some of projects we use a lot of digital photographs, also digital video, to record how people are living or in what environment the product may be involved, what competitive product may be out there, what stimulating material is important to the product, a lot of that we can find through magazines, books"

The aim of this question was to find out when and where they sourced information. These resources included magazines, books, libraries, the Internet, designers, engineers, consumers, manufactures, exhibitions, specialists, and first hand experience, not forgetting sketching, rendering, and modelling. All the resources mentioned were primarily used during the concept generation phase.

Question:
What kind of information do you look for within the resources you use?

Sample responses:
"it depends on each project, what sort of product really, it is essential to understand the manufacturing process they are going to use"

"a lot is existing products within market"

Most of the responses were that the type of information would depend on the projects. However, there were some general subject areas such as technical, social, trade, related design projects, user-product relations, competitive products, understanding the manufacturing process, customers, styling, lifestyle, and technology.

Question:
Are there any specific resources you use to help stimulate ideas?

Sample responses:
"It's something you build in your life, for me it everything you touch and see"

"we sit round a table to generate ideas, or from media, magazines, or gather consumers together"

This question was intended to identify the material that the designers personally use to stimulate ideas. The responses showed that there was no specific resource. The common agreement is that designers can be influenced by everything they see, especially things that induce emotional responses. The resources included magazines, taking photos, talking to people, newspapers, in short, everything surrounding them. Furthermore, the responses indicated that ideas do not only come out during the design process, but could also happen after work.

Question:
Do you use images, and if so, at which point in the process?

Sample responses:
"before our design work, we start to create mood boards, mood movies, take from magazines, mixtures of colour and movment, do before any design work"

"the good thing about an image is people can react to it very easily, the other side is everyone reacts in different ways, ...we have to be quite conscious about the use of images to stimulate people, on one hand not push them in the direction they don't want to go, and use these image to colour their opinion or to put words in their mouths"

Designers' responses showed that they all use images within the design process, and mainly use them at an early stage. On the other hand, there were three designers who believed that images were used all the way through the design process. According to the responses, there are two ways visual materials are used; one is for visual reference boards and research in order to enhance the designers' understanding and visualization, the other is for communicating with clients because images with words are a useful tool to present intangible design concepts (for example to ... "use images to tell a story and to show the brand views").

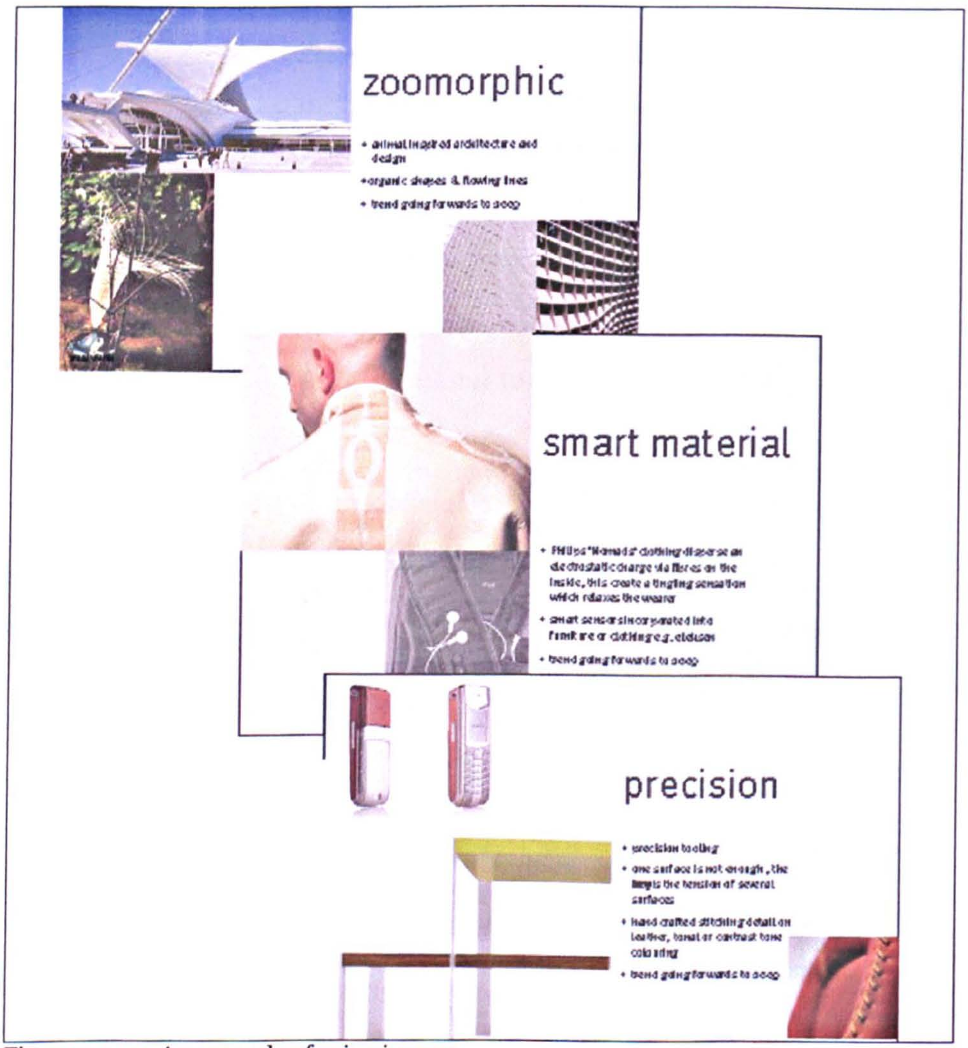


Figure 4.1-03: An example of using images.
Source: Tangerine Product Direction and Design

Question:
When you have all the design requirements, do you have a mental image in mind, and if so, can you describe it?

Sample responses:
"set of different values or products in our mind, ...sometimes we have mental pictures of some of these values"

"the place this object will be, that is what I usually have in my head"

This question tried to find out if they knew what kind of images they would look for at the beginning of the design process, or whether designers just browse through everything to find something that would catch their eye. Some designers asked what kind of mental image was meant. All the responses indicated that they definitely have visualization in mind. Their responses included what the environment of the product would be, where the design may go, what it would be, particular audiences, size, and shape. If their mental image was of what the product would be like, they all stated that in the end the result changed but the main theme would still be there.

Question:
Within the design process, at which points and with whom do you discuss your ideas? What is the emphasis within the discussion?

Sample responses:
"we discuss the design work with everybody, we share all the ideas between ourselves, we discuss everything together"

"there are different levels of discussion, some of the discussion is just in you head, or in a team or between the team and client"

Only three interviewees did not usually discuss ideas with people because they were used to working alone, otherwise, they all agreed that discussion happened all the way through the project, and it would happen with the design team, boss, client, manufacturer, and could also happen with users or friends. Discussion emphasis relates to the stage of the design process.

The responses to this first set of questions showed that images are used and discussed throughout the design process, to analyse and develop ideas and to:

- Communicate with clients
- Study the consumers
- Help to express the themes of the project
- Understand related environments
- Look for functional solutions.

These possibilities are all used to enhance the designers' visualization in order to develop the design products. They also reflect the study of Eckert and Stacey (2000) that designers use images as source of inspiration, etc.

According to the designers' responses, product design is to establish the value of a product and also to show its brand value (Figure 4.1-04). Product value is divided into physical and contextual. The physical value is presented by a product's format and features while function and characteristics represent the product's contextual value. The format is the product's physical properties such as colour, material, form, and texture. The function means the product's purpose is a requirement of the product's users and where it is needed.

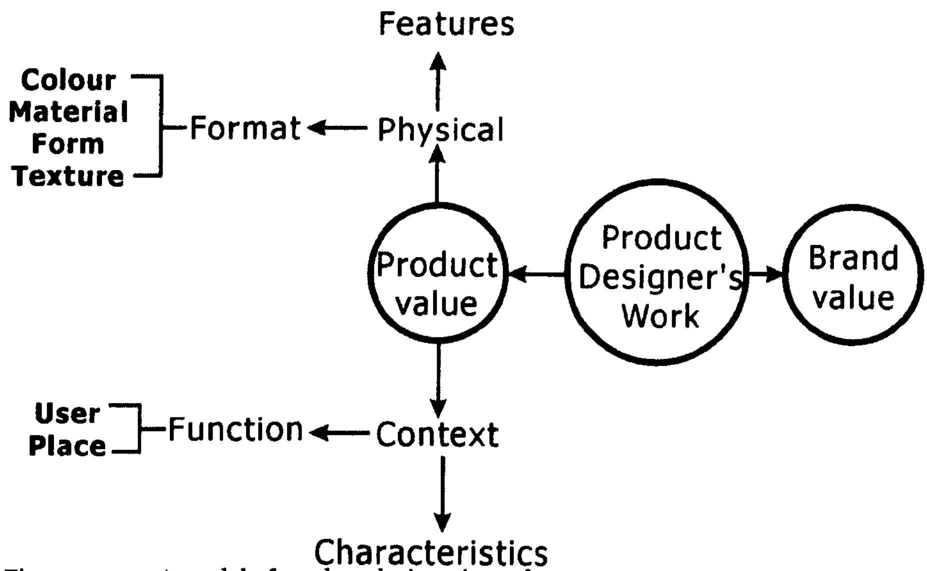


Figure 4.1-04: A model of product designer's work.

4.1.3.2 How designers store and access images

Question:
Do you have a personal collection of images you use for inspiration, and if so, what are they? How do you store them? How do you classify them?

Sample responses:
"we have videos, magazines, books, and a cabinet for resources material"

"images can mean lot of different thing to different people, so some images you can store with a lot of different titles or a lot of different names, so it's not easy to ...., we don't really classify them, just by project or in our heads"

According to all the responses, designers did not actually have formal collections of images. They had mainly accumulated magazines or books, or images from previous projects. If the materials had been used for other projects, then they might be stored digitally but were generally classified by project title or client.

The companies interviewed all had a good informal collection of magazines or books, and stored the images they used for the projects. When they needed images to assist their research, they would start with magazines, books or the Internet.

To use books and magazines, designers either skim through them quickly to find something they need or they use their memory to look for a specific image that they have seen before. They implied that this activity wasted time, but sometimes it could bring about new ideas from images that caught the designers' eyes while they went through all the magazines.

When using the Internet, the designers used a search engine, such as Google, or an image bank website to find images by inputting keywords or searching in the categories provided by the website.

4.1.3.3 The status of product semantics in a practical field

Question:
What is your understanding of product semantics?
Do you use product semantics within the design process?
Yes – can you describe how? No – why do you not use them?

Sample responses:
"In visual terms, it means what the product tries to do"

"Product Semantics is a visual language"

"Product Semantics is the language of the product"

"Product Semantics relates to semiotics; it is the visual code of products"

"The use of visual devices to give people a way of visually reading"

"Product Semantics is the meaning of a product"

"Product Semantics is a link to a culture, styling and fictional association"

This question tried to identify the level of understanding and use of product semantics in designing or interpreting a product or an image.

However, none of the designers used this theory within the design process; some of them were even trying to avoid it. They all stated that they probably used it subconsciously as it is a natural process within design. People educated before the 1980s were not particularly familiar with product semantics or they did not have an idea of what the theory of product semantics was. They recognised that it did not affect their work.

The results support the previous study of Brown (1999):

"In all 12 out of the 34 designers polled (35.3%) acknowledged regular use of semantic thinking in the design of products. However, 17 out of the 34 (50%) designers polled in the field study indicated no regular or conscious use of product semantics in the design process."

In conclusion, most designers have knowledge about product semantics, even if their definitions vary slightly. However, product semantics is viewed as a theory and seen as common sense which in practice functions subconsciously.

4.1.3.4 The words designers use when describing visual features

Questions about the images: What is your feeling and reaction? Questions about the products: How would you describe the visual quality and property of this product?

Sample responses:
"simple, geometric form, engineering, machine, masculine"

"the weight is my first impression, quite sharp, quite hard, not a friendly thing, very good quality"

"it's very playful and toy like, and it rubbery so it kind of feels like a toy"

Images may be used to convey words or concepts that the designer uses as a talking point for progress meetings and meetings with clients. The analysis of the words used by designers as they talked about the products is presented below and in Chapter 5.

Responses to the products were very similar and varied only with personal preference. It reflected Vernon's (1962) work which observed that motivation, emotion, personality, knowledge, and experiences affect people's perception. However, it could be concluded from some of the points made that:

(1) If they had knowledge about the brand, then responses were more concerned with style of the brand (e.g. the Lamy pen).
(2) Age and design influenced their views, especially concerning the MiniDisc player.
(3) The cable tidy proved an interesting object. If the designers had seen

it before, their appreciation was very strong. However, even if the designer had not seen it before, they still felt it was a very interesting object.

A list of descriptive word was made from the interview scripts of descriptions of products and images. All the words were mapped onto a word table and found to logically divide into 13 information types:

1. **Colour;**
2. **Material;**
3. **Texture/finish**
4. **Form;**
5. **Style;**
6. **Time/age;**
7. **Price/value;**
8. **Consumers/users;**
9. **Environment;**
10. **Emotion;**
11. **Activity;**
12. **Lifestyle;**
13. **Character.**

The designers used a lot of adjectives to describe the representation of products. Their responses could be divided into rational or emotional, and they all related the attributes of the products. (See Chapter 5, p138)

4.1.4 Conclusion

The aim of the interviews was to try to understand the role images play within the design process, and observe what kind of subjects and keywords were used by designers when they were searching for images. The results showed that designers use images to communicate with clients, to understand consumers, to assist in expressing the themes of the project, to understand the related environments, or to search for inspiration or functional solutions. Some of the results were the same as the literature review (see Section 2.6, p.82). Designers indicated that their thought processes can be influenced by their immediate surroundings. Also they can be influenced by any visual materials from magazines, books, the Internet or by taking photos, and they usually focus on a specific subject or detail. Basically, according to the responses, images have three different roles:

(1) Image Function: reasons why designers use images.
Interviews demonstrated that designers use images in order to communicate with clients, study consumers, understand related environments and assist them to express themes of the project. These are all concerned with communication, interpretation and understanding. Image Function is supported by Image Content and Image Context below.

(2) Image Content: what the image physically presents.
Interviews demonstrated that there are two main groups: PRODUCT and NON-PRODUCT images.

PRODUCT images: these include images of part or whole products (Figure 4.1-05).

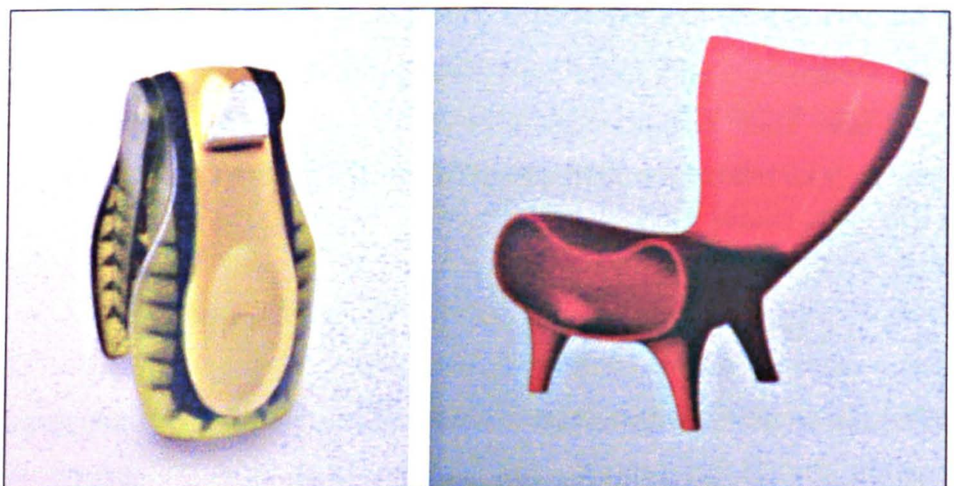


Figure 4.1-05: Product images.
Source: Lefteri 2001, p.60 and p.140

NON-PRODUCT images: these include all sorts of images, such as: *Theme images*: images with specific subjects (Figure 4.1-06) and Art works: paintings, drawings, photos or sculpture images (Figure 4.1-07) .

Figure 4.1-06: 'Theme images' of Non-product images.
Source: Wallpaper magazine (May, July/August 2002)

Figure 4.1-07: 'Art works' of Non-product images.
Source: *Museum of our wishes* (Keonig 2001)

(3) Image Context: the general and additional information conveyed by the image. Information from PRODUCT images includes:

- **Product Properties**

  According to the literature research and the fieldwork results, product properties include: material, colour, form, and texture. Size and weight also are not included because they cannot be measured from an image.

- **Product Context**

  Includes users, places, product fields, characteristics, attitudes, and emotions.

Information from NON-PRODUCT images includes:

- **Design Elements**

  Includes colour, form, material, texture.

- **Concepts**

  Includes emotions, characteristics, attitudes, user, and place/activity.

As can be seen, Product Properties are very similar to Design Elements.

The types of interpreted information could also be divided into 2 groups: tangible and conceptual. Tangible information is about product properties such as colour, form and so on while conceptual information can be grouped into: characteristics, lifestyle, emotion, quality and value. Figure 4.1-08 illustrates this categorization and also its relationship between the information conveyed by image context.

The information type also reflects Mooij's (1998) statement of the elements of a product association network, e.g. product attitudes, users, places, activities, and value (see Section 2.1.5, p.32). The interview results relating to emotion also supported Cupchik (1999) and Desmet's (2002) view that product emotions are, first, between those conveyed by products and those elicited by products; second, those that we experience towards products.

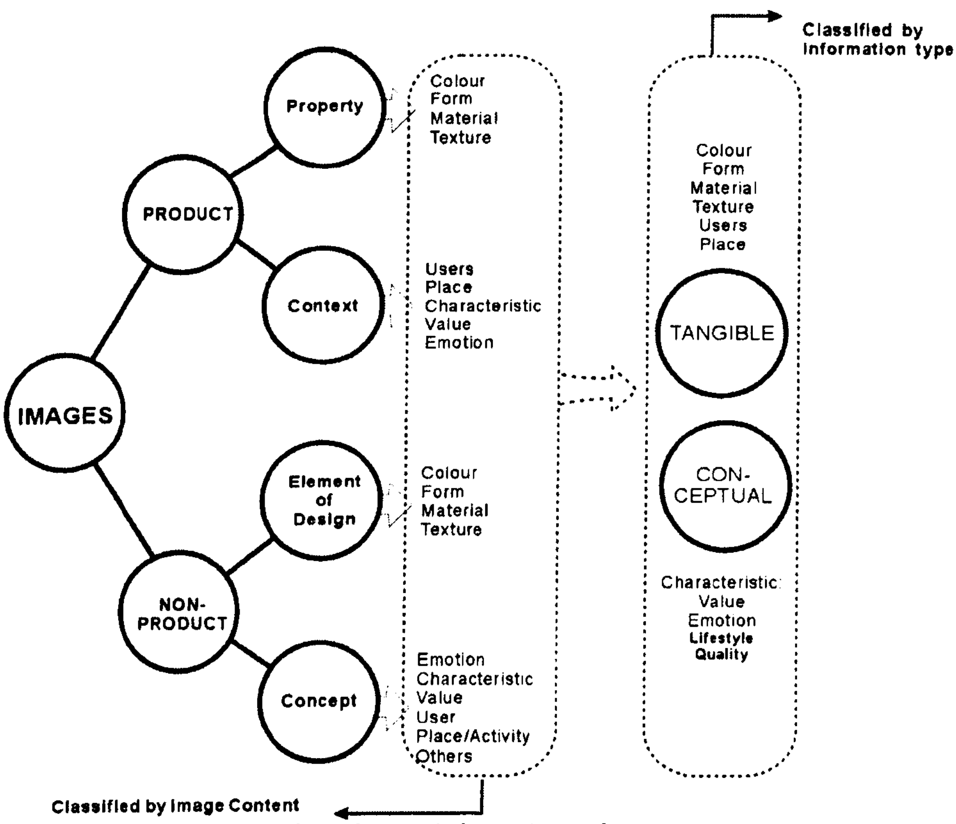
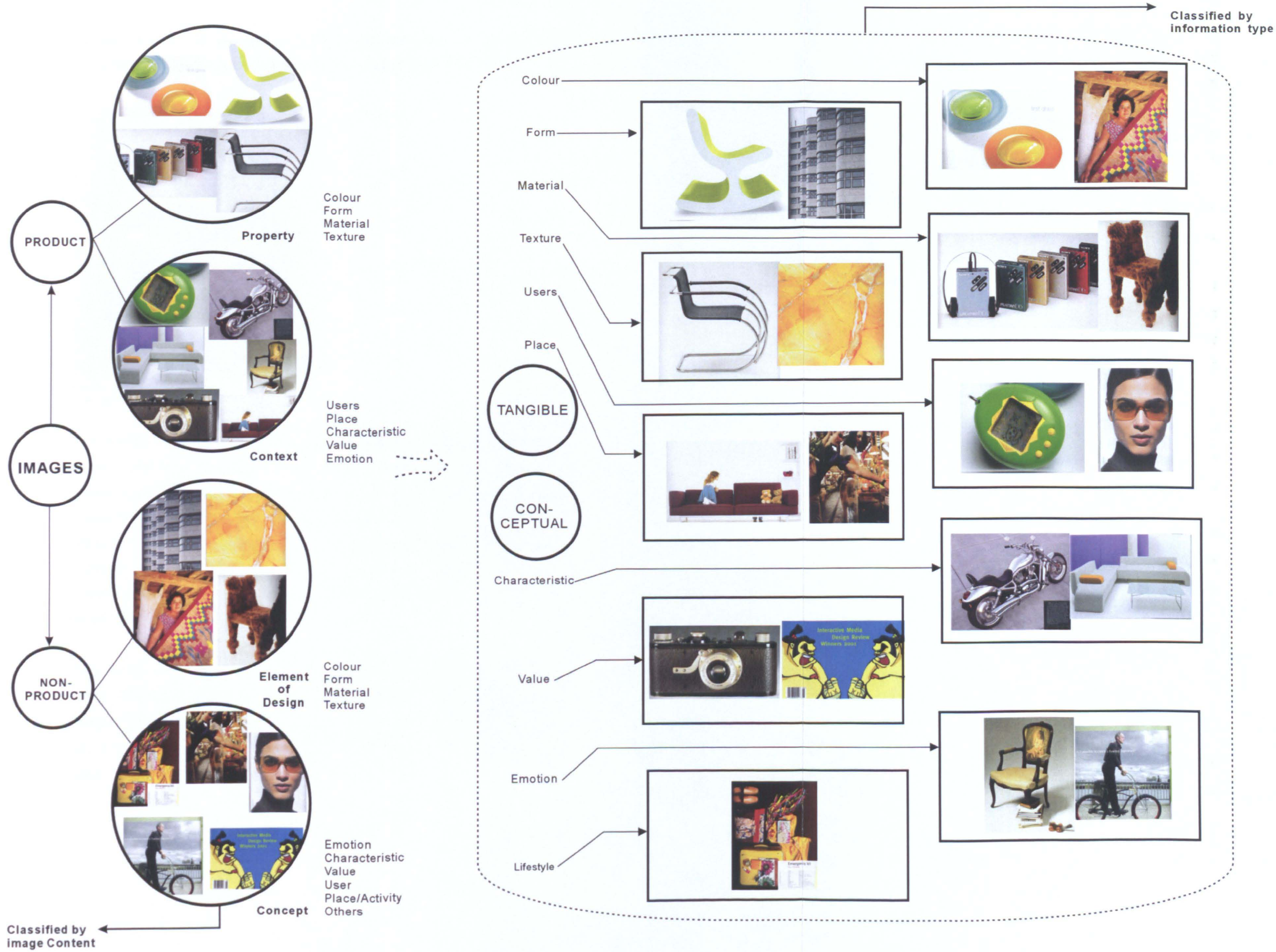


Figure 4.1-08: The relationship of image information and content.
(See next page for visual examples)

The interview results indicated that people interpret images differently; however, as designers indicated that when an image is associated with a word (and vice versa), there is rarely a disagreement. For example,



The relationship of image information and image content (refer to Figure 4.1-08)
Sources: see Appendix B1, p.237

Figure 4.1 –09 could be perceived differently but when it with keyword 'decorative', it leads people's interpretation in the same direction.

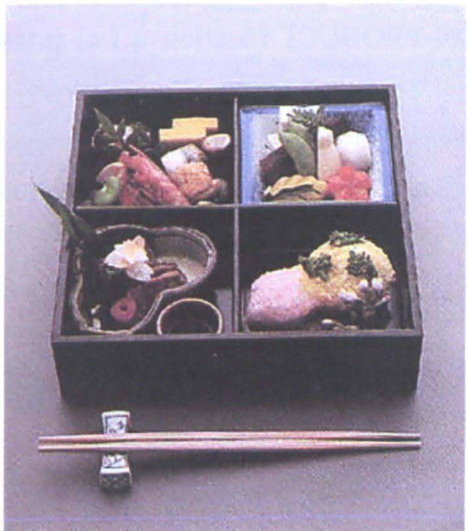


Figure 4.1-09: Japanese lunchbox.
Source: Ekuan 2000

The results also show that designers are aware of 'product semantics' theory and use it within their design; however, they apply it subconsciously. And do not generally see it as a tool to be used in the conscious realm. The classification of images within a visual database requires conscious consideration to identify appropriate keywords. Because of the unconscious nature of 'product semantics', it is not, therefore, of any great value in this classification process and was not pursued further in this research.

To sum up, a model of image information was built from the interview result. This classification was used to develop an image database (see Chapter 5 &6). In order to give the classification a broader foundation, it was necessary to include more images in the workshop based survey of image information.

4.2 Workshop

The visual materials used by designers can be physically divided into two image groups, PRODUCT and NON-PRODUCT (Section 4.1.4, p.115). Additionally, the types of interpreted information can be divided into 2 groups: tangible and conceptual. Several information types (e.g. colour, material, lifestyle, etc.) were identified from the interviews (see Figure 4.1-08). However, the number of images and products used in the interviews was small. In order to verify that the information types were appropriate, a workshop was planned.

4.2.1 Aim of workshop

The aims of the workshop were to establish if the information classifications defined were appropriate, and also to understand the range of information an image could deliver. In order to develop an appropriate image database, the workshop also aimed to understand:
1). What the similarities and differences are when different designers classify the same images?
2). Would designers classify image differently when they only have either PRODUCT or NON-PRODUCT images? (See Section4.1.4, p.115)

4.2.2 The image material

The duration of the workshop would determined the number of images which could be classified, and as Stone (1984) suggests, a research schedule should be as short as possible without compromising the aims of the study. The length of the workshop was set at 90 minutes, as this fitted the availability of the participants. A pilot showed that in a 90 minute workshop around 100 images could be classified. The images were presented in a size of 7x7 cm to economically cut from a printed page, as shown in Figure 4.2-01 and Figure 4.2-02. They were collected from 8 books and 25 magazines (see Appendix B1, p.235). The interview responses showed that designers use a variety of types of images;

therefore the selection of images was made from books available in the library and magazines published in 2000-2002 (The two years preceding the workshop). A total of 288 different images were prepared.

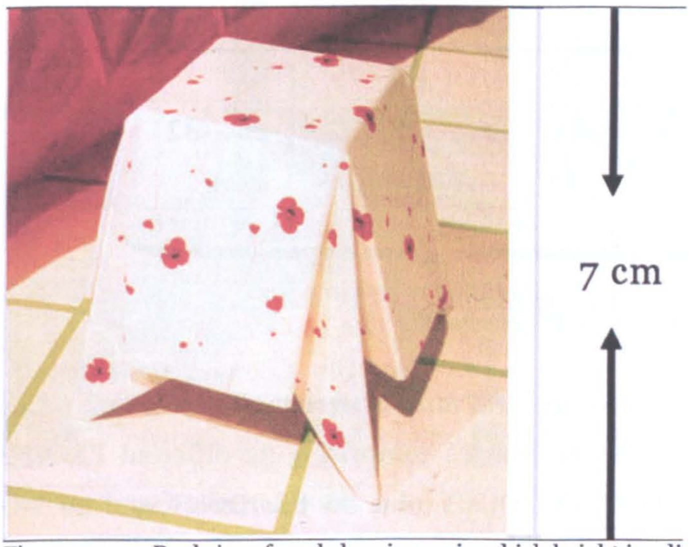


Figure4.2-01: Real size of workshop image in which height is adjusted to 7 cm.
Source: *Plastic Materials for Inspirational Design* (Lefteri 2001)

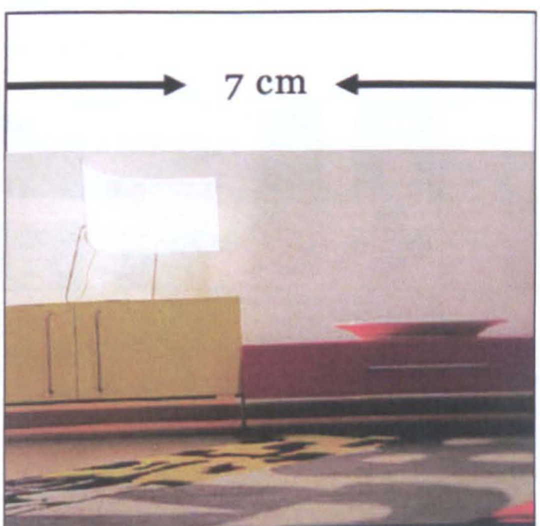


Figure 4.2-02: Real size of workshop image in which width is adjusted to 7 cm.
Source: Wallpaper magazine

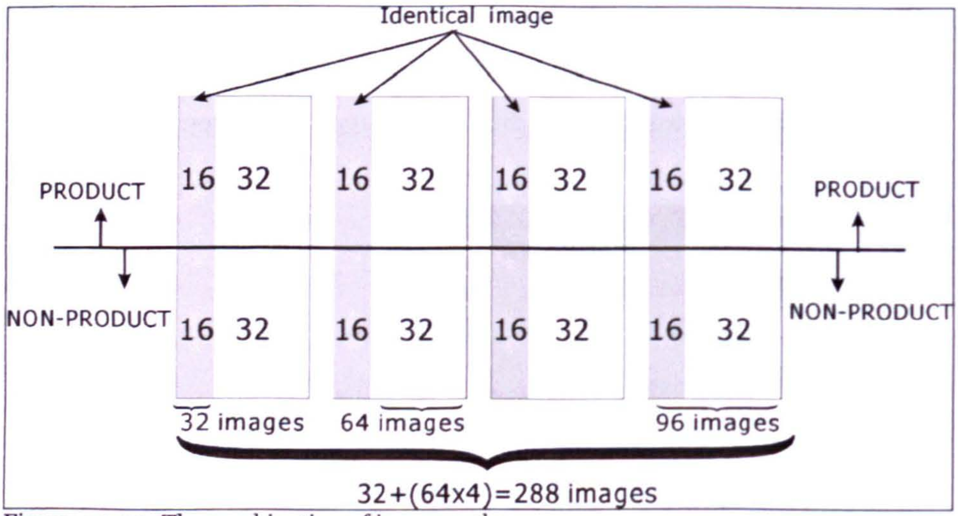


Figure 4.2-03: The combination of image packs.

Figure 4.2-03 shows how the 288 images were made up of four packs of images. Each pack held 96 images comprising 32 different PRODUCT and 32 different NON–PRODUCT plus 16 PRODCUT and 16 NON-PRODUCT images which were the same (Figure 4.2-04). The 16+16 identical images were used to compare the classification difference among participants.


16 *identical* PRODUCT images 16 *identical* NON-PRODUCT images
Figure 4.2-04: The identical images

4.2.3 Approach and the participants

Nine MA Industrial Design students from Central Saint Martins College of Art & Design participated in this workshop which was conducted in the MA student's studio (Figure 4.2-05). A brief introduction to the research, interview results and aims of the workshop was presented on OHP before they started.

The participants were asked not to classify the images into groups by product types and they did not need to classify the images which they did not understand. They were also asked to give names to their classification groups.

Figure 4.2-05: Workshop pictures

The participants were divided into two groups. It was also intended to find the main information types which different types of images convey.

a). Group 1

There were five students in this group and they were each given a different pack of images. For further analysis participants of Group 1 were named participant A, B, C, D and E. In the image packs, the PRODUCT and NON-PRODUCT images were separated. They were asked to firstly classify the PRODUCT images, then the NON-PRODUCT images. As a result, each of the participants would produce two sets of the classification categories.

b). Group 2

The other four students were also given a pack of images each. They were named participant a, b, c, and d. In their image pack, the PRODUCT and NON-PRODUCT images were mixed.

The two-group approach aimed to find out whether image content would affect the way they classified images. Participants A & a, B & b, C & c, and D & d had the same image pack. The idea of this was to understand what were the similarities and differences when different designers classify the same images. Participant E was an unexpected participant and was not included in the analysis.

4.2.4 Results and analysis

The analysis of the workshop results is divided into four sections.
Section 4.2.4.1 focuses on the PRODUCT images classifications of participants in Group 1, in order to understand how participants classified PRODUCT images and to find the specific information conveyed by PRODUCT images. This section also includes the analysis of identical images from the groups.
Section 4.2.4.2 focuses on the NON-PRODUCT images classifications of participants in Group 1, in order to understand how participants classified NON-PRODUCT images and to find the specific information conveyed by NON-PRODUCT images.
Section 4.2.4.3 presents the results and analyses of participants in Group 2.
Section 4.2.4.4 is a comparison section. It compares the results of participant A & a, B & b, C & c, D & d, and the identical images between two groups.
(See Appendix B2 for complete results)

4.2.4.1 Group 1-PRODUCT images

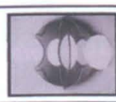
The 34 categories created by the participants (A, B, C, D) are shown in Table 4-03.

Table 4-03: Result of first group classified PRODUCT images

	Participant A	Participant B	Participant C	Participant D
I.	High tech small devices (use with hand)	Fast moving lines	Domestic appliance	Cute
II.	Furniture	Egg holders	Furniture	Structural
III.	Vehicle	Ashtrays	Transport	Simple
IV.	Glass, ceramic, container	Mechanical engines	Electronic	Difficult
V.	Lamps	Watches, clocks	Lighting	Old
VI.	Office	Reflections	Pens	Stylish
VII.	Old forms for kitchen use	Colours mixing	Luggage	Masculine
VIII.	Modern forms for kitchen use	Strings		Feminine/ Organic
IX.	Home appliance	Switches		
X.		Baskets shapes		

Fourteen images were not classified and as can be seen in Table 4-04. This was because their content was ambiguous.

Table 4-04. Not classified images.

Participant	
A	
B	
C	
D	

(Pictures with black frame are identical images)

Even though the participants were asked not to classify the PRODUCT images by the type of product and product's physical properties, the most categories participants created were the intention/purpose/use of the product, such as 'vehicle', 'lamps', 'home appliance' etc. This indicates that the product category remains the most intuitive way of classifying PRODUCT images.

Table 4-05. Similar categories from different participants.

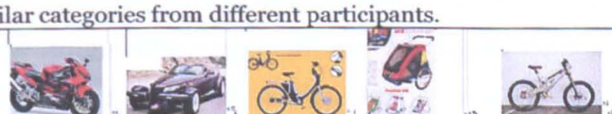
Vehicle (Participant A)	
Transport (Participant C)	

Table 4-05 shows how participants used 'vehicle', 'transport' and 'wheels' to describe similar image content. A similar example was the use of 'lamps' and 'lighting' illustrating both their understanding of the meanings of words and their preferred usage of words.

'Wheels' and 'lighting' are not specifically product types and they can also be a definition of the products. Because they are tangible terms, they can be readily recognised in a database. However most of the classifications were performed from the type of product; some participants also use the feelings or sensations to describe the emphasis and representation of the products, such as 'old', 'modern', 'cute' and 'sexy' etc.

Table 4-06: Group 1 results of *identical* PRODUCT images

Participant A	Participant B	Participant C	Participant D
High tech small devices use with hand	Fast moving lines	Domestic appliance	Cute
			
Furniture	Egg holders	Furniture	Structural
			
Vehicle	Ashtrays	Transport	Simple
			
Lamps	Mechanical engines	Electronic	Old
			
Office	Watches, clocks		Stylish
			
Old forms for kitchen use	Reflections		Masculine
			
Modern forms for kitchen use	Strings		Feminine/organic
			
Home appliance	Switches		
			

Table 4-06 shows the categories of *identical* PRODUCT images. The excluded identical images are shown in Figure 4.2-06. These images were all not easily identifiable products, especially, when participants classified images mostly by product types. The significant features were, that if these 4 images were classified, they were classified mostly by their appearance and characteristic. For example, in Figure 4.2-06, **image 2** was in the category of 'feminine/organic' and **image 4** was in the category of 'cute'. **Image 3** was only classified by participant B in the category of 'reflections'.

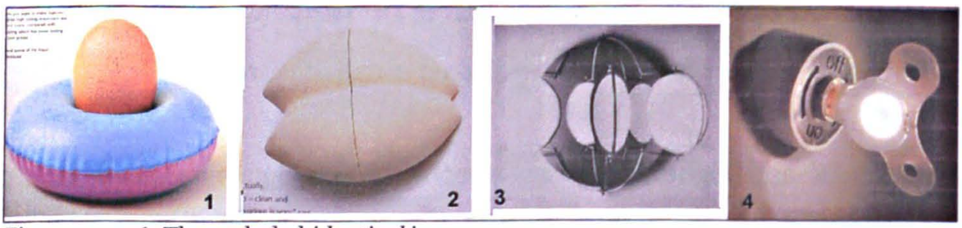


Figure 4.2-06: The excluded *identical* images.

As shown in Table 4-04, participant D was the only one who classified the images according to their context. However, the categories given by participant B were very different. The categories were neither of real product types, nor of the context of the images. They were named according to the function of the products, appearance of products, and the interaction of products. This indicated that there are many ways to define a product and the kind of information a product conveys. This also indicated that the image context (see Section 4.1.4, p.115) is not only about what information images convey (image information) but also about how the viewer interprets images (image subject). Therefore, image context can also be classified into image information and image subject.

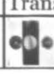
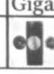
These results also indicated that when a category is the type of product, the images are exactly the same, even if the category is divided by sensations. As shown in Table 4-07, participant A and C had the same category 'Furniture' which included the same images. Participant D also had these 2 images in categories of 'Sexy home furnishing' and 'Uncomfortable furnishing.'

Table 4-07. The same category with the same images

Participant A	Participant C	Participant D
Furniture	Furniture	Sexy home furnishing
 	 	
		Uncomfortable furnishing
		

However, Table 4-08 shows that the same image could be grouped into very different categories especially in relation to characteristic descriptions. This indicated that people have different ways of interpreting images, which supports Carroll's (1964) observation (see Section 2.5.1, p.77).

Table 4-08. Same image with different category name.

Participant B	Participant C	Participant D
Light shapes design	Transport	Gigantic
		

Overall, the Group 1 PRODUCT image categories may be summarized into category types as shown in Table 4-09. The category types are defined from analysis defined by participant. Linguistically, most of the category types are defined by nouns, such as 'product type', 'product form', 'material appearance' and so on. Again, these are tangible terms, so they can be readily recognised in a database. Second to 'product type', 'style appearance' was the most popular method used to classify PRODUCT images. 'Style appearance' is defined by the use of adjectives as the descriptive words. This shows that after 'product type' adjectives are the most used descriptive words e.g. 'mechanical', 'cute', 'simple' and so on.

Table 4-09. The summary of PRODUCT image categories

Category type	No.	List of categories
Product type	20	A-II, A-III, A-V, A-VI, A-IX, B-II, B-III, B-V, C-I, C-II, C-III, C-IV, C-V, C-VI, C-VII
Style appearance	10	A-I, B-IV, D-I, D-II, D-III, D-IV, D-V, D-VI, D-VII, D-VIII
Product form	3	B-VIII, B-X
Product type + style appearance	3	A-VII, A-VIII
Material appearance	2	A-IV, B-VI,
Colour appearance	1	B-VII,
Product form + sensation	1	B-I,
Function	1	B-IX

(Refer to Table 4-03 for the list of categories.)

4.2.4.2 Group 1 - NON-PRODUCT images

The 43 categories of NON-PRODUCT images created by Group 1participants are shown in Table 4-10.

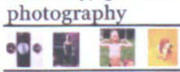
Table 4-10: Result of Group 1 NON-PRODUCT images.

	A	B	C	D
I.	Industry/factory business	Toy	Transport	Boring
II.	Cartoon	Happy	Furniture	Scared
III.	Sports	Architecture, external design	Fun	Childish
IV.	Music	Sex	Architecture	Happy
V.	Business men	Textile design	Related	Miserable
VI.	Family/woman relation	Light shapes design	Art	Active
VII.	Children objects		Pollution	Static
VIII.	Publicity/ product photography		Domestic	Virtual
IX.	Rooms		Retail	Gigantic
X.	Food, plants		Medicine	Natural
XI.	Nature		Education	Refresh
XII.	Young people, individuals		Hospital	Lonely
XIII.			Alcohol	

The results show that most categories were titled according to the content of the images, such as 'cartoon', 'music', 'architecture' and 'home' etc. There are only a few categories which were based on emotions; such as 'boring', 'fun', 'happy' and 'lonely' etc. Unexpected categories were the product types 'transport' and 'furniture' as they were asked not to classify images by product type.

Table 4-11 shows the categories created for identical NON-PROUDCT images. In Table 4-11, there are fewer categories which have the same name than the identical PRODUCT image categories have (see Table 4-06). Some of the categories which include the same images have some similarity in the names which were created, such as 'fun' and 'happy'; 'cartoon', 'art' and 'virtual'.

Table 4-11. *Identical* NON-PROUDCT image results of Group 1

Participant A	Participant B	Participant C	Participant D
Industry/factory business	Sex	Transport	Boring
			
Cartoon	Textile design	Fun	Happy
			
Family/woman relation	Light shapes design	Related	Miserable
			
Publicity/ product photography		Art	Active
			
Rooms		Domestic	Static
			
Young people, individuals		Retail	Virtual
			
		Education	Gigantic
			
		Hospital	Refresh
			
		Alcohol	Lonely
			

In Table 4-12 there are six category types identified from the interviews with a number of additional ones groups under 'Miscellaneous'. These included 'Industry/factory business', 'cartoon', 'sports', and so on.

Table 4-12. The summary of NON-PRODUCT image categories

Category type	No.	List of categories
Miscellaneous	24	A-I, A-II, A-IV, A-XI, B-IV, C-V, C-VII, C-VIII, C-IX, C-X, C-XI, C-XIII, D-VII, D-VIII, D-IX, D-X, D-XI
Emotion/Sensation	9	B-II, C-III, D-I, D-II, D-III, D-IV, D-V, D-XII
Object	8	A-VII, A-VIII, A-X, A-XII, B-I, C-I, C-II
Art & design	6	B-III, B-V, B-VI, C-IV, C-VI
People	3	A-V, A-VI
Space	2	A-IX, C-XII
Activities	2	A-III, D-VI

(Refer to Table 4-10 for list of categories.)

4.2.4.3 Group 2

The four participants in this group had the same images as the first group of participants but with the PRODUCT and NON-PRODUCT mixed. The results are shown in Table 4-13 and Appendix B2. There are a total of 55 categories; there are 10 categories which only included PRODUCT images, and 10 categories which only included NON-PRODUCT images. The results show that participants were more concerned with the context of images in their classifications in this section. The results also show that PRODUCT images could be categorized by product context. But fundamentally the participants classified product images by a product's physical properties.

Table 4-13. Results of Group 2.

	a	b	c	d
i.	Novelty	Nice for eyes	Highly designed life/contemporary	Visuals that triggered emotion thoughts
ii.	Functional and fun	Freedom to see	Annoying/irritating object	Poetic functional
iii.	Stylish	Plastics and industrial design	Wealth bourgeois life	Just poetic
iv.	Action	True love	Institution	Non-emotional products
v.	Japanese style	Design for evolution	Imitation	Male-world
vi.	Organic	World of design	Leisure + pleasure	Functional & interesting
vii.	Child-like	Basic	Craving of speeds	Sweet, giving, and thought through design
viii.	Boring	Wood and boxes	Early adopters	Overworked design/ 90's style
ix.	Emotion	Art	Sustain ability	Nature
x.	Destructive	Despair	Classical context on form	False reality
xi.	Space	Bad influence	Cultural difference	Created emotion
xii.	Simple	Child-ness	Cookery	Uninteresting images
xiii.	Masculine		Multiplicity	Perception of time and place
xiv.	Strange		Desire of health	Repetition
xv.				Practical

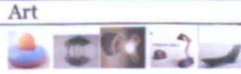
Where participants had similar categories such as 'child-like' (participant 'a') and 'child-ness' (participant 'b'), the images within these categories were very physically different, as shown in Table4-14. This indicates that even different kinds of image content could present the same concept. It implied that images associated with words would give the image a stronger identity.

Table 4-14. Similar category, different images

Participant a	Participant b
Child-like	Child-ness
	

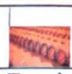
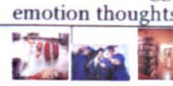
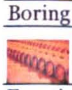
The results of identical PRODUCT images in Group 2 (Table 4-15) shows that the relationship between the name of the categories and images were not directly related. However, compared with the results of Group 1, the names of categories in Group 2 were less physical and more characteristic features. It shows that when PRODUCT and NON-PRODUCT images are mixed, it helps to reduce participants' interest in the images' physical properties and focuses them on the images' context.

Table 4-15. Identical PRODUCT image results of Group 2.

Participant a	Participant b	Participant c	Participant d
Novelty	Plastics and industrial design	Highly designed life/contemporary	Visuals that triggered emotion thoughts
			
Functional and fun	Design for evolution	Annoying/irritating object	Poetic functional
			
Stylish	World of design	Wealth bourgeois life	Just poetic
			
Action	Basic	Leisure + pleasure	Non-emotional products
			
Destructive	Wood and boxes	Craving of speeds	Male-world
			
Simple	Art	Early adopters	Functional & interesting
			
Strange	Child-ness	Sustain ability	Sweet, giving, and thought through design
			
		Classical context on form	Nature
			

The results from the classification of the identical NON-PRODUCT images are shown in Table 4-16. It is difficult to find any similarities in Table 4-16, either between the names of the categories or the images within a category. This reflected that the variety of interpretations of an image could be very different even from people who have similar educational background (see Section 2.5.1, p.77).

Table 4-16. Identical NON-PROUDCT results of Group 2.

Participant a	Participant b	Participant c	Participant d
Novelty	Freedom to see	Annoying/irritating object	Visuals that triggered emotion thoughts
			
Stylish	True love	Wealth bourgeois life	Poetic functional
			
Organic	Design for evolution	Institution	Just poetic
			
Child-like	World of design	Imitation	False reality
			
Boring	Wood and boxes	Early adopters	Uninteresting images
			
Emotion	Despair	Sustain ability	Repetition
			
Destructive	Child-ness	Multiplicity	
			
Space		Desire of health	
			

The categories of Group 2 could be summarised into six category types. Emotion and characteristic are the main category types.

Table 4-17. The summary of Group 2 categories

Category type	No.	List of categories
Emotion/Sensation	18	a-viii, a-ix, a-x, a-xiv, b-i, b-ii, b-iv, b-x, b-xi, c-ii, d-i, d-ii, d-iii, d-iv, d-vi, d-vii, d-xi, d-xii
Characteristic	17	a-I, a-ii, a-iii, a-iv, a-v, a-vii, a-xiii, b-vii, b-xii, c-i, c-v, c-ix, c-x, d-v, d-viii, d-ix, d-xv
Themes	9	a-vi, a-xii, b-v, b-vi, c-iii, c-viii, c-xi, d-x, d-xiv
Object	3	b-iii, b-viii, v-ix
Space and time	4	a-xi, c-vi, c-vii, d-xiii
Place	1	c-iv

(Refer to Table 4-13 for list of categories.)

4.2.4.4 Comparison of two groups

Participants A, B, C, and D had the same image packs as participants a, b, c, and d. Comparing their categories shows that there was little commonality in the names indicating that the method of classifying images varies between people. It reflects Trask's (1995) statement that the choice of vocabulary is highly variable, even when people try to deliver the same concept.

4.2.5 Comparing the workshop results with the interviews

As the aim of the workshop was to test the conclusions of interview results. The participants of workshop were people who had at least one year professional experiences to reduce the difference for comparison. The information types collected from interviews were: Colour, Material, Texture/finish, Form, Place, User, Lifestyle, Characteristic, Quality, Emotion, and Value (see Section 4.1.4, p.115). Table 4-18 shows the category types defined from the workshop results. A comparison of interview information types with these category types, as shown in Figure 4.2-07, demonstrates that most of the interview information types are related to the category types. The differences are:

a). 'Lifestyle' and 'Value' from information types are not found in the category types; however, tracing back to workshop results, there are categories showing these qualities, e.g. 'Stylish', ' Organic', 'boring', 'basic', etc.

b). The different category types are Activities, Art & design, Function, Object, Product type, Theme, and Topic. Apart from 'Function', the others all are related to the information types. For example, 'Theme' and 'Topic' are normally involved in characteristic. Therefore, 'Function' should be added as a category to define an image.

Table 4-18. Category types of workshop results

Group 1_PRODUCT image	Group 1_NON-PRODUCT image	Group 2
Product type	Topic	Emotion/Sensation
Style appearance	Emotion/Sensation	Characteristic
Product form	Object	Themes
Product type + style appearance	Art & design	Object
Material appearance	People	Space and time
Colour appearance	Space	Place
Product type + sensation	Activities	
Product form + sensation		
Function		

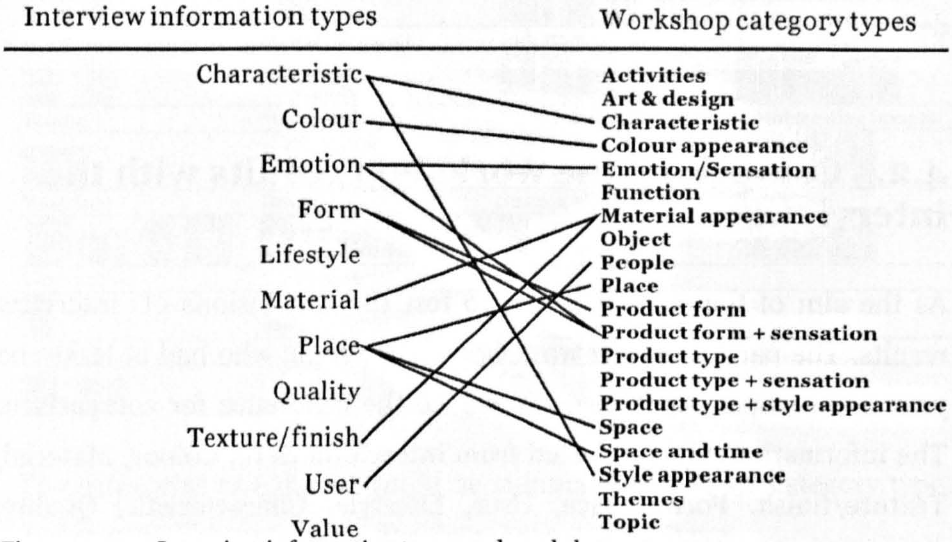


Figure 4.2-07: Interview information types and workshop category types

Overall, the workshop results proved that the information types derived from the interview results are appropriate. As a result, the interview information types plus 'Function' were used as the main categories for further application within this research.

4.2.6 Discussion

The aim of this workshop was to determine whether the main information types summarised from the interviews were appropriate. The results indicated that the information types were generally the same as the interview results and would be the foundation for further development. Furthermore, it showed that 'characteristic' descriptions are important.

The results also show that the words used in describing similar objects or subjects vary greatly. Nevertheless, there is a connection between these words. Hudson (1995) stated that words that share the same meaning are **synonyms**, and the workshop results showed that a synonyms dictionary could help to group some of these words. For example, 'vehicle', 'transport' and 'wheels'.

Overall, the categories resulting from the interviews are appropriate (see Section 4.2.5, p.133). It also supports Vernon's (1962) statement that perception varies among people, according to how their knowledge and experience have been acquired, and no two observers will perceive a given scene in exactly the same manner.

4.3 Conclusions

Images were analysed from their three roles: image function, image content, and image context (see Section 4.1.4, p.115). However, Section 4.2.2.1 suggested images' contexts should be classified into image information and image subjects because of the different sources. Therefore, images may be analysed from four different aspects (Figure 4.3-01): function, content, information and subject.

- Image function: the reasons for using an image, which have been described in Section 4.1.4.
- Image content: what is present inside the image, there are two main groups: PRODUCT and NON-PRODUCT.
- Image information: the information that is conveyed by images, see Section 4.1.4.
- Image subject: the interpretation of the information in the image, for example, colour and material are tangible subjects, and characteristic and value are conceptual subjects.

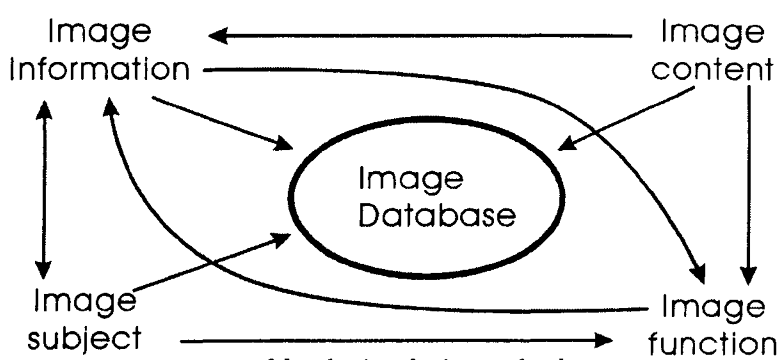


Figure 4.3-01: Aspects of developing the image database.

The content of images allows the visual materials used by designers to be first physically divided into PRODUCT images and NON-PRODUCT images. Then, the subject matter of the interpreted information may be divided into *tangible* and *conceptual* (Figure 4.3-02).

Figure 4.3-02 also shows the relationship between the image content and the image subject and how they are connected by the image information.

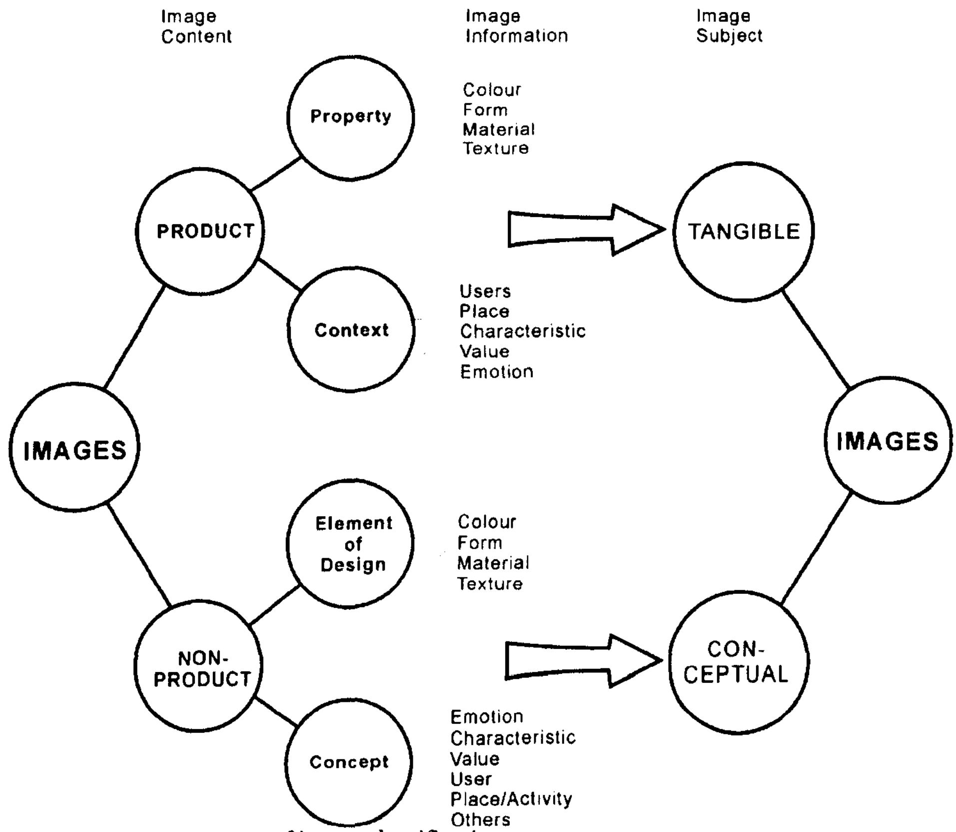


Figure 4.3-02: Structure of image classification.

This information about the images was used to provide the main categories within which to develop relevant descriptive words. In order to construct an image database for product design professionals. Chapter 5 discusses the further development of the classification of categories.

Chapter 5
Classifications

In the previous chapter, the survey outcomes provided some information categories to describe the images. This chapter focuses on developing these to establish an integrated category model to define the images. The issues are tackled from the perspective of language and image. As a result, an image is defined by the information in three divisions: SPECIFICATION, EMOTION, and CHARACTERISTIC.

In section 5.1 the use of language to describe images is discussed. Section 5.2 examines the information provided by the content and the context of images. In Section 5.3, the three divisions are discussed and the categories of the divisions and the members of the categories are demonstrated.

5.1
Language

5.1.1 Language syntax

Results from the interviews and the literature review showed that the language used could be classified by language syntax into: nouns, verbs and adjectives. The possible syntaxes are (see Figure 5.1-01):

1. Noun +verb + adjective
2. Noun + adjective
3. Object + verb + adjective

Figure 5.1-01 shows that the Nouns include descriptors, such as product type, colour, material etc. The range of available adjectives is large and open-ended, while the range of nouns is comparatively small, and the Verbs are limited to the range of sensorial actions (e.g. feel, smell) (these are known as "copula verbs"). The nouns normally describe the reactions of sense; therefore, the verb vocabularies do not have much effect on the logic of communication. For example, 'red colour *looks* warm' is the same as 'the red colour *is* warm'. Consequently, the keywords discussed in this study were nouns and adjectives.

Nouns include the words colour, material, texture, weight, etc and they are the tangible property of an image as mentioned in Section 4.3. Adjectives used in design communication involve emotional, characteristics, value and functional descriptions. The range of vocabulary could be huge; therefore a manageable collection of words for the system has to be considered. This is further discussed in Section 5.2 and 5.3.

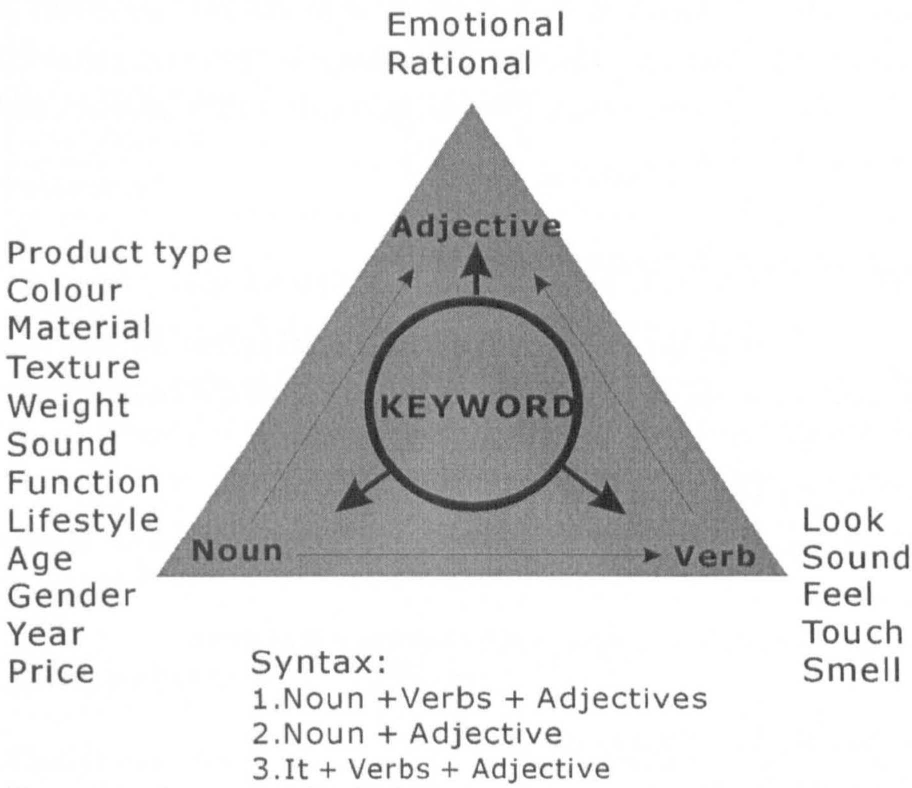


Figure 5.1-01: Language syntax structure.

5.1.2 Image language

'Objects can exist as visual forms in their own right and can be used without any other reference. A vase or Lego building block for children, for example, do not necessarily require any accompanying text in order for them to be used or understood. They have visual or tactile qualities that communicate directly with great effect. Two-dimensional images, however, are different. As a means of personal expression they communicate with great immediacy. They can have a profound effect in stimulating a range of reactions, although this may not be exact or capable of calculation in advance. For practical purposes, however, in forms such as maps or diagrams, imagery in two dimensions generally requires being supplemented by text for it to establish any kind of precision (Heskett 2002, pp.83-84).'

Heskett's explanation emphasises the importance of using text with images. Carroll (1964) and Vernon (1962) both indicated the effect of language on perceptions. The value of an image is, therefore, enhanced by its linguistic association through keywords which identify and interpret its content.

5.1.2.1 Image language structure

The analysis of all the designers' responses showed that the language they used to discuss the images and products could be synthesised into:

(1) The **object** + **adjective**

This product is **ergonomically** designed; **the handle** is very **ergonomic**.

It is **functional**. It is designed with a **geometrical form.**

(2) The **object** + **sense** + **adjective**

This product **looks** fun.

It **looks/feels** heavy. It tries to **show** quality.

It **looks** cheap. The material **looks/feels** warm.

(3) Style

This is **1980's design**.

This is **Bauhaus Style**. It reminds me of **Memphis.**

(4) The function of product

It is **portable**. It seems you can **open it.** It is comfortable to **hold**.

(5) A description/interpretation.
It is **house ware**. It is **furniture**.

(6) Cause and result
It is a good/bad design, **because** the graphic is too small.
The colour is very strong **so** it looks very modern.

Table 5-01. The relationship between the image language structure and language syntax.

Image language structure	Example	Language syntax
The object + adjective	The handle is ergonomic.	Noun + Adjective
The object + sense + adjective	The material looks cheap.	Noun + Verb + Adjective
Style	It is *Bauhaus* style.	Noun
The function of product	It is portable.	Verb; Adjective
A description/interpretation	It is furniture.	Noun
Cause and result	The colour is strong so it looks warm.	Noun + Verb + Adjective

The relationship between the image language structure and language syntax is shown as Table 5-01. The table shows that nouns and adjectives are the main classes used in dialogue, and that this has been derived from research as reflected in Eckert and Stacey's (2002) observations. However, the number of keywords is contrary to Eckert and Stacey's observation and the range of available nouns is comparatively small, while the range of adjectives is large and open-ended.

5.1.2.2 Image descriptions

The interview responses showed that designers' descriptions of images could be divided into Subjective and Objective responses:
Objective responses are the dialogue about the tangible information (Noun; see Section 5.1.1, p.138) of an image or physical properties of a product. They are rational responses. They provide a general introduction to an image or a product, for example, 'the handle is ergonomic', and they are based upon fact, designers' rational experiences, or how the products meet functional needs. The relationship of objective responses with the language classification in Section 5.1.1 is shown as the circle of 'Objective' and 'Adjective' in Figure 5.1-02.

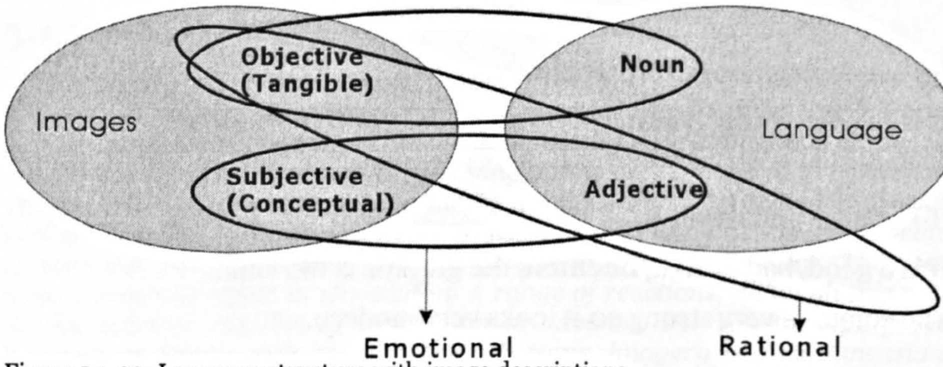


Figure 5.1-02: Language structure with image descriptions.

Subjective responses are emotional responses. They can be divided into direct and indirect responses. Direct responses are essentially feelings which are an emotional reaction to an image or a product. For example, 'it is comfortable'. Indirect responses are associated feelings which are caused by a part of an image context or a product property. For example, 'this function is clever'. These present the conceptual information of an image.

Figure 5.1-02 and Figure 5.1-03 also show the relationship between the image description and the language syntax. Nouns only appear in objective responses while subjective responses only involve Adjectives.

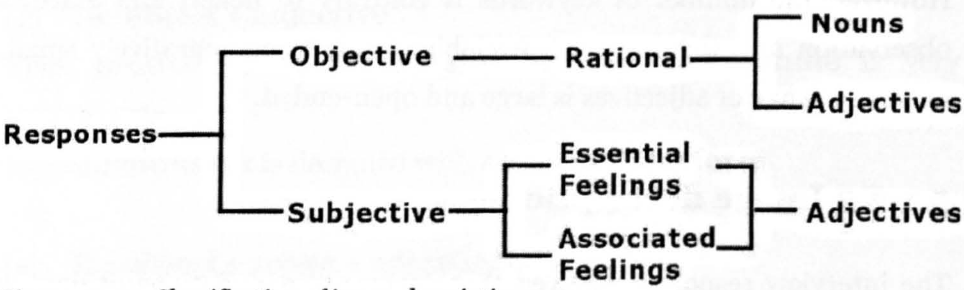


Figure 5.1-03. Classification of image descriptions.

5.2 Images

5.2.1 Image content

The focus of this research is a visual database for use by product designers, and in this context image content can be simply split into PRODUCT and NON-PRODUCT images (see Section 4.1.4, p.115):

(1) PRODUCT images

A PRODUCT image is one containing an individual product or a collection of products (Figure 5.2-01). It can also be a detail of a product or an image with specific information such as material, texture or function (see Section 4.1.4, p.115).

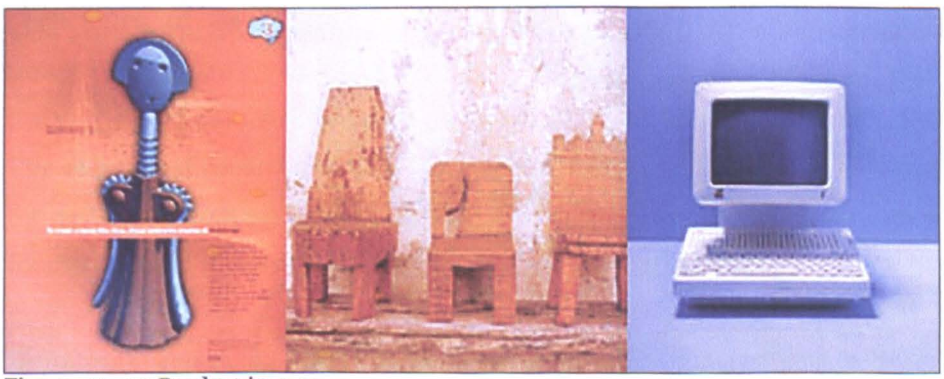


Figure 5.2-01: Product images.
Source: I.D. and INVIEW magazine

(2) NON-PRODUCT images

NON-PRODUCT images cover a substantially wider range of subject matter (Figure 5.2-02) such as users, environments, and art works. In discussion, designers give the images specific definitions and use them to present a subject or a theme.

Figure 5.2-02: Non-Product images.
Source: Digital Vision, Smart Design: Products that change our lives (Grinyer 2001) and Taste Today—The role of appreciation in consumerism and design (Lloyd Jones 1991)

5.2.2 Image information

Figure 5.2-03 shown the relevant information that is conveyed by PRODUCT and NON-PRODUCT images. However, this classification model is too complex to define an image.

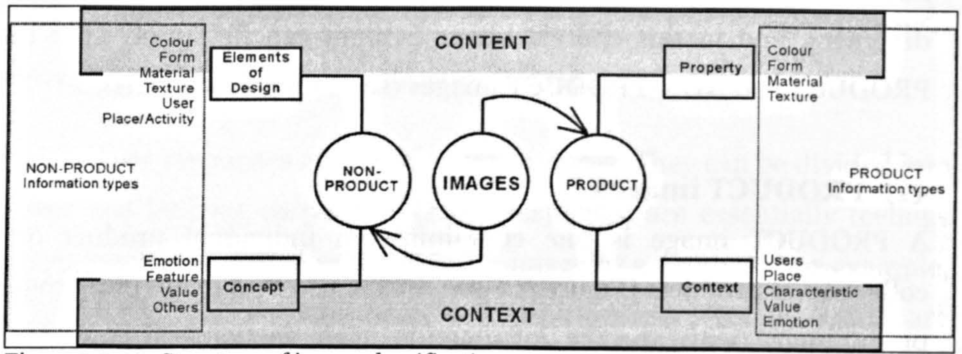


Figure 5.2-03: Structure of image classification.

Referring to Figure 4.3-02, the information types, tangible and conceptual, make up an understanding of an image. Figure 5.2-04 shows this division of information.

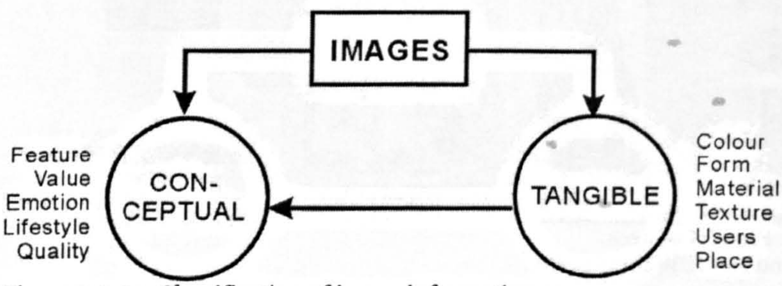


Figure 5.2-04: Classification of image information.

Descriptions of tangible information are mostly Nouns, and for conceptual information are Adjectives (Figure 5.2-05). Figure 5.2-04 shows that tangible information is about product properties such as colour, form and so on, and product market segmentations (users and places). This information is typically used in a design brief and hence can be seen as forming a product specification (see Section 2.1.2, p.18). The term “SPECIFICATION” (see Figure 5.2-07) has therefore been adopted to describe the tangible information contained in an image.

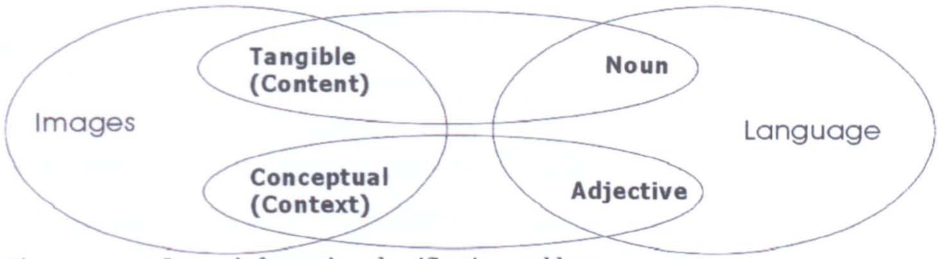


Figure 5.2-05: Image information classification and language syntax.

Conceptual information, however, is a construct of tangible information interpreted by the viewer. This information can be grouped into: features, lifestyle, quality and value and put into an information division, named "CHARACTERISTIC".

Observations from the interviews with designers indicated that the interaction between an image and a designer's view could be represented as Figure 5.2-06. A viewer can receive information not only about the proprieties of an image, but also about its representation, because images of objects already have some interpretation attached to them in the way they have been photographed or drawn (Ecker and Stacey 2000). The emotional reaction of the viewer to the image is therefore influenced by its representation. The words used to describe these reactions have formed a third information division, named "EMOTION".

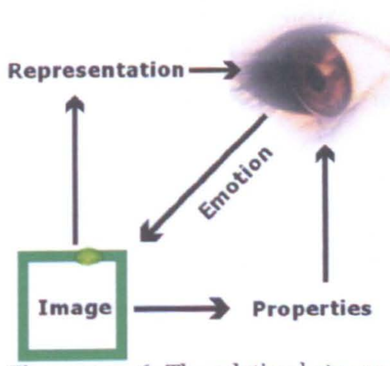


Figure 5.2-06: The relation between an image and a viewer.

Combining Figure 5.1-03 and 5.2-04 into Figure 5.2-07 demonstrates that conceptual information embraces not only the subjective data but also some objective. The objective responses included are features and lifestyles, while value, quality and emotion are the subjective responses.

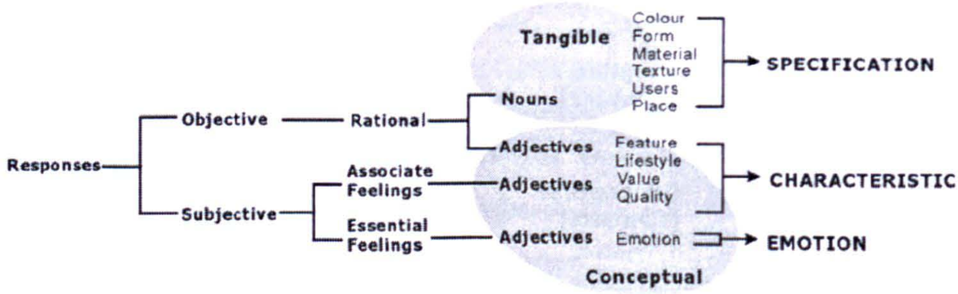


Figure 5.2-07: The relationship between image information & image descriptions.

Figure 5.2-07 also shows that the totality of information derived from an image may be grouped into the three divisions described below.

a). SPECIFICATION information is objective, tangible information.

b). CHARACTERISTIC information is subjective, conceptual information which includes features, value, lifestyle and quality.

c). EMOTION information is the viewer's initial response to an image.

Referring the information divisions to product design, Figure 5.2-08 illustrates the relationship between SPECIFICATION and CHARACTERISTIC. The tangible information in SPECIFICATION may be divided into the product's 'Format' and 'Function' which are the 'Physical' and 'Context' aspects of a product, making up its value. These in turn describe the 'Features' and 'Characteristics' of the product forming the CHARACTERISTIC division.

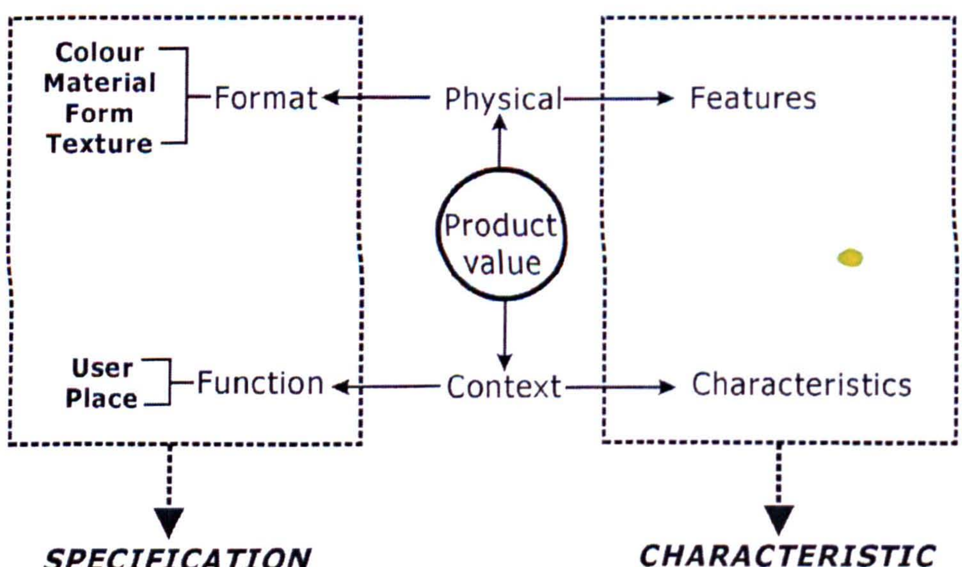


Figure 5.2-08: The work of design with the divisions.

Cupchik (1999) identified that industrial design objects have stimulus oriented and response oriented perspectives; stimuli are provided by the content of objects and how the observer responds to these. On this basis the SPECIFICATION and CHARACTERISTIC divisions provide the information eliciting the EMOTION responses. In summary, the words used to define an image can be grouped into three divisions: SPECIFICATION, EMOTION, and CHARACTERISTIC, see below Figure 5.2-09.

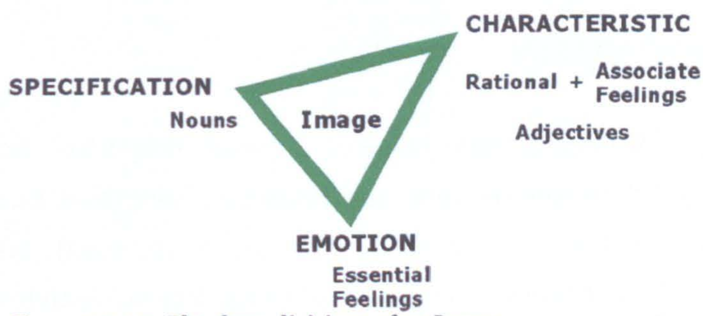


Figure 5.2-09: The three divisions of an Image.

The three divisions actually associate with each other, e.g. a 'red' 'soft' 'plastic' 'chair' appears 'warm', 'comfortable', and 'modern'. And the possible emotional reactions could be "like" and "happy". Figure 5.2-10 shows the relationship between the divisions. The plastic material represents the chair's modern feature, the red colour represents a warm feeling and makes the user happy, and the comfortable features make the user like the chair.

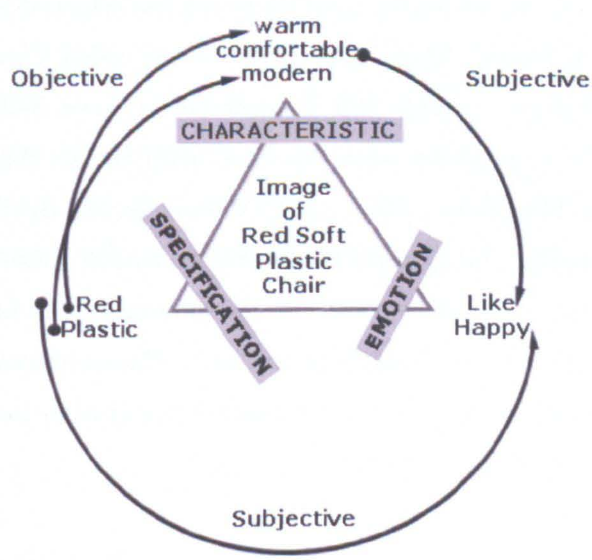


Figure 5.2-10: Product analysis showing the relationship between the three divisions.

5.3
The Three divisions

Keywords in each division are the main method of defining an image. This section discusses what kind of keywords should be included and how they are classified into categories. These categories and keywords need to be clearly understandable in order to avoid users spending too much time in selecting them, and to avoid causing confusion.

5.3.1 SPECIFICATION

The SPECIFICATION information involves product properties and market segmentations. In this division, the categories, identified from the literature research (see Section 2.1.6, p.34 and 2.2.2, p.40), are: Colour, Form, Material, Texture, Gender, Age, Class, Places, Activities and Product Field (Table 5-02).

Colours, Forms, Materials and Textures are the visual properties of products and the physical design elements. The categories of users' Gender, Age, Class, Places, and Activities are the market segmentations used to define users. The product field is included because the results of the workshop (see Chapter 4, p.100) indicated that product types forms a fundamental way of classifying images.

The members of Colour, Form, Material, and Texture were selected from the studies of Flurscheim (1983), Manzini (1986), Wong (1993), Gasson (1974), Bevlin (1977), Lefteri (2001), and Danger (1987) (see Section 2.2.3). Some of Texture's members were selected from the workshop results in Appendix B3. Members (Table 5-02) were selected by their distinguishable visual quality and general terms. For instance, there are many different plastics e.g. PP, ABS, Acetate, so the general term plastic was selected as the member name. Members of Users, Places/activities, and Product field were selected from standard market use (Kotler 2000, Doyle 1998, and Lambin 2000; see Section 2.1.5, p.32).

Table 5-02. Categories and members of SPECIFICATION division.

Categories	Material	Colour	Form	Texture
Members	Steel Iron Stainless steel Aluminium Copper Glass Rubber Wood Plastic Ceramic/Porcelain Composite materials Others	Violet group Blue group Blue-green group Green group Yellow group Orange group Brown group Red group Pink group Grey group White Black Others	Natural/organic Man-made Verbal Abstract Calligraphic Geometric Others	Smooth Rough Soft Hard Coarse Regular Uneven Harsh Sensuous Sticky
Categories	**Users**	**Class**	**Places/activities**	**Product Field**
Members	Gender Male Female Age Under 6 6-11 12-19 20-34 35-49 50-64 65+	Upper Uppers Lower Uppers Upper Middles Middle Class Working Class Upper Lowers Lower Lowers	Home Office School Public space Out door Sport Water sport Winter sport Restaurant Others	Electric Domestic Furnisher Transport Medical Toy Others

5.3.2 EMOTION

This division is intended to provide users with a record of their emotional reactions to images. Most images are product images and the vocabularies to express emotions are very varied, so in order to provide an appropriate number of keywords to include different emotions, Desmet's (2002) study of product emotions (see Section 2.1.5, p.32) was adopted. It includes 14 members: Indignation, Contempt, Disgust, Unpleasant surprise, Dissatisfaction, Disappointment, Boredom, Desire, Pleasant surprise, Inspiration, Amusement, Admiration, Satisfaction, and Fascination. In Desmet's study animation graphics were used (see Figure 5.2-01) as these can express the emotions more clearly to users. However, according to Carroll (1964) and Vernon (1962), people's perceptions of images vary. Because the database resulting from this research will use keywords, emotions are represented by words.

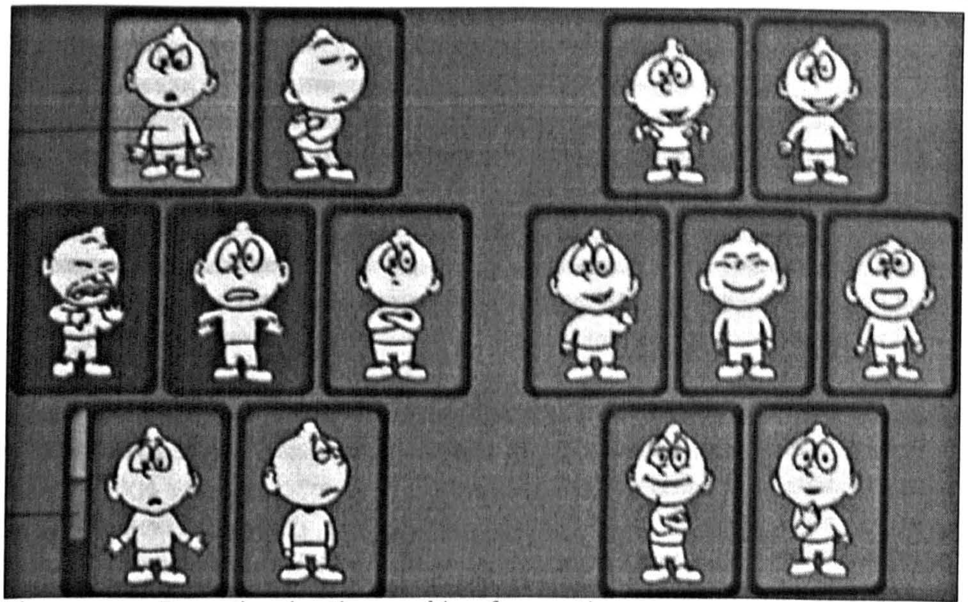


Figure 5.3-01: Desmet's animation graphics of 14 emotions.
Sources: Desmet 2002, p.61

5.3.3 CHARACTERISTIC

Keywords of the CHARACTERISTIC division basically came from interviewed designers' descriptions of products and images. As discussed in Section 5.2.2, CHARACTERISTIC division involves adjectives. Therefore, adjectives were picked up from interviewed designers' descriptions of products and images. There were 120 keywords selected from the interview scripts (Table 5-03). In Table 5-03, there were a few nouns selected because they were used as adjectives.

From a linguistic perspective, the representation of the meaning of a word is called a concept (Seiler and Wannenmacher 1983; see Section 2.2.1, p.35 for detail). In order to classify keywords effectively, they were categorised using their concepts as references (see Appendix D1, p.258). The classification also follows Löbner's (2002) prototype theory (see Section 2.2.1.2, p.38).

The concepts used for the keywords were taken from Roget's Interactive Thesaurus. Usually, a word has more than one concept so the criterion for choosing a concept was general use. For example, ***fantastic*** has concepts of **difference**, **quantity**, and **superiority**; **superiority** was selected.

Table 5-03. Selected keywords from interviews.

50s	Complicated	Fascinating	Integrate	Portable	Soft
60s	Confusing	Fast	Interesting	Pure	Sophisticated
80s	Conservative	Fashionable	Fit	Quality	Special
Adjustable	Contemporary	Friendly	Jewellery	Real	Speed
Appreciated	Cool	Fun	Jumping	Reasonable	Sporty
Attractive	Cosy	Functional	Loose	Recreated	Sticky
Awkward	Cute	Funky	Low tech	Relax	Strong
Balance	Decorative	Genius	Mature	Reliable	Styling
Beautiful	Different	Geometric	Mechanical	Romantic	Substantial
Bizarre	Disappoint	Good	Middle	Safety	Technical
Boring	Dynamic	Great	Modern	Satisfied	Thick
Bright	Elegant	Happy	Mystery	Scrappy	Traditional
Cheap	Energy	Hard	Nature	Semantics	Typical
Cheerful	Engineering	Heavy	Nice	Serious	Ugly
Childish	Ergonomic	High quality	Old	Sharp	Uniform
Classic	European	High tech	Organic	Simple	Unnecessary
Classical	Exciting	Horrible	Original	Simplistic	Valuable
Clever	Expensive	Impressive	Particular	Simulate	Warm
Cold	Fake	Individual	Peaceful	Small	Weak
Comfortable	Fantastic	Industrial	Playful	Smooth	Young

Furthermore, there are a few words whose concepts are not the same in the thesaurus when used in contemporary verbal communication (e.g. ***awkward*** is not suitable for the concept of **inability, difficulty**, and **unsocial action,** when using it to describe a product or design.) On the other hand, there were also emotion words such as **appreciated, funny, happy** etc. which were included. In this selection, in order to distinguish them from EMOTION, they are defined as Feelings.

As discussed in Section5.1 the keywords in Table 5-03 were split into **Subjective** and **Objective**, using the definition from Collins English Dictionary (2001):

- **Objective**:
  1. Existing independently of perception or an individual's conceptions
  2. Undistorted by emotion or personal bias.
  3. Of or relating to actual and external phenomena as opposed to thoughts, feelings, etc
- **Subjective**:
  1. Belonging to, proceeding from, or relating to the mind of the thinking subject and not the nature of the object being considered
  2. Of, relating to, or emanating from a person's emotions, prejudices, etc,
  3. Relating to the inherent nature of a person or thing; essential
  4. Existing only as perceived and not as a thing in itself.

Then they were grouped into second levels such as positive and negative under **Subjective**; physical and behaviour under **Objective**. The sub-level was developed until the groups of keywords fell into the natural groups. As a result, there were ten **Subjective** categories and 22 **Objective** categories (Table 5-04 & 5-05). Some words which were ambiguous, in that they could either be **Subjective** or **Objective**, were re-categorized after the categories had been designed. For example, 'warm' could belong in the **Subjective** category of 'physical sensation', however, it also could belong in the **Objective** category of 'colour features'.

Table 5-04. Categories of **Subjective** keywords.

Level 1	Level 2	Level 3	Keyword
Subjective	Feelings	Physical sensation	Cold Comfortable Cosy Relax Warm
		Liking	Appreciated Simulated
		Specificity	Different Individual Particular Special
		Interestingness	Interesting Exciting
		Kindness	Peaceful
	Positive	Beauty	Attractive Beautiful Cute Fascinating
		Superiority	Classic Clever Fantastic Cool Impressive Great Genius
		Quality	Good Nice High-quality
		Happiness	Happy Fun Cheerful Satisfied Recreated Playful
	Negative	Negative	Awkward Bizarre Boring Disappoint Horrible Ugly Weak Unnecessary Confusing

Table 5-05. Categories of **Objective** keywords.

Level 1	Level 2	Level 3	Level 4	Keyword
Objective	Physical	Visual features	Simplicity	Simple Simplistic
			Complexity	Sophisticated Complicated
			Formality	Ergonomic Semantics Geometric
			Stylishness	Fashionable Elegant Styling Funky
			Masculinity	Energy Sporty Technical Engineering Mechanical Industrial
			Femininity	Romantic Jewellery Decorative
			General	European Dynamic
			Unstylishness	Typical Conservative Uniform
			Period	50s 60s 80s Traditional Modern Classical
		Functional features		Adjustable Portable Friendly Functional
		Colour features		Pure Warm Bright
		Physical features		Small Middle Thick Heavy
		Texture features		Sticky Hard Soft Jumping Smooth Sharp
	Behaviour			Childish
	Value			High-tech Low-tech Quality Reasonable Reliable
	Price			Cheap Expensive
	Status	Age		Young Old Mature Contemporary
		Importance		Substantial Valuable Serious
		Components		Balanced Loose Integrate Fit Scrappy
		Origin/source		Original Natural Organic
		Safety/stability		Speed Fast Safe Strong
		Miscellaneous		Real Fake

Furthermore, these categories also relate to the model of the product designer's work (see Section 5.2, p.143) Figure 5.3-02 shows how the **Objective** categories represent the values of the features and characteristics of products and the **Subjective** categories emanate from the **Objective** features.

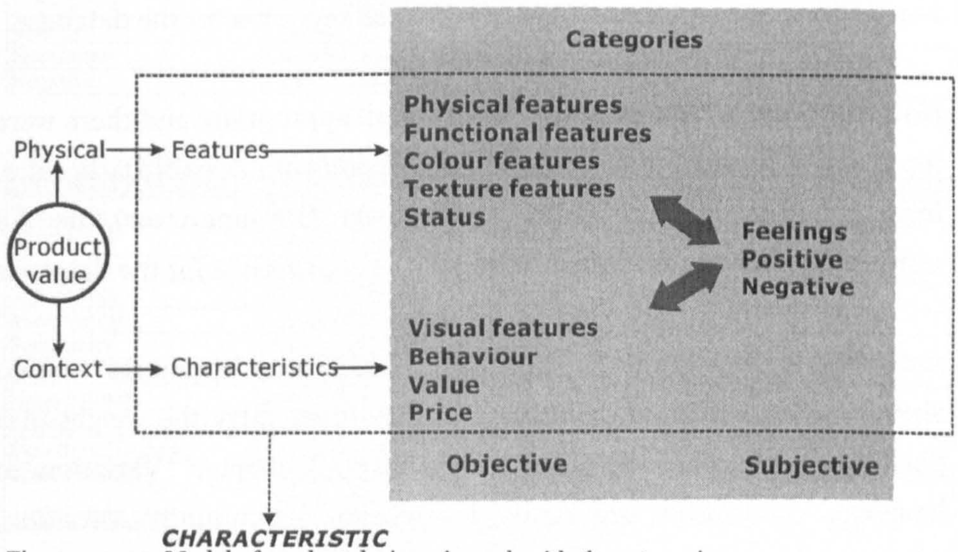


Figure 5.3-02: Model of product designer's work with the categories.

The categories in Table 5-06 (taken from Table 5-04 & 5-05) were also tested against another collection of keywords. These were taken from Kuno's (1999) *Colours In Context* list of "Image words". And it was found that 47 of the interview keywords matched Kuno's keywords.

Table 5-06. Categories of CHARACTERISTIC division.

Physical sensation	Complexity	Texture features
Liking	Formality	Behaviour
Specificity	Stylishness	Value
Interestingness	Masculinity	Price
Kindness	Femininity	Age
Beauty	General	Importance
Superiority	Unstylishness	Components
Quality	Period	Origin/source
Happiness	Functional features	Safety/stability
Negative	Colour features	Miscellaneous
Simplicity	Physical features	

"Image words" are Kuno's description of sensations to stress the commonality and universality of the names of 658 colours under 56 themes. These themes include literature, art, music, handicraft, celestial bodies, nature, daily life etc. and are similar to Danger's (1987) colour attributes.

Danger (1987) proposed that colour could represent attribute such as age, personality, sex, size, mood, markets, etc. which are similar to the PRODUCT and NON-PRODUCT context information types in the 'Structure of image classification' (see Figure 5.2-03). Dangers' work, therefore, provides a further link between Kuno's "Image words" and the categories identified from the interviews (Table 5-06). Consequently it was decided to adopt these "Image words" as keywords for the database.

However, Kuno's "Image words" were not all appropriate and there were too many of them (538 words). In a discussion with Martin Darbyshire, from Tangerine Product Direction and Design (2nd supervisor), the 538 words were down to 146 which were seen as appropriate for the database.

According to Bouillon and Busa (2001), words have 'meanings' that go above and beyond their definitions as they often carry the weight of a person's own experience. Also Trask's (1995) chapter "Variation in language" addressed geographical variation, community variation, educational background variation, and sex and gender, which affect the use of vocabularies. The choice of vocabulary is highly variable, even when people try to deliver the same concept. As a consequence, deciding on the number of keywords for the developing system was problematic. As the database focuses on providing organised, design oriented image storage, the provision of a well-structured, image context relationship with products is more important than seeking to define keywords. As these can be expanded later, therefore, the prototype for the image database was set to provide keywords collected from the interviews results (120 words) and Kuno's "Image words" (146 words).

Tables 5-07 and 5-08 are the results of categorising "Image words". The categories cover the large majority of words but those which fell outside, and did not warrant additional categories, have been group under 'Miscellaneous'. Moreover, Kuno's keywords did not include words appropriate for two categories ('Age', 'Safety/stability').

Table 5-07. Categories of **Subjective** "Image words".

Category	Keyword
Physical sensation	Aromatic Comfortable Emotional Fragrant Moist Relaxed Silent Wild Tasteful Spicy Tangy Tranquil
Liking	Admirable Affable Alluring Gentle Sweet
Specificity	Distinctive Dramatic Unique Thorough
Interestingness	Precious
Kindness	Calm
General	Indifferent
Beauty	Beautiful Pretty
Superiority	August Clever Dandy Excellent Exciting Exquisite Innovative Powerful Smart Wonderful Witty Wise
Quality	Classic
Happiness	Cheerful Delicate Graceful Happy
Negative	Grim Strange Vague

Table 5-08. Categories of **Objective** "Image word".

Cateogry	Keyword
Simplicity	Earthy Plain Simple
Complexity	Complex Complicated Elaborate
Formality	Technical
Stylishness	Chic Cool Elegant Fancy Funky Gaudy Refined
Masculinity	Animated Masculine
Femininity	Decorative Feminine
General	Dynamic Nostalgic Rhythmical Sporty
Unstylishness	Antiquated
Period	Fresh Youthful Traditional
Functional features	Friendly Open Supple
Colour features	Bright Cold Glittering Hot Light Pure Radiant Warm Vivid Transparent Translucent
Physical features	Dense Firm Fit Hard Heavy Humorous Sharp Shiny Small Solid Still Vast Straight
Texture features	Coarse Rugged Smooth Soft
Behaviour	Active Aggressive Confident Discreet Docile Easygoing Ingenuous Quiet
Value	Valuable
Price	Opulent Rich
Age	
Importance	Dignified Influential Prestigious Serious Substantial
Component feature	Orderly
Origin/source	Ethnic Natural Organic Original Radical Primitive
Safety/stability	
Miscellaneous	Absolute Airy Assured Authentic Balanced Basic Clear Clean Explicit Healthy Immaculate Obvious Precise Refreshing Robust Rustic Visionary Sure Volatile

5.4 Conclusions

The interviews and workshop showed that the information an image can convey includes tangible and conceptual information. Perceptions of the information were divided into subjective and objective responses. By taking language analysis and image analysis as the starting point, three information divisions were established to provide a structure for recording image keywords. These are SPECIFICATION, EMOTION and CHARACTERISTIC and each division has its own categories and keyword members. The keyword members of the SPECIFICATION and EMOTION division are selected from the literature search. The keyword members of the CHARACTERISTIC divisions were collected from interviews and Kuno's (1990) *Colours In Context*.

The proposed database was developed using these three divisions as a structural framework. It reflected Eakins and Graham's (1999) indications of images' attributes (see Section 2.3.1, p.51).

Chapter 6
Image database development

6.1
Introduction

As described in the previous chapter, the database development aims to provide designers with an organized image database. The development is based on the model of three information divisions: SPECIFICATION, EMOTION, and CHARACTERISTIC. The name 'ImageNexus' has been given to the database.

6.1.1 How does the database work

ImageNexus is used to store images and associate them with keywords in the categories provided. By using this structured database, designers can later search the images in a more accurate way. For example, the designer could search for products made of 'wood', which represents 'happiness'. Although there are other ways to search images for 'wood' and 'happiness' using, for example, indexing practice which relies largely on text descriptors or classification codes (see Section 2.4.2, p.72). However, this method does not facilitate finding the image whose contents represent a 'happy' 'wood' product as product designers might require. Because ImageNexus will be developed around the three information divisions, it can provide the optimum results.

The system will benefit designers by enabling them to optimise their use of an image, because it will show all the possible information required from a product design point of view. Also, the lists of keyword members can assist designers in using the power of words to enhance the value of an image. For example, if an image is defined as 'happy'; it may also be defined by other keywords in the same category as 'happy', such as 'cheerful'. Although it may take more time to define an image, it will benefit designers when, for example, they need to show images to their clients because it will assist ensuring the most appropriate image are used.

6.1.2 System development requirements

In order to provide product designers with an appropriate database, the development of ImageNexus was an interactive design process. Over a period of two years, four versions of database were created. The creation of each version was followed by an evaluation of its strengths and weaknesses. Following this trial-and-error approach, improvements were made to each new version to correct the flaws identified in the previous version.

The requirements that needed to be met by ImageNexus were defined before the development process was started. However, some requirements emerged and crystallised during the development of the first three versions. The 'early' versions were designed to meet the following requirements.

1). To meet interface design principles in Section 2.4.2;
2). To provide functions which define images by using categories;
3). To provide the facility to record extra information from the images in free text;
4). To provide search methods based on both categories and free text.

During the development process, and on the basis of the conclusions drawn from evaluating the final three versions of ImageNexus, further requirements were formulated:

a). Direct display: in order to reduce the time spent in defining an image, the subcategories provided should be directly displayed in the first place;
b). Provision of brief online instructions for each function.

6.2 Database development

6.2.1 Database model

As described in Section3.4.1, the database development was based on the Entity-Relationship Model (ERM) (Figure 6.2-01). Every single image has its attributes and it also has relationships with other images.

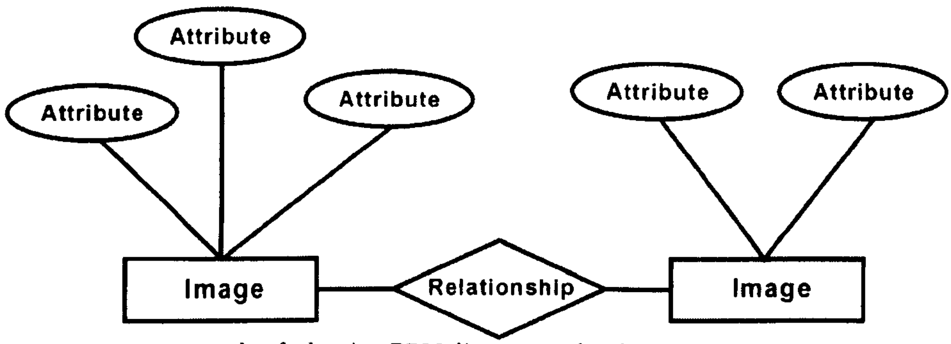


Figure 6.2-01: A sample of adopting ERM diagram to develop ImageNexus.

The database is used to define images and search images by the relationship based on three information divisions. The fundamental functions of this image database are defining (sorting/recording) images and searching images.

a). Defining an image

The functions provided to define an image are based on the research outcomes with keyword categories in three divisions: SPECIFICATION, EMOTION, and CHARACTERISTIC. It was established that these categories should always be displayed on the screen. The database should also have an extra division for the user to record the image's source details.

b). Search

The design of the search page should be the same as that for the image definition page in order to reduce confusion. The search function keeps the traditional search method of keywords. However, there are two ways to search. Either by entering words directly into the search box or by selecting from the categories provided.

6.2.2 Interface design

In Figure 6.2-02, 6.2-03, 6.2-04, the interfaces of ImageNexus concepts are shown in development. These first three designs were used to find which display method was most suitable for providing information and working fast and intuitively. Each of the three interface designs was briefly explained and its advantages and disadvantages are discussed with two experts (one studied a descriptive framework for type forms with a computer based application; the other one is a professional web designer who is responsible for the research and design direction of Web Design for Business (2001))

6.2.2.1 ImageNexus-1

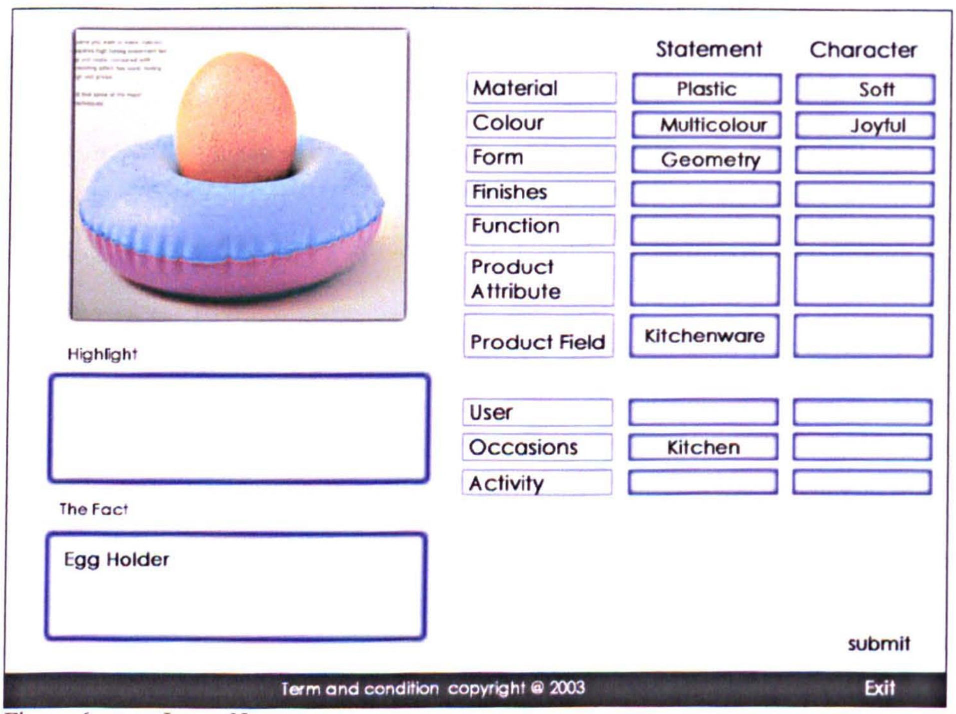


Figure 6.2-02: ImageNexus-1.

At the early stage of this research (and after the survey of existing database Section 2.3.2, p.54), it was decided to provide categories to define images. ImageNexus-1 (Figure 6.2-02) provides columns to record the statement and the character of material, colour, form, and so on. The interface operates in a 'pop up' fashion: choices of statements (properties) and characters are made visible by scrolling the mouse pointer over the cells. The advantage of ImageNexus-1 is that the image is large and clear. The disadvantage is that 'Highlight', 'The Fact', 'Statement', and 'Character' are presented in the same style of frame, even though their operations are different. This causes users confusion.

6.2.2.2 ImageNexus-2

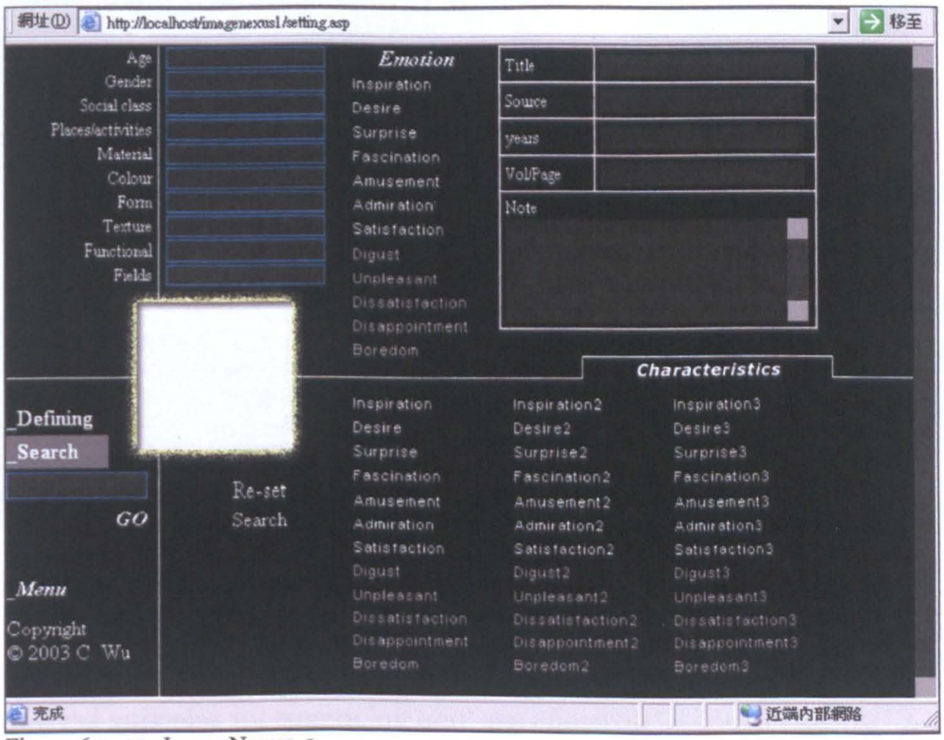


Figure 6.2-03: ImageNexus-2.

This version of the database (Figure 6.2-03) was the first that was developed after the three information divisions had been made. A 'pop up' function is used to choose members of age, gender, social class, material, and so on. EMOTION and CHARACTERISTIC members are displayed directly on screen as 'active words': each word can be selected or un-selected. Although this version has used a different format to present different functions, the disadvantages are:

a). The extra information part (the table in the top right corner of Figure 6.2-03) takes up too much space.

b). The background axes are too confusing.

c). Headings are not consistent, because it is difficult to know what belongs to headings 'EMOTION' and 'CHARACTERISTIC'.

6.2.2.3 ImageNexus-3

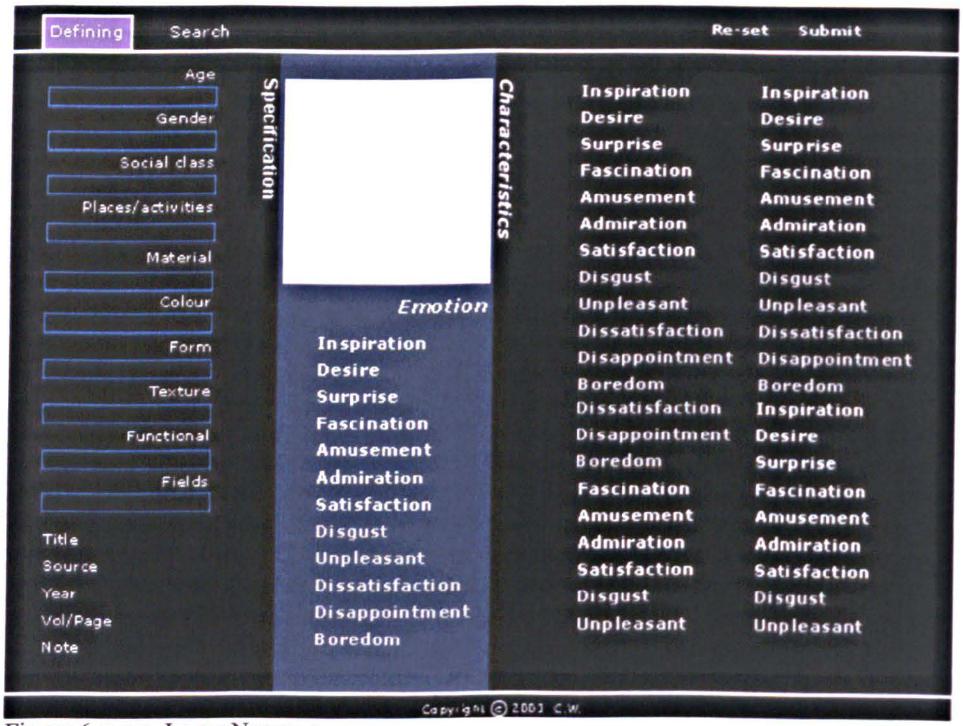


Figure 6.2-04: ImageNexus- 3.

In this version (Figure 6.2-04), the way of displaying categories and members is the same as ImageNexus-2. The SPECIFICATION and CHARACTERISTIC divisions use 'pop up' menus for selecting keywords; the EMOTION division uses 'active words' for selecting keywords. The difference is that ImageNexus-3 has a coloured section in the middle to distinguish different divisions. However, professionals suggested that the titles of the divisions should be presented in a more consistent way, and the same functions should be presented in the same way.

6.2.2.4 Final version

The final version of ImageNexus is shown as Figure 6.2-05. Firstly, this version meets the interface design principles: the information can be directly accessed, it is simple and consistent (Lynch 2001), it uses serif or sans serif font (Tetrarch 2002 and Lynch 2001), and bright or highlighted colours for emphasis (Galitz 2002). Secondly, the three information divisions are presented in the same format and operated in the same way. Finally, it has instructions to show how to operate the database.

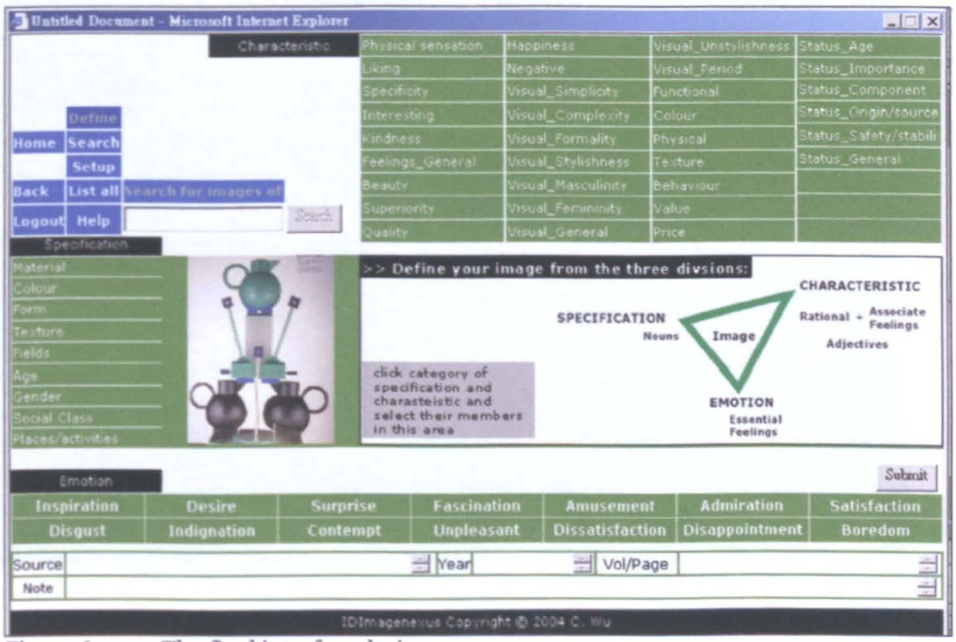


Figure 6.2-05: The final interface design.

6.2.3 ImageNexus in detail

The structure of ImageNexus is shown as Figure 6.2-06. There are three functions included: Define, Search, and Set-up. And it opens with a home page as Figure 6.2-07.

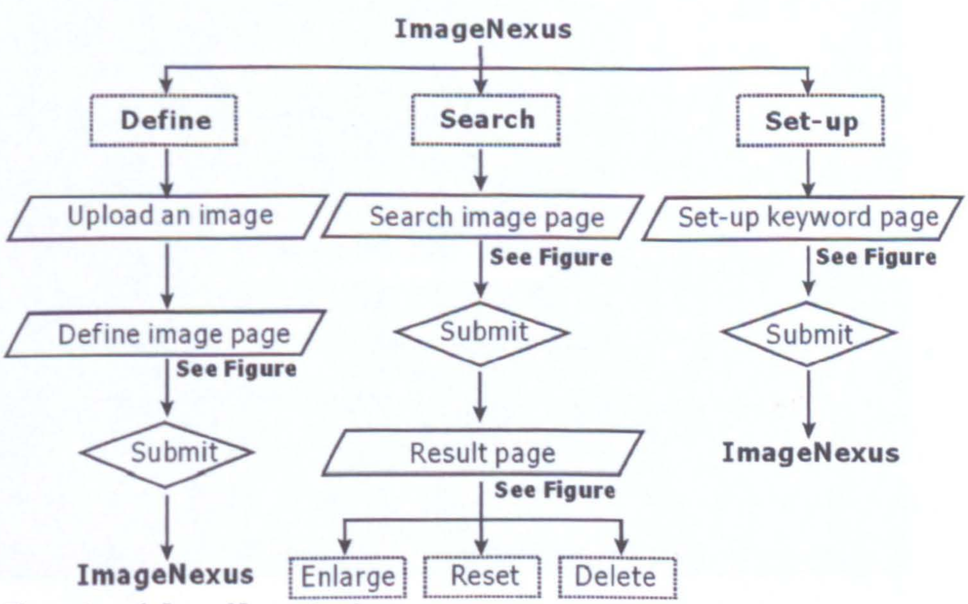


Figure 6.2-06: ImageNexus structure.

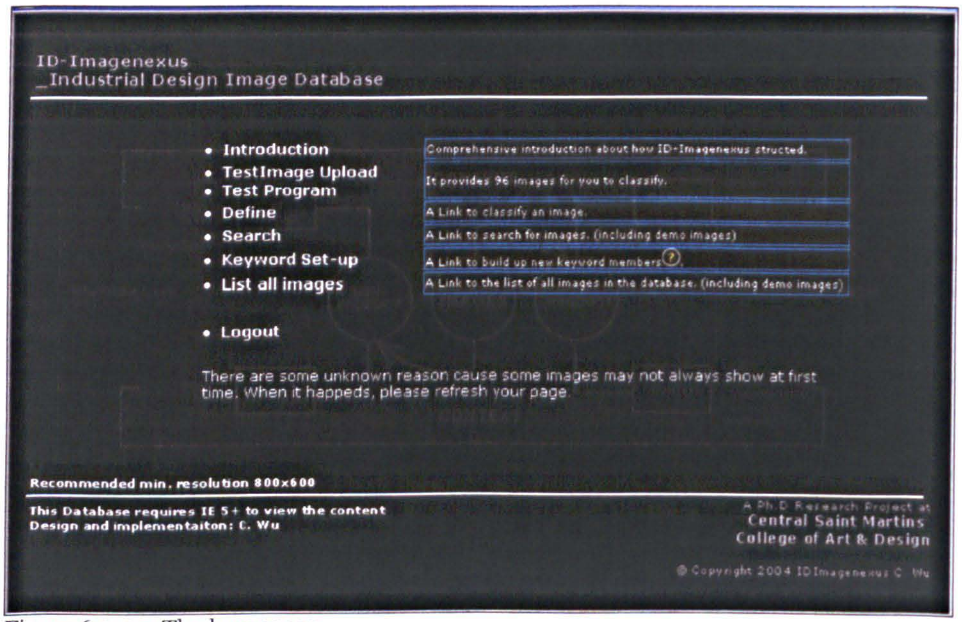


Figure 6.2-07: The homepage.

6.2.3.1 Define

This function is to record features of an image for future use. First it needs to upload a JPG format image file within 100K bytes. The upload page is shown as Figure 6.2-08. The limitation of file format and size are to reduce the running time of the database.

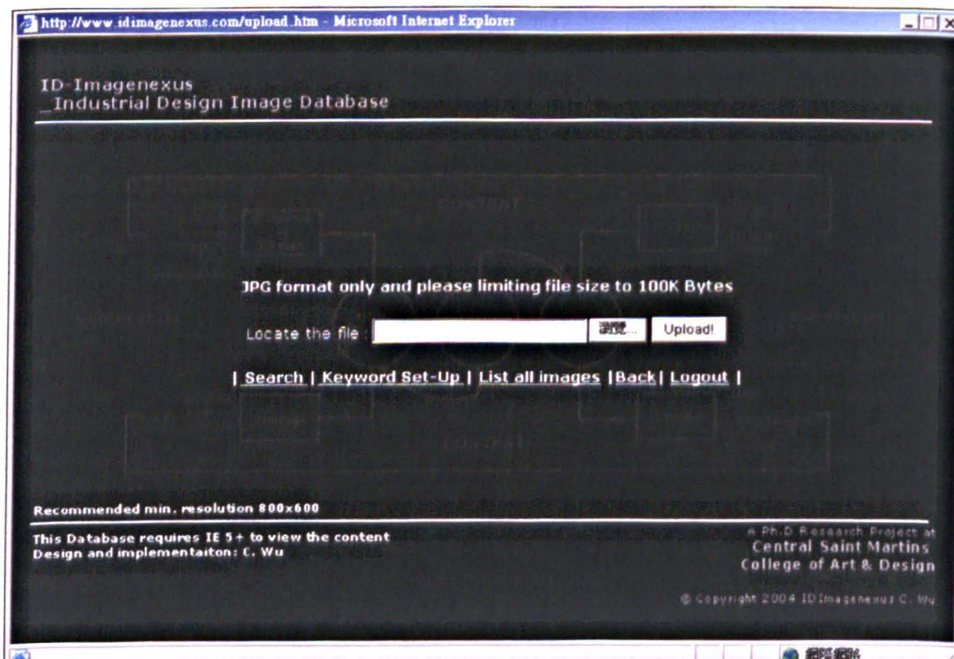


Figure6.2-08: Interface of upload image page.

Then the upload page leads to the main image-defining page as Figure

6.2-05. It can be seen from this screenshot that help is provided in the use of the page. Figure 6.2-09 explains the screen's five areas, they are:

a). Zone A

This contains categories of the CHARACTERISTIC division. When one of the categories is selected, its members will show up in Zone D.

b). Zone B

This contains categories of the SPECIFICATION division. When one of the categories is selected, its members will be shown up in Zone D.

c). Zone C

The image is shown in Zone C.

d). Zone D

This shows one category's members when one of the categories of the SPECIFICATION or CHARACTERISTIC division has been selected.

e). Zone E

This shows members of the Emotion division.

f). Zone F

This is designed to allow users to add additional information about an image, such as the source of the image.

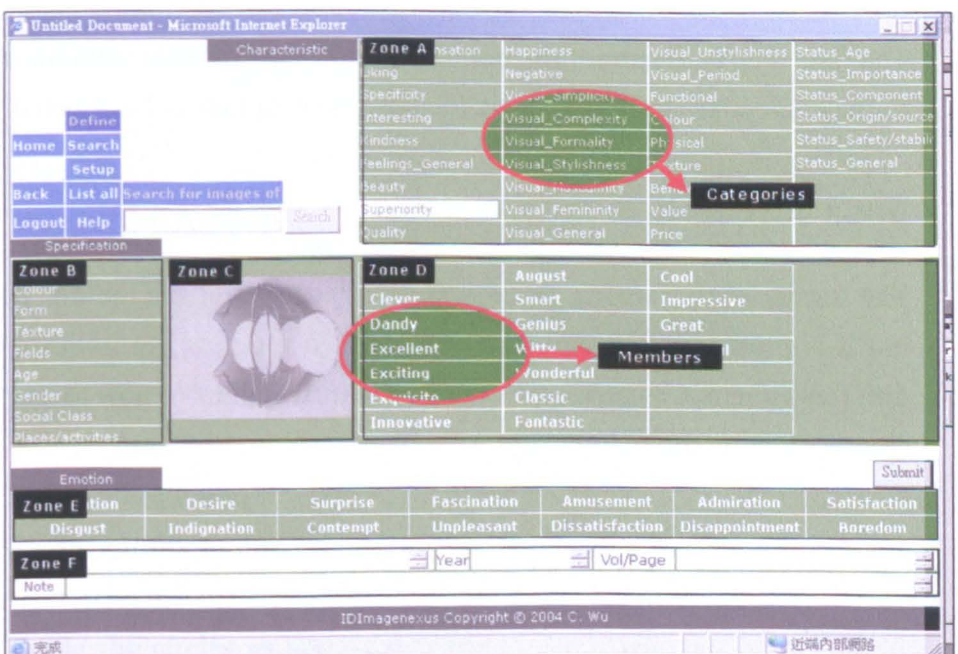


Figure 6.2-09: Interface format of define page.

When a category is selected, ImageNexus uses different colours to show the category's state. As shown in Figure 6.2-10, when the category of SPECIFICATION or CHARACTERISTIC is shown in dark green, it means its members have been selected to define the image. But when the category of SPECIFICATION or CHARACTERISTIC is shown in white, it means the category's members are now shown in Zone D.

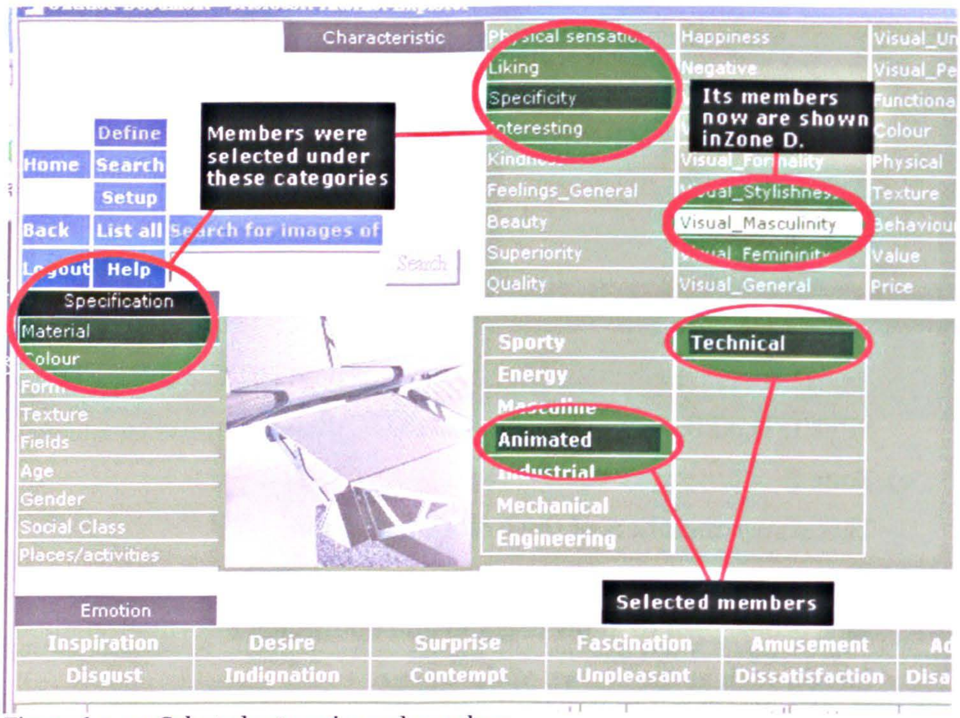


Figure 6.2-10: Selected categories and members.

The final step is to submit the definitions and the interface will link back to the homepage as Figure 6.2-07 to allow the next task to be selected.

6.2.3.2 Search

The format of the 'search' page is the same as that of the 'define' page, but it is presented in a different colour (Figure 6.2-09) to indicate the different function. Figure 6.2-11 shows the instructions of how to use the search when on the search page.

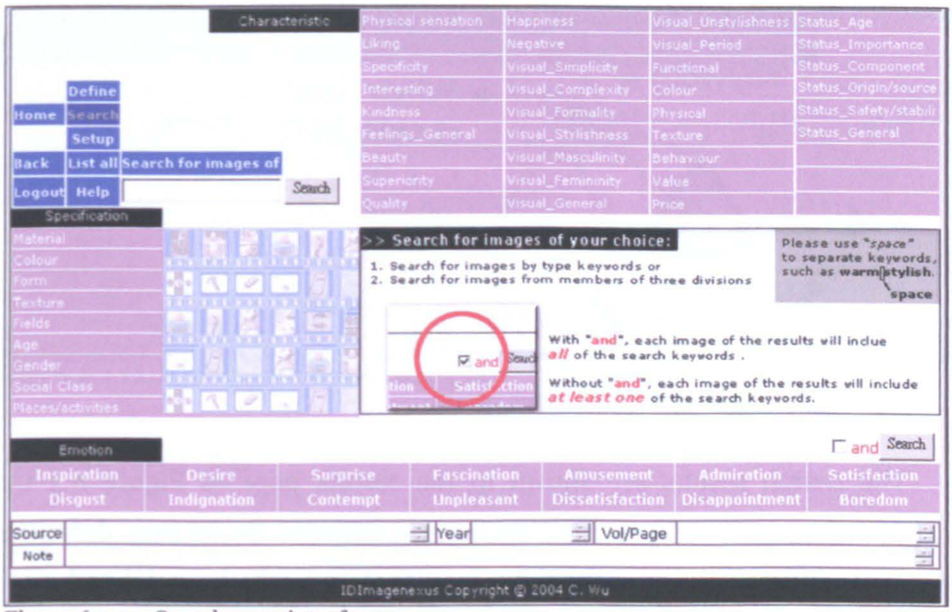


Figure 6.2-11: Search page interface.

There are two ways to carry out an image search. One is to type keywords in the 'search' box (see Figure 6.2-12) and this function is the same as any general search function on the Internet. The other is to use the interface to do a search, which operates in the same way as the define page.

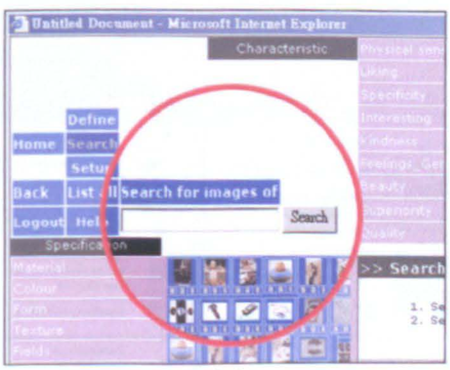


Figure 6.2-12: Search box.

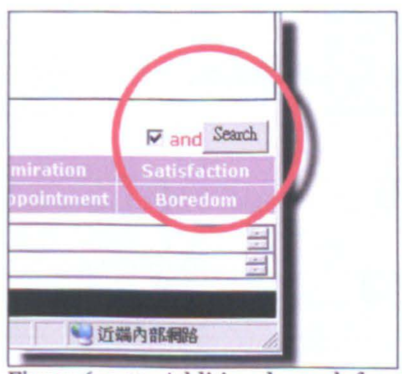


Figure 6.2-13: Additional search function.

An additional search function 'and' (Figure 6.2-13) is provided to allow search results to meet all the keywords. For example, if three keywords were selected, normally the search results would be the areas covered inside the circles as shown in Figure 6.2-14. However, when the 'and' function is selected, the search results are only in the overlapping area.

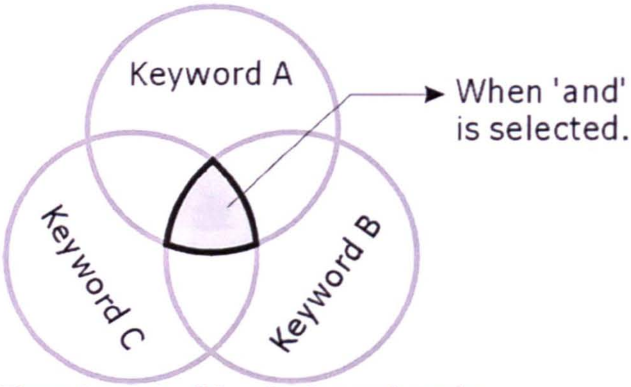


Figure 6.2-14: 'and' function in search results.

The search results are shown in the results page as Figure 6.2-15. It directly shows all the search results and includes the images' definitions. It also allows each image to be redefined, refreshed, or deleted. Figure 6.2-16 shows how to operate the 'redefine', 'refresh', and 'delete' functions. The 'refresh' function is used to recall the images which did not appear the first time. Images also can be enlarged by double clicking on them.

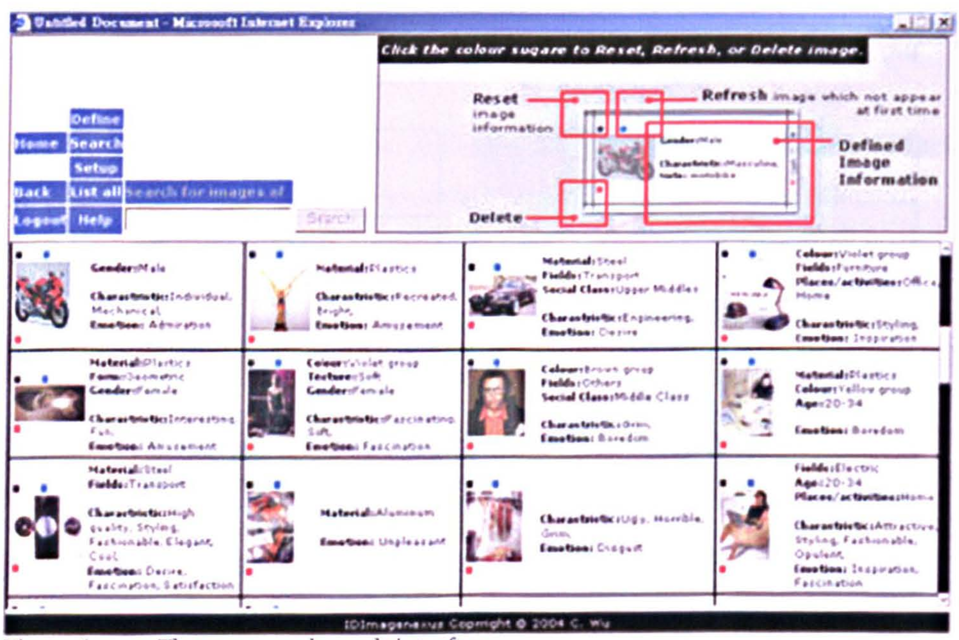


Figure 6.2-15: The new search result interface.

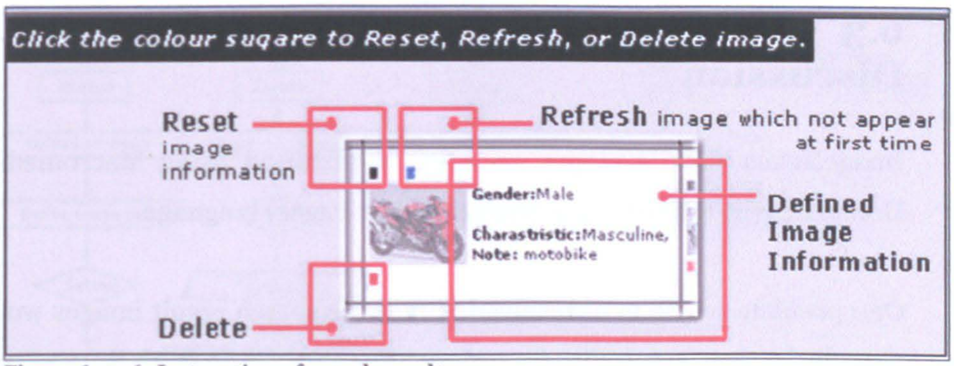


Figure 6.2-16: Instruction of search result page.

6.2.3.3 Set-up

The 'set-up' page is for adding new keywords to the SPECIFICATION and CHARACTERISTIC divisions. In Figure 6.2-17 Zone A_C and Zone A_S are categories of SPECIFICATION and CHARACTERISTIC. Zone C shows members of a selected category. Keying in new members into the empty box (see Figure 6.2-18) would add new members.

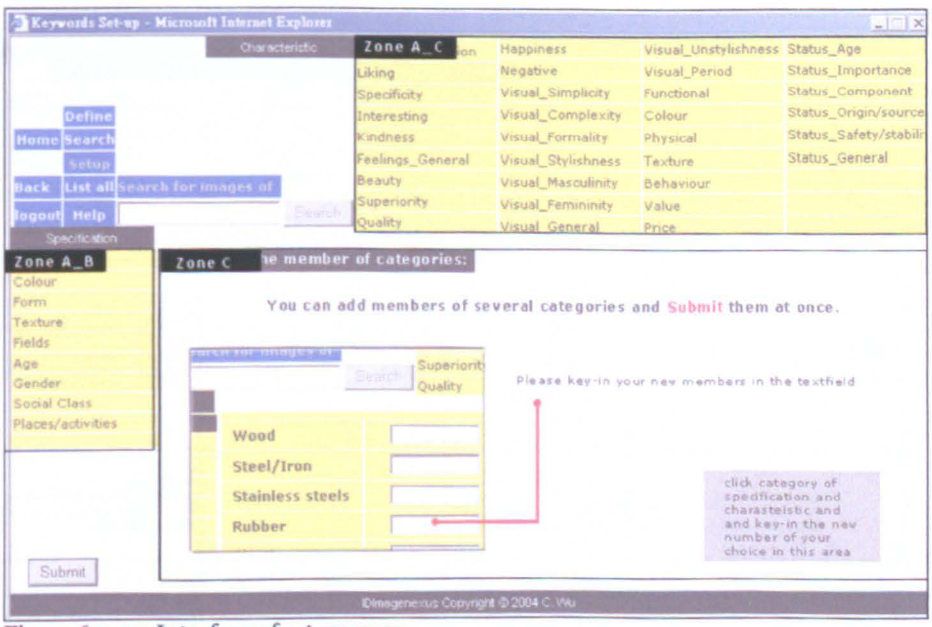


Figure 6.2-17: Interface of set-up page.

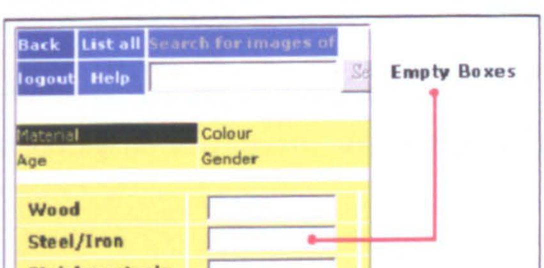


Figure 6.2-18: Empty boxes for keying in new members.

6.3 Discussion

ImageNexus was developed on a PC workstation using Macromedia's Dreamweaver MX with ASP (Active Server Pages) language.

One problem which is unresolved is that the search result images would not all be presented the first time. Therefore a refresh button was provided to re-call the image (Figure 6.2-16).

ImageNexus also would not work on the Netscape browser and Mac systems. This was caused by the new "layer" function of Dreamweaver MX. This function was not integrated with other browsers at the time of system development. This problem came to light in the finishing stage of system development. The system was not changed as evaluation on PCs is still possible.

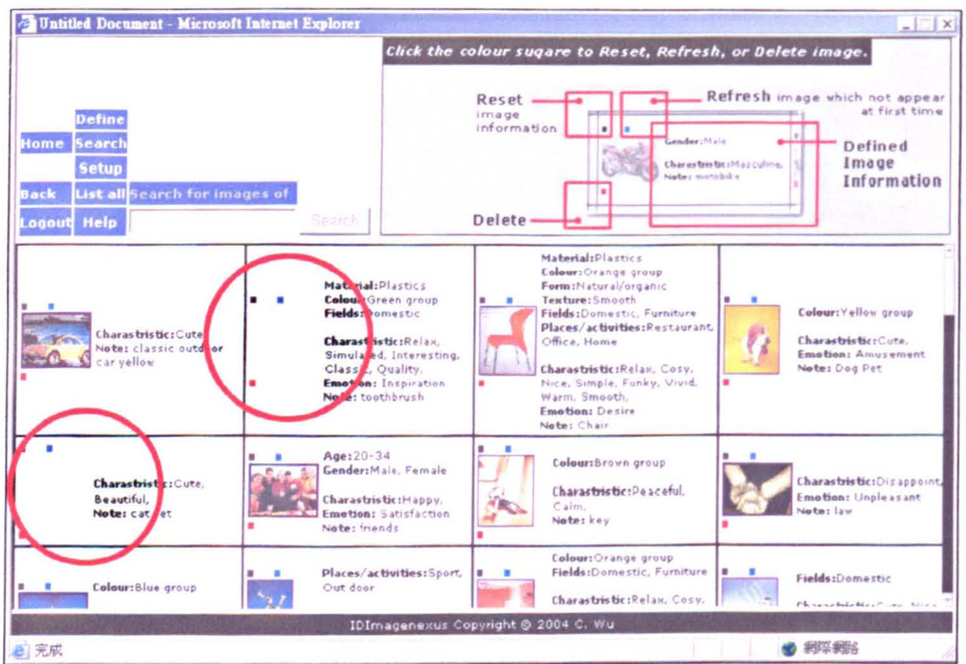


Figure 6.3-01: Missing images in result page.

The "list all image" function was added in order to provide an overview of existing images in the database. The new structure of ImageNexus is as Figure 6.3-02.

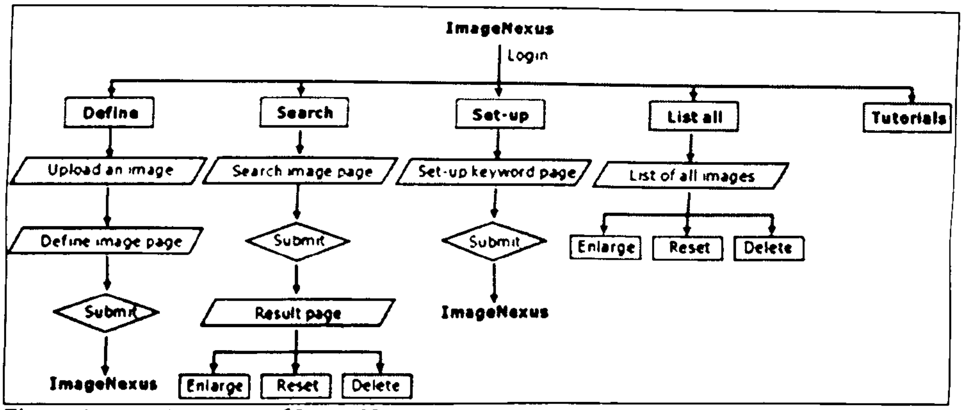


Figure 6.3-02: Structure of ImageNexus.

The fundamental functions of the system are to define and search images. The interface design focuses on following the guidelines identified during the literature search. It could be improved significantly with more user testing and information technology support to provide additional features, such as a simultaneous demo or explanation of each function. Because this research is concerned with constructing the relationship between keywords and images within the product design process, user evaluation did not involve the interface design in either the graphic aspect or interaction aspect. However, a usability evaluation which focused on users' understanding and acceptance of the system was required.

Chapter 7
Image database evaluation and discussion

This chapter describes the evaluation of the ImageNexus database, which indicated that it provides appropriate image storage facility for product design use. The prototype was acceptable to evaluators, although it will require some professional work on the system development detail before it is ready for extended trials. It was anticipated that during evaluation workshops, users would comment on the number of keywords being too great. However, the outcome of the workshop was that the number and classifications of the keywords was deemed to be appropriate and comprehensible.

7.1
Strategy for evaluation

This section describes the process used for evaluating ImageNexus. It is divided into four sections. Firstly, methods of evaluation are described; secondly, the aim of evaluation is explained; the third section focuses on the questionnaire design and finally, describes the participants and the procedure for evaluation.

7.1.1 Methods of evaluation

In order to examine the usability of ImageNexus and test the understanding of the use of the three-division model to define images, an evaluation is needed. According to the literature review, usability test and expert review are the most popular methods of examining an application. Web Design for Business (2001) suggests that usability tests need between five and ten people who are representative of intended users of the site, but are not familiar with the project, for an hour (see Section 2.4.3, p.75). These users should be asked to try to achieve certain goals which are typical of the user goals the site has been designed to facilitate.

Therefore it was decided to run an evaluation workshop with five to ten people who had product design backgrounds. They would be asked to carry out some tasks and their actions would be observed. In addition, professional product designers were asked to act as expert examiners, working from their offices.

7.1.2 Aims of evaluation

The aims of ImageNexus evaluation were:

1. To evaluate the user's understanding of the design of database interface;
2. To evaluate the user's understanding of the system structure;
3. To evaluate the user's understanding of the categories and the three divisions;
4. To evaluate the value of the database.

In order to achieve these aims, observation of users' operations and a questionnaire were included with tasks in the evaluation workshop. Observation was by watching how participants moved their mouse between categories when carrying out set tasks. The focus was on the initial mouse movements made by the user, in order to understand what their first target information division was and to compare their operation with the results of the questionnaire.

7.1.3 Questionnaire design

The questionnaire (Table 7-01) was designed to achieve two targets:

1. To comply with usability evaluation principles (see Section 2.4.3, p.75);
2. To meet the aims of evaluation.

Heather and Stone (1988) suggest that a closed questionnaire can be used when the questions to be asked are relatively simple and unequivocal and it is easy to analyse. Open questions are used to allow and encourage respondents to give their opinions fully (Heather and Stone 1988). It was therefore designed as a multiple choice closed questionnaire plus some open questions to collect users' suggestions. There were 10 closed questions designed for the evaluation, and two open. In addition participants were invited to comment on the closed questions.

Table 7-01: The questionnaire questions.

Q1	Introduction to ID-Imagenexus is Clear/ Not clear
Q2	The three divisions of image information are Adequate/ Inadequate
Q3	The information provided for defining an image is Good/ Sufficient/ Poor
Q4	Which division is the most useful to define images? Specification/ Characteristic/ Emotion/ Additional Notes
Q5	Is the characteristic division comprehensible to you? Yes/ No
Q6	Is it easy to find the right keyword? Yes/ No
Q7	Is it a useful application for you? Yes/ No/
Q8	Which division did you use the most to define a search? Specification/ Characteristic/ Emotion/ Addition Note/Search Box
Q9	Was it easy to define a search? Yes/ No
Q10	Was the search result sufficient? Yes/ No
Q11	What kind of additional information would you need to better understand the divisions?
Q12	What additional categories or members do you suggest adding?

7.1.4 Participants and procedure

Eight postgraduate students (who had at least one-year experience) and five professional designers participated in the evaluation because they were accessible and they were interested in taking part. Five students attended the workshop (Figure 7.2-01) and one professional designer also participated in the same format. The other three students and four professional designers evaluated the system via the Internet and their evaluations were obtained by email and telephone. The times they spent on the system were recorded each time they logged in and out. The participants were:

1. Five MA Industrial design students at Central Saint Martins College of Art & Design, UK
2. Three MA Industrial design students at Sheffield Hallam University, UK
3. Five professional product designers

MA students (CSM) Workshop:

This took around 2 hours. Five participants were asked to define the images provided for up to 90 minutes, to search images and to complete questionnaires. A brief induction was given before the workshop started. Instructions were provided on both screen and paper. The database was operating on a remote host and each participant was given a unique identity number in order to record their results separately. As a reward, each participant could choose to have a copy of the system when the research is finished.

Procedure:

1. Define images provided (within 90 minutes);
2. Follow instructions to search images (see Appendix E2, p.263);
3. Answer Questionnaires.

MA students (SHU):

These participants evaluated the system via the Internet but otherwise their procedures were the same as the evaluation workshop with CSM MA students.

Professional product designers:

Professional product designers were treated as expert evaluators. They were able to try the system and complete their evaluation within a month. Each was given the ImageNexus web address and a unique identity number.

Figure 7.1-01: Workshop photographs.

7.2 Analysis

7.2.1 Anticipated problems

A number of factors that would be likely to affect the evaluations were taken into account before the analysis.

1. The amount of information for the first time user
   There are 56 keyword categories on the screen. They are all necessary to cover the range of images for product design use. When the system becomes more familiar to users the usability will increase; however, first time users may feel too much pressure.

2. Time pressure
   The participants would need to spend more than an hour on the evaluation. They would need to repeatedly browse the categories to finish the task. It was anticipated that they would feel pressure during the evaluation. Additionally, the images provided might not interest every participant and they might become bored.

3. Interface design preference
   The interface design was function oriented. Its design and operation were limited by the author's information technology skills. Also the participants are designers, therefore they may be more critical abut the interface than other professionals.

7.2.2 Observation of participants

In the evaluation workshop, the participants read the instructions very carefully before they started their evaluation. At the start of the workshop, the participants worked slowly because they tried to define all the categories within the SPECIFICATION division. They went through each category and its members and they recorded all the physical details of the images. It was then explained that they do not need to go through all the categories. Their operations were more intuitive after the demonstrations and explanations. The differences are shown in Figure 7.2-01 and 7.2-02. Figure 7.2-01 shows that nine categories in SPECIFICATION division are defined. And Figure 7.2-02 shows that there are only five categories (material, fields, age, social class and places/activities) for the left image and three categories (colour, age and gender) of the right image.

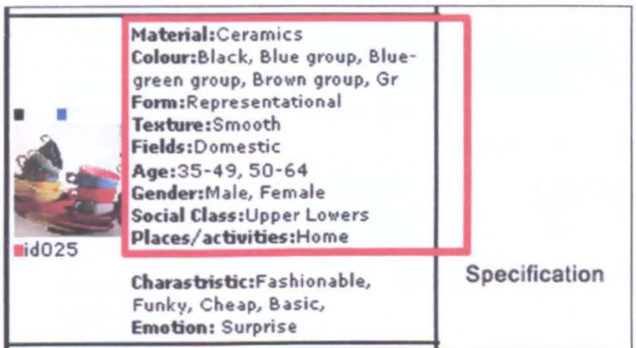


Figure 7.2-01: Classification record of participant 'Id025' before demonstrations and explanations.

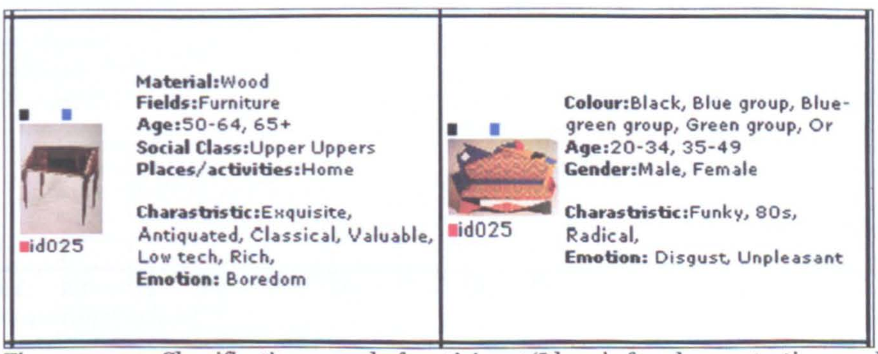


Figure 7.2-02: Classification record of participant 'Id025' after demonstrations and explanations.

Figure 7.2-01 shows that the participant defined all the categories in SPECIFICIATION division. Figure 7.2-02 shows that the participant defined the categories needed in SPECIFICIATION division after explanations. Figure 7.2-02 also shows the ideal purpose of ImageNexus.

7.2.3 Analysis

The overall of the evaluation questionnaire are shown in Figure 7.2-03 and Table 7-02.

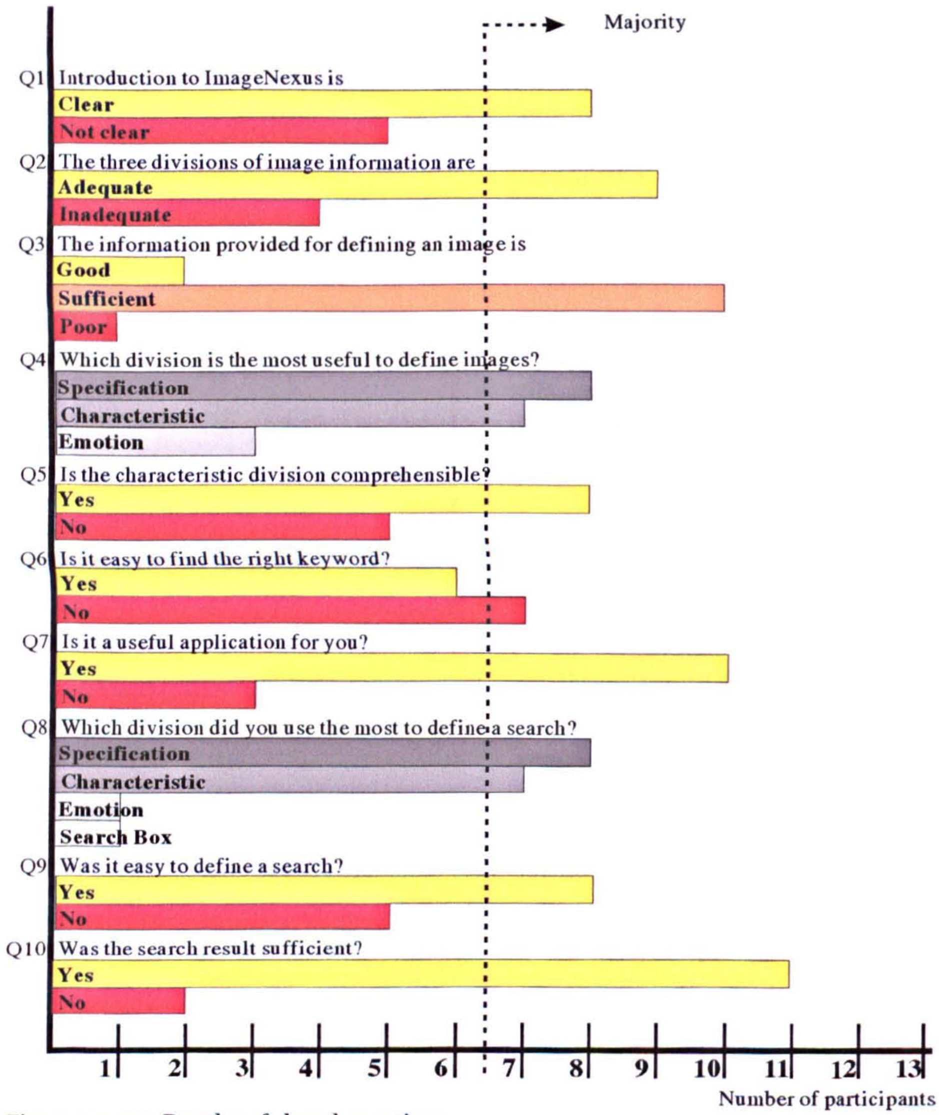


Figure 7.2-03. Results of closed questions.

Table 7-02. List of comments from evaluations.

Q1	Introduction to ID-Imagenexus is				
Clear	62%	Not clear	38%		
Comments: words not clear on categories table confusing when you don't pay attention; too long; have demo clarify better the actual intention of the database; not very intuitive too complex It needs a clear one paragraph summary of what it does and who it is for. maybe too many words, the designers will have no patience to read that. seems quite detailed which could be good					
Q2	The three divisions of image information are				
Adequate	69%	Inadequate	31%		
Comments: emotion is unnecessary it's great that you can personalise the categories a lot of repetition of words too complicated- less categories needed emotional is quite tricky because is very related to the mood of the user too many choices too complex too many keywords to get confused by encouraged me to think in detail about my responses to the image					
Q3	The information provided for defining an image is				
Good	85%	Sufficient	7.5%	Poor	7.5%
Comments: much too many categories but need to be simple sometime I wanted more negative adjectives images could be larger I found some adjectives are quite similar and some are never used. personalisation and flexibility is good					
Q4	Which division is the most useful to define images?				
Specification	44%	Characteristic	39%	Emotion	17%
Additional Notes	0%	Search Box	0%		
Q5	Is the characteristic division comprehensible to you?				
Yes	69%	No	31%		
Comments: too many categories, categories not clear, some characteristics are double some of the categories are confusing; I would have positive and negative quality mostly but some are limited the titles are not comprehensible but is a bit messy; I believe because it's the first time difficult to find the definable words in "emotion" part some words are not in popular use some keywords are too similar, some are not easy to define their meaning many keywords are too similar it would become more familiar with more use					
Q6	Is it easy to find the right keyword?				
Yes	46%	No	54%		
Comments: categories not clear/ too many too many, personalizing will fix that too many options needs 4-5 categories need to do a lot of "hunting" through menus to find what you think is appropriate you are limiting the user to your own "design language" too many choices too many to get confused by too many					
Q7	Is it a useful application for you?				
Yes	77%	No	23%		
Comments: But it needs to be improved/ interface and menu bar are not clear* I would use it for visual research, but would like to be able to upload larger file I will need to personalize a lot Needs a considerably simpler and usable interface* only some keywords are useful to define images Not enough for intuitive response I could customise it to suit the way I think and the words I use					

Q8 Which division did you use the most to define a search?					
Specification	53%	Characteristic	33%	Emotion	7%
Additional Notes	0%	Search Box	7%		
Q9 Was it easy to define a search?					
Yes	62%		No	38%	
Comments: too many categories/ characteristics hard to find in many categories not clear how to use the keywords in connection with the categories maybe too many search techniques on the screen at once too many keywords good to be "specific" or "open" as a way of searching					
Q10 Was the search result sufficient?					
Yes	85%		No	15%	
Comments: bigger image size but it would depend how many images you added to the database					
Q11 What kind of additional information would you need to better understand the divisions? Comments: example in pictures/ icons emotion bit is a little confusing; I don't understand how I would use it in real life; because it depends too much on when I enter the images. examples need less categories I would use colour to show the groups There is already too much information Maybe u can add the help button(including the description)beside the divisions time to experience the depth of information –the sophistication of this is good					
Q12 What additional categories or members do you suggest adding? Comments: colour to separate the categories personalize date of entry in database bigger image size not many negatives most characteristic division in comprehensible but some are limited list all images there could be a "list by" option, like list by material none; remove some be more specific, use a type of product category make clear to the user the result of their efforts in using the database Interface is not good for the user*					

The analysis is divided into two sections: (a) Usability evaluation; (b) Evaluation of the image classifications. Usability evaluation covers the first two aims of evaluation which include evaluating the design of the system interface and the participants' understanding of the system structure. Evaluation of the classifications of image information focuses on the participants' understanding of the categories and the three divisions, and analysis of the value of the database.

7.2.3.1 Usability evaluation

Usability evaluation focuses on evaluating the design of the system interface and the user's understanding of the system structure. The questions covered and the results are summarised in Figure 7.2-04. As shown, the results listed for 'Question 3' include the results of 'Good' and 'Sufficient' because 'Good' and 'Sufficient' are positive results.

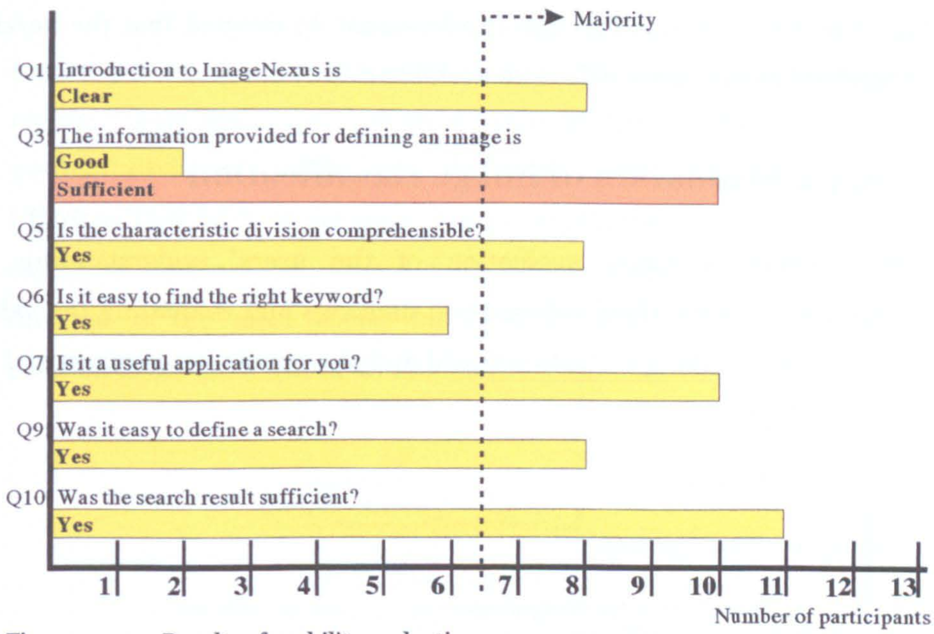


Figure 7.2-04. Results of usability evaluation.

Figure 7.2-04 shows the participants agree that ImageNexus is understandable, useful and sufficient. However, comments from individual participants included: introduction was too complex, the EMOTION division was unnecessary, the database needs a considerably simpler and more usable interface. Most comments were anticipated or can be incorporated in a future version. For example, one of the major comments was that the "introduction" was too long and complex. The participants suggested the use of images to explain and demonstrate the procedures; fewer words, more images.

The major comments on the question "Is it easy to find the right key word?" were about the number of categories and keyword members, and all participants indicated that there were too many of them. The participants said they would need to personalize the categories and keyword members for further use. However, one of the professional 'expert' evaluators thought that the depth of information would help designers look more deeply at the image. The system would assist them in evaluating images more carefully before showing them to their clients.

There were only 3 participants who did not think it was a useful application. One (student) claimed that he would need to personalise the category members; one (student) did not have any idea how it could be used and what it was for; one (professional A) claimed that the he/she found only some keywords were useful to define images.

7.2.3.2 Evaluation of image classification

This section includes evaluation of the users' understanding of categories and the three information divisions and evaluating the value of the system. The questions covered and the results are summarised in Figure 7.2-05.

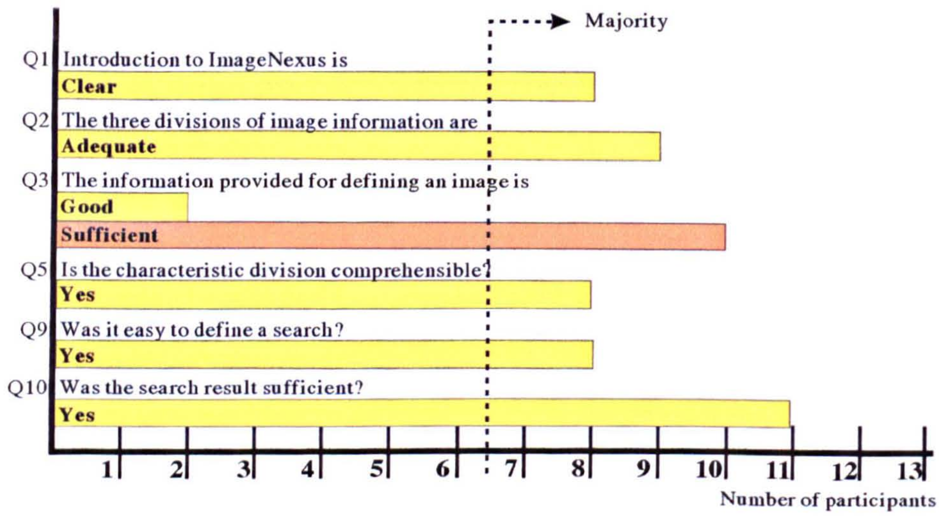


Figure 7.2-05. Results of the understanding of categories and three divisions.

Figure 7.2-05 shows the participants agree with the classification of image information. Their comments were the same as the previous discussions, that too many categories meant that time would be needed to remember where a keyword was. There were no disagreements over the information structure for an image.

The suggestions were mostly about the interactive functions with the system, such as "date of entry in database", a "list by" option, such as list by "material" etc. As expected, the other major comments were about the design of the interface (see Table 7-02).

Furthermore, only 3 out of 13 participants indicated that the names of Characteristic categories were confusing and not comprehensible. The confusion was caused by there being categories with the same name in the Specification and Characteristic divisions, such as Colour.

Figure 7.2-06 shows the results of two different groups. Comparing Figure 7.2-03 and 7.2-06, it shows that SPECIFICATION is the most useful division both in defining and searching images. CHARACTERISTIC is the second most popular one. However, when the results of students and professionals are separated, CHARACTERISTIC division is the most useful for professionals and SPECIFICATION division is the most useful for students.

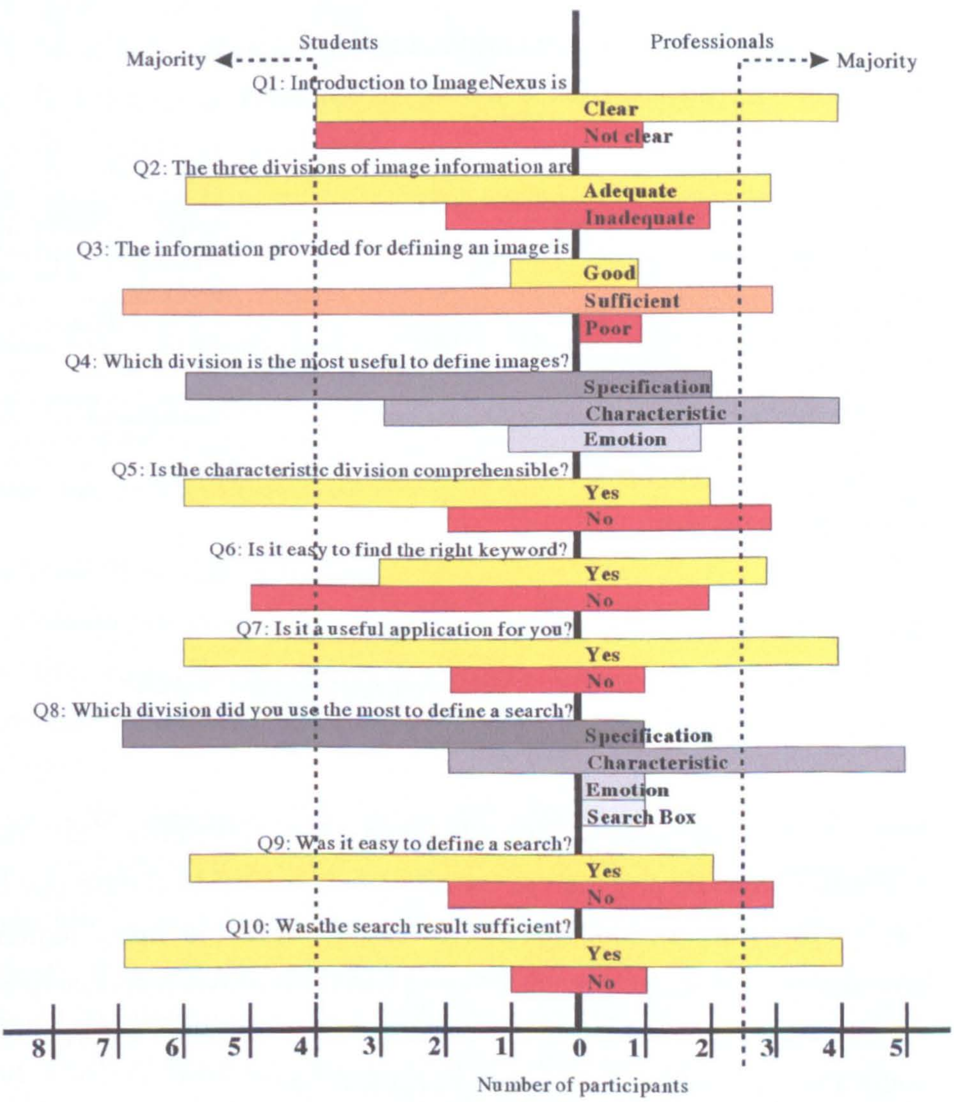


Figure 7.2-06. Results of two different groups.

To sum up, the results indicated that the structure of the system is understandable and the value of the system is appreciated. The following two case studies show more details of participants' responses.

7.2.4 Case studies

These two cases relate to people who were involved in the interview. They both have more than 5 years' experience in design consultancy. The following shows their comments. Both showed great interest in using ImageNexus in their work.

7.2.4.1 Case study 1

Time spent on ImageNexus: 82 minutes and 31 seconds
Experience: 5 years' experience in design consultancy

Table 7-03. Results and comments of case study 1.

Q1	Introduction to ID-Imagenexus is	Clear
Q2	The three divisions of image information are	Adequate
Q3	The information provided for defining an image is	Sufficient
Q4	Which division is the most useful to define images?	Characteristic
Q5	Is the characteristic division comprehensible to you?	No
Q6	Is it easy to find the right keyword?	Yes
Q7	Is it a useful application for you?	Yes
Q8	Which division did you use the most to define a search?	Characteristic
Q9	Was it easy to define a search?	No
Q10	Was the search result sufficient?	Yes
Comments: Many keywords are too similar (Q 5) Not enough for intuitive response		

The two negative answers from the questionnaire:

- Is the characteristic division comprehensible to you?
- Was it easy to define a search?

They were answered "No" because the keywords in the CHARACTERISTIC division are too similar. It is hard to choose one of the keywords and it would be confusing to have too many similar keywords for one image. He felt it would lose the intuitive response to an image. However, he chose the CHARACTERISTIC division as the most useful and used division (see results of Q4 and Q8).

He stated that the system would be good for use in teamwork, because team members would need to list all the possible interpretations of an image. But for his personal use, he would rather store the first inspiration he had from the image. He felt that you could always look at an image more deeply later, but you would forget what your first inspiration was when you saw that same image again and again.

7.2.4.2 Case study 2

Time spent on Imagenexus: 90 minutes
Experience: 10 years' experience in design consultancy

Table 7-04. Results and comments of case 2.

Q1	Introduction to ID-Imagenexus is	Clear
Q2	the three divisions of image information are	Adequate
Q3	The information provided for defining an image is	Sufficient
Q4	Which division is the most useful to define images?	Specification; Characteristic; Emotion
Q5	Is the characteristic division comprehensible to you?	Yes
Q6	Is it easy to find the right keyword?	Yes
Q7	Is it a useful application for you?	Yes
Q8	Which division did you use the most to define a search?	Characteristic
Q9	Was it easy to define a search?	Yes
Q10	Was the search result sufficient?	Yes
Comments: seems quite detailed which could be good (Q1) encourages me to think in detail about my responses to the image (Q2) personalisation and flexibility is good (Q3) it would become more familiar with more use (Q5) same comment as above (Q6) I could customise it to suit the way I think and the words I use (Q7) good to be "specific" or "open" as a way of searching (Q9) but it would depend how many images you added to the database (Q10) time to experience the depth of information –the sophistication of this is good		

Because there was no Microsoft Windows PC system in his studio, the evaluation was carried out using the workshop procedures on a laptop. In this case, the designer's excitement continued throughout the workshop. His questionnaire results are shown in Table 7-04.

During his operation, he tried to record keywords in all the categories of the SPECIFICATION division. He mentioned that the database would help him consider images more carefully before showing them to his clients. It is very important to choose the right images to express the theme. Furthermore, he stated that the three divisions are very useful, but which division he used most would depend on the images. A very strong statement he made was that it is the sophistication of the system which makes it a good application. It forces you to think in more depth about an image. Again, he stated that it is "trial and error" that builds up the relationship between the user and the system; therefore he would enjoy trying the interface and functions without reading the instructions.

7.2.5 Summary

- **Complaints about the interface design.**

  There was no complaint about the interface design within the professionals' evaluations. All the comments and suggestions about the interface design were from students. The reasons could be:

  1. **Experience differences**

  Because of working experience differences, professional designers would focus on how the system could help them rather than how they feel about the system.

  2. **Purpose differences**

  Professional designers take the system as a design tool to assist their work; however, students use the system more like personal image storage.

- **There was no negative comment about the names of categories.**

  Professionals did not have any negative comment on the names of categories. They accepted the categories provided which suggests that the categories structure is correct.

7.3 Discussion

The results show that the database is accepted and appreciated. Although there were comments on the number of keyword members, it did not affect the value of the system.

It was anticipated that participants would need to personalise the keyword members. The set-up page has provided the function for participants to organise their own members. One issue to arise here is that the 'default' members may need to be made changeable, because the original option was that the users could only add new members into each category, they were not allowed to delete default members.

To improve the usability of the system would require experts (interface designer and programming engineer) to participate in the development. Their participation would help to sort out the problems between database system and interface system.

A new version of the instructions was created following participants' comments. It is flash format, and it shows only a small amount of the content of each page. It includes also animated demonstrations. See appendix F for details.

Chapter 8
Review and conclusions

The first part of this research was carried out in order to understand the role images currently play within the product design process. The results of this survey were used to develop a classification of image types and of reference keywords, which led in turn to the construction of an image database for professional use in product design. Such a database enables designers to significantly reduce the amount of time which they currently spend in searching sources for inspiration, either searching for new images in magazines or on the Internet, or searching for existing ones within their own collections. A well-structured image database for product designers enables them to consult images more easily, and it also facilitates communication of visual ideas between designers, thus augmenting its potential value in the professional design process.

A literature review confirmed that images are an important inspiration resource for designers, and a survey of existing databases showed none to match product designer's requirements.

An overview of this chapter is given below.

Section 8.1 Literature review

This section briefly introduces the literature review process and conclusions.

Section 8.2 Interviews and workshop

This presents the results of interviews and workshop.

Section 8.3 The three divisions and classification

This section introduces the three divisions and shows how the classification process relates to linguistic theory.

Section 8.4 Database and evaluations

An overview of database development and evaluation results is given in this section.

Section 8.5 Limitations of the research

Section 8.6 Conclusions

Section 8.7 Indications for future work

Further investigations into the database and other relevant studies are discussed.

8.1 Literature review

The literature review involved three main domains: product design, language, and images. Images are important within a design project and have several roles. Within the design process, images are used:

- To find directions for design improvements (Jones 1992).
- To assist designers' visual thinking (Baxter 1995).
- To act as stimuli for idea exploration and as reminders about people (RSA Inclusive Design Toolkit 2004).
- To communicate with others (Section 2.2.4, p.48).

The existing database survey indicated the need for an appropriate image database for product design professionals. The image classification method stemmed from at Mooij's (1998) statement that the elements of messages conveyed by a product include the brand's visual image, attributes, users, place/occasions and value. This was confirmed by interview results.

The interface design principles in Section 2.4 were used as guidelines and supports for system development and the advantages and disadvantages from the current database survey (see Section 2.3.2.3, p.64) were also used to assist in the development of the system.

The principles of linguistic theory and understanding of perception psychology were used in classifying the descriptive words.

8.2 Interviews and workshop

Following Eakins and Graham's (1999) recommendations (see Section 2.3.1, p.51) on the study of image data management, interviews and a workshop were carried out to understand how designers use and classify their images, and to collect the keywords they associate with images. The results of interviews and workshops demonstrated the importance of the role images play within the design process, and the need for designers to organise their collections.

As a result, images can be divided into PRODUCT and NON-PRODUCT images according to their content. During the interviews, designers interpreted the provided images and products, and this showed that there are basic information types conveyed by images (See Section 4.1.3.4, p.114), including Colour, Material, Texture/finish, Sound, Time/age, Price, Consumers, Environment, Weight, Function, Lifestyle, and Trend.

In order to keep the interview duration to within an hour, there were only five products and five images used. A workshop was planned to ensure the information types from the interviews were appropriate. Consequently, the workshop results showed that the information types were appropriate. The interviews and the workshop suggested the need for an image database and confirmed the literature review findings.

8.3 The three divisions and classification

The interview and workshop results analyses showed that the information conveyed by images involves many subjects and it was decided to group these into three individual information divisions. The first division includes colours, materials, textures, forms, functions, users and lifestyle. The keywords are therefore defined to collect words relating to an image's physical properties and qualities. This division was named SPECIFICATION.

The second division is EMOTION. In this, the keywords are chosen to record designers' emotional reactions to an image. This was based on interviewees' responses which showed that their interpretations of images include not only their perceptions of the images but also their emotional reactions to them.

The final collection of information was named CHARACTERISTIC. This is a collection of descriptive words used to express the context of images. The plan was to collect keywords from interview scripts, books and magazines. It was expected that the number of keywords would be large. However, when the collection of keywords started, it proved to be difficult to select descriptive words from them because:

- the meaning of words varies according to their context;
- the use of language varies among people (this was supported by the literature search);
- when collecting adjective keywords from books or magazines numbers need to be limited but establishing criteria for the selection is problematic.

As the interview scripts showed that there were a lot of words used repeatedly, it was decided to base the keyword collections of the CHARACTERISTIC division on these scripts (120 words). In addition the keyword collection from Kuno's (1999) *Colours In Context* list of "Image words" (538 words), which was identified during the literature search, was also incorporated. The reasons were:

- Kuno's "Image words" are also descriptive words used to describe subjects, such as age, food and so on;
- Kuno's purpose in choosing those words is the same as this research, to express images;
- Kuno's list of "image words" has a strong correlation with the keywords collected from interviews. More than half of the interview keywords were covered in Kuno's list of "image words".

As explained in Section 2.2.3, two strategies were considered to classify the CHARACTERISTIC division (see Appendix C, p.256 for detail) and after evaluation the thesaurus based approach was applied. However it was found that this method resulted in an increase in the number of words. Consequently, the whole classification process was reconsidered.

8.3.1 Linguistic theory

It became apparent that a theoretical understanding of words was required, to resolve the classification problem. Reading and expert advice confirmed that the knowledge area of linguistics could resolve this. Consequently, semantics was identified as being the appropriate theory. It is the study of the meaning of words and the relationship between the meanings. The meaning is a mental description, a **concept** (Löbner 2002). A concept for a word is information in the mind that allows people to recognise the differences between similar words. This approach was adopted to categorise the descriptive keywords by grouping those of the same concept together. The concepts were found in Roget's Interactive Thesaurus (First Edition, 2004) (see appendix D, p.258). This method was approved by my advisor, a senior Lecturer at the School of Social Sciences, Humanities and Languages, University of Westminster.

This approach clearly presents the relationships between descriptive words and the objects described. It helps clarify the idea of how a word is used differently, e.g. 'firm' may be about *texture* or about *stability*. And it also helps to identify which concept of a word is more useful in product design. For example, 'bright' has concepts for *intelligence, happiness, colour* and so on, but *colour* is the most suitable concept in the product design sector.

8.3.2 The relationship between the three divisions

This three division model allows designers to define the relationship between an image's' qualities and its physical properties. This combination records what designers see and how they perceive an image (see Figure 5.2-08). In addiction, the categories within the CHARACTERISTIC division encourage designers to look more carefully at an image. For example, a "cheap" product could be one whose 'value' is cheap or whose 'price' is cheap; a "cold" image could be one whose 'physical sensation' is cold or whose colour/form is cold. As designers become more familiar with these distinctions, the better they understand what their perceptions are.

This three-division structure clearly demonstrates the relationship between images and viewer, and also the relationship between properties and qualities. It assists designers in organising images more accurately.

8.4 Database and evaluations

A web-based image storage database, named ImageNexus, was structured around the three divisions. It was developed based on the Entity-Relationship Model (ERM) model (Zaïane 1995). The features of ImageNexus include direct access, simplicity and consistency (Lynch 2001). It uses serif or sans serif font (Tetrarch 2002, Lynch 2001), and uses bright or highlighted colours to emphasize (Galitz 2002) features. The prototype web site containing ImageNexus provides three major types of interaction:

(1.) Definition page: to define an image and store it for future use;

(2.) Search page: provides the same categories as the 'define' page for searching for an image;

(3.) Set-up page: allows additional keywords to be added to the categories of SPECIFICATION and CHARACTERISTIC division.

Most interviewed designers interested in taking part in the evaluation dropped out because the evaluation process needed a period of time. In the end, ImageNexus was tested by five product design professionals and eight MA Industrial design students at Central Saint Martins College of Art & Design and Sheffield Hallam University.

The results successfully show that the development of the system was accepted and appreciated. Because the evaluation focused on participants' understanding of the system, it was anticipated that first time users could feel intimidated by the large number of keywords. The feedback comment confirmed this.

8.4.1 The usage of the database—ImageNexus

Product designers search images for inspiration or for communicating with others. The results from the interviews indicated that designers have a mental image concept of the images they search for. Generally, they go through magazines or books for images they need. In recent years, their image searching has relied more on the Internet. The advantage of these methods is that resulting unanticipated images can arouse designers' inspirations; however, according to the survey, the percentage of this kind of inspiration is low. The disadvantage is that designers need to spend a lot of time either browsing magazines or books that they have seen before, or checking over thousands of images on the Internet.

ImageNexus was set up to assist product designers in organising their image collection most effectively for their use. As a result, ImageNexus not only provides designers with a means of storing their images, but it also helps them to extend their image mapping with words. For example, when they search for 'beautiful' images, the system would show them other associated words: 'attractive' or 'fascinating'. This function assists designers to have further insights into their projects, because it indicated other possibilities. It helps to define where a design project theme can go and stimulates creative thinking.

ImageNexus not only allows designers to use their images productively, but also has no effect on their enjoyment of browsing magazines or books with a cup of tea/coffee. ImageNexus assists designers in organising their images for future use. It does not replace the need to find new images by any established methods.

The value of ImageNexus is in that it not only benefits product designers but also helps researchers who investigate consumers' perceptions. For example, ImageNexus could be used as a questionnaire to understand how consumers interpret certain images or products.

The value of ImageNexus grows for users with extended use as they understand more fully the structure and experience the associations they make. As one designer said, the real value of ImageNexus is when it has a large number of images.

8.4.2 ImageNexus and other image databases

ImageNexus is a prototype. It was developed to prove the concept of using descriptive keywords to organise images for use in product design use. It will need further technological support to improve its accessibility for long-term use. However, it has shown its value and capability. Its value is not only as defined by the results of the evaluation, but it is also about the difference between it and other image databases (see Section 2.3.2, p.54).

ImageNexus provides three divisions to record an images' physical properties, the viewers' emotional reactions, and the visual quality of images. Also the three divisions cross relate to each other, especially in the search function. The designers can define their search not only in one division but also in all the divisions.

The other image databases only provide the function to record the physical properties of an image and an extra column to record an image's characteristics (see Section 2.3.2, p.54). The physical properties are about file type, file size, name of image and image type. There is a column for the features of an images, which is good to record intuitive perception to the images. However, it is harder to record comprehensive information for future use.

ImageNexus might not provide images as much as Google's image search engine, but the size of ImageNexus will increase gradually and the accuracy of its search results is incomparable.

8.5 Limitations of the research

The review of the assumption

From the outset of the study it was assumed that:

1. there is a structure that can express the relationship between an image and the information it conveys. This was demonstrated.
2. a database could be developed around this structure which would assist designers in organising and searching for images. The prototype database developed was able to verify this.

The evaluation and limitations of the research

1. The study first used interviews as a survey method to understand the role images play in the design process. A standardised open-ended interview was considered an appropriate method to provide the required information. As a result, the survey obtained sufficient information for the research. If time had allowed, more interviews of this type would have been beneficial.
2. Knowing the difficulty of obtaining sufficient numbers of professionals, the workshop to test the information types derived from the interviews was designed to be run with MA students. The students were chosen within the criteria that they had at least one year of professional experience but access to professionals would have been valuable.
3. A long-term evaluation of the database would have given better results. This was not possible because of the limited time available for the professionals and MA students involved. A further evaluation would provide more detailed information to inform the next stage of

development.

4. Because of time limitations, evaluation of the divisions' contents was carried out as part of evaluating the database as a whole. In order to fully understand the value of each division and improve their role for the future database, a separate review process would be required.
5. The interface of ImageNexus was developed using the basic principles of interaction design. Extended user testing and an iterative design process, with support from information technology professionals, would lead to an improved product.

8.6 Conclusions

The aim of this research was to develop a collection of key descriptive words and construct a prototype electronic image database for product professional's use. Initial assumptions about the relationship between the images and the information they conveyed were confirmed by interviews, workshop and analysis. The fieldwork also helped to understand:

1). The reasons designers use images in the design process;

Designers use images to understand the products they are designing, the users, the environments of use, and to gather ideas and information and to help them express their concepts.

2). How they store and access images;

Designers normally store and access the digital images they have used by the name of project they work on. They do not usually store digital images as references for future use. They keep the magazines and books and search for images they have seen before by memory.

3). The words they use in describing visual features in the images;

The words could be divided into subjective or objective responses. and were developed into three information divisions.

4). The way images are used in communication.

Images are used, with keywords, to assist designers to express or emphasise their ideas.

ImageNexus was developed around the three information divisions and evaluated by product design professionals and MA students. The evaluation responses showed that ImageNexus is a useful tool worthy of further time investment.

In addition, the study also found that every individual has different responses to the same object but received similar information from the same object. This shows that there is a language used in the design object and product designers understand this language. The finding reflects Monö's (1997) comment that a designer should aim at understanding product language better in order to be able to improve his design.

8.7
Indications for future work

8.7.1 Current image database improvement

Based on the author's current understanding of ImageNexus, specific improvements would result from work on:

1). Further investigation of the CHARACTERISTIC division
The classification of the CHARACTERISTIC division has been tested by a collection of keywords from Kuno's (1999) work. According to evaluation results only eight out of thirteen participants (69%) understand the categories within the division. Further refinement of the names of categories and their keywords would make this division more comprehensible to the users.

2.) Additional information categories
Additional information categories could be added to the database, such as:

- Brands: in recent years branding has become increasingly central to design. For example Gobe (2001) stated that sensory design is the new branding power tool. It is one of the main concerns in marketing a product and as the interview results indicated, the front-end phase of the design process is heavily involved in marketing strategy. Designers are required to use visual aesthetics in enhancing brand value for their clients. Figures 8.7-01 and 8.7-02 show how images can be used to reinforce and enhance the perceived value of a corporation.

Figure 8.7-01: Example of images used in enhancing a 'corporate image'-1.
Source: Tangerine Product Direction and Design

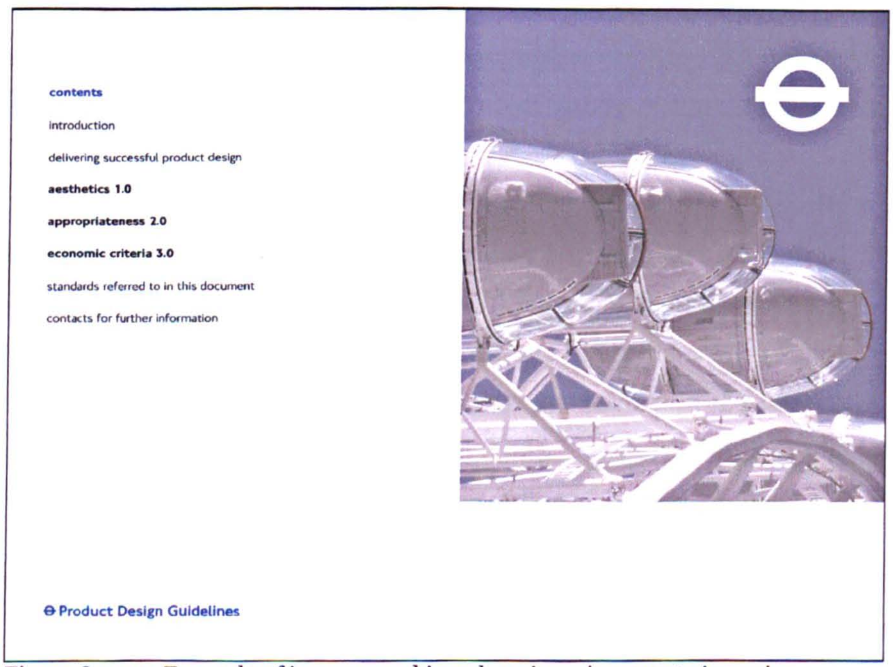


Figure 8.7-02: Example of images used in enhancing a 'corporate image'-2.
Source: Tangerine Product Direction and Design

- Size/weight of product: size and weight are also part of a product's physical properties. As the alarm clock in Figure 8.7-03 shows, it is hard to tell how big the clock is from the image. A category to record size/weight would help designers' perception of the product's reality.

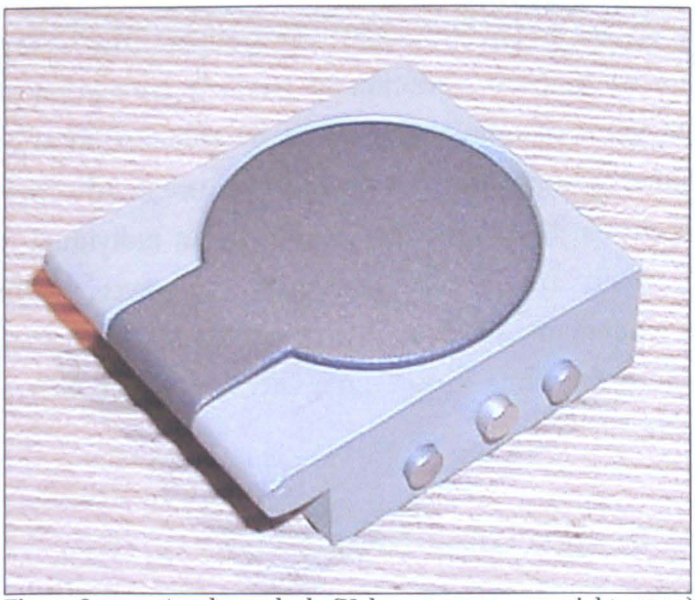


Figure 8.7-03: An alarm clock. (Volume: 4x3x1 cm, weight: 400g)

- Sounds: sounds are an important part of a product, for example, the different click sounds on a keyboard represent different qualities/materials. Furthermore, for safety or the human factors, sound is a requirement of certain products, for example kettles require sounds as alarms to warn of water boiling. Sound is also attractive to people, and new information technology could help make recording sound easier. However, the question remains of how to search sounds, and what sort of keywords to use.

3.) Additional functionality in interaction

A mood board function that allows designers to move images onto a design board would make the image database more directly involved in a design project.

4.) Extending its use to other design disciplines

ImageNexus can readily have its use extended to other design professionals. An evaluation of ImageNexus by those from other disciplines would impact on the content of the three divisions and improve ImageNexus's value.

8.7.2 Perception variety

The literature showed that the variation in people's perception was affected by gender, socio-economic status, and geographical locations. The possible effects of these variations on this study were not discussed. As the database is primarily designed to be used by an individual, the images' content would be 'read' consistently. However, further investigation into understanding how variables between participants lead them to perceive the same image differently and select different images would be valuable.

8.7.3 Product design thesaurus

According to the workshop results, participants used different words to express the same things. For example, a 'circle' and a 'wheel' could represent the same things. A product design thesaurus would be a relationship network to assist the thesaurus method in the product design process because it could help to develop relevant visualisations. It could be developed as the Visual Thesaurus at www.visualthesaurus.com (Figure 8.7-04). In Figure 8.7-04:

- The word appears in the centre and is surrounded by words and meanings that are related to it.
- Clicking on any word can transfer it to the centre and consequently see the words and meanings related to it.
- Rolling over a circle can show its definition and usage examples.

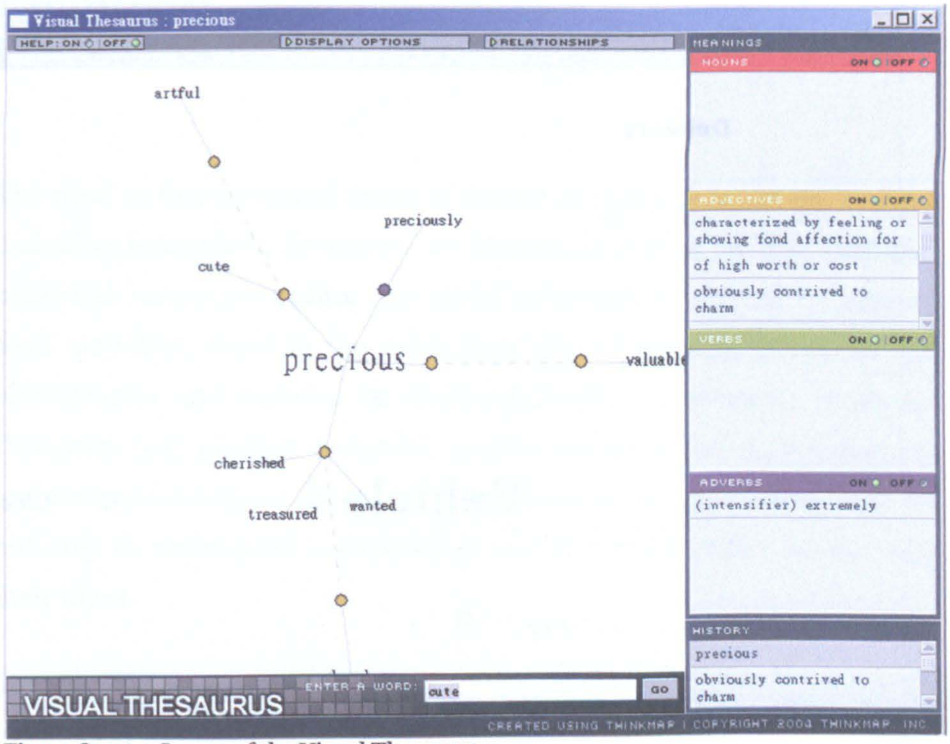


Figure 8.7-04: Image of the Visual Thesaurus.
Available from: www.visualthesaurs.com, Nov 2004

The difference between a product thesaurus and a visual thesaurus would be that the links between words are defined by the words' visual form, function, and meaning. See Figure 8.7-05 for example. The product/object appears in the centre and is surrounded by the word's meanings, functions, and shapes that are related to it (Figure 8.7-05). Rolling over a circle can show its connection relations. The difference in a product design thesaurus is that the relationship between words is connected not only by meanings but also by functions and shapes. In addition, the words can be presented with images or links to relevant image databases.

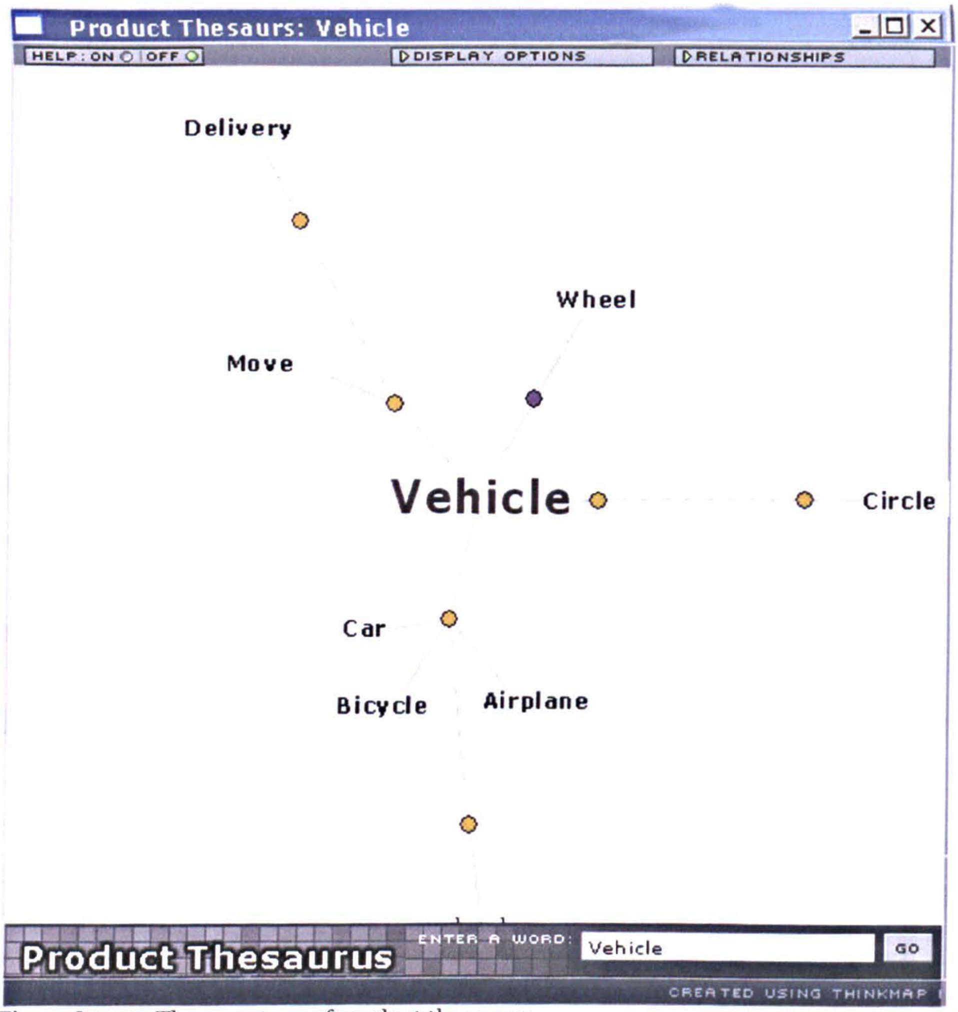


Figure 8.7-05: The prototype of product thesaurus.

Chapter 9
Critical context of research

The need to find a desired image is shared by many professional groups, including journalists, designers, art historians and so on. For example, historical researchers often use visual information sources to support their activities, those in the publishing and advertising industries use photographs and pictures to illustrate articles or promote products. Designers (e.g. product designers, graphic designers, interior designers, architectural designers, even engineering designers) use visual material not only to understand a project but also to support and communicate their ideas.

Traditionally, an image is found by browsing books, magazines or specialized image collections from libraries and organizations. Since images have become digitalized and the capabilities of information technology have grown so rapidly, the volume of images stored digitally has increased enormously. Users in many professional fields have greatly benefited from the ability to index and access images.

There are a number of indexing methods. Many picture libraries use keywords as the main form of retrieval. They assign index terms to the whole image, the main object depicted, and the image's setting. Thesaurus and retrieval software have been developed to allow users to submit and refine queries at a range of levels (Eakins and Graham 1999). A newer technology for retrieving images is Content-Based Image Retrieval (CBIR), which uses automatically-derived features such as colour, texture and shape (see Section 2.3.1, p.51). Either method is effective when the desired image is well defined by, for example, date, colour, object, or event. However, to find images to fit the needs of a design process is very difficult. Designers normally know the theme of the image they are searching for, but they do not have a mental image of how the image looks. Also when product designers search for an image, they search for its context meaning rather than its content. For example, to design a comfortable luxury armchair, designers may search for images which represent 'comfort' and 'luxury'.

In addition, existing image databases do not appear to be particularly reliable. Section 2.3.2 has shown the poor match between a query and the indexing language. The language disparity is often caused by differences in individuals' use of words. So that the mental image associated with a word will vary. Consequently a clear association of a word with an image is very important when the image is used as a communication aid to express a concept.

As an example, Figure 9.0-01 shows images used on a theme board for a design project. Without explanations these images could convey very different meanings by different people. What do they seek to communicate? It is difficult to tell what the theme is without association with words or a title.

Figure 9-01: Design project images.
Source: Grinyer 2001, pp.106-107

The theme board was used in the design of the shaver, 'Cool Skin', by Philips Design. The design of 'Cool Skin' focused on a specific male lifestyle and used the concept of 'Balance in Contrasts' to define the emotions embodied in the design of the shaver, as shown in Figure 9.0-02.

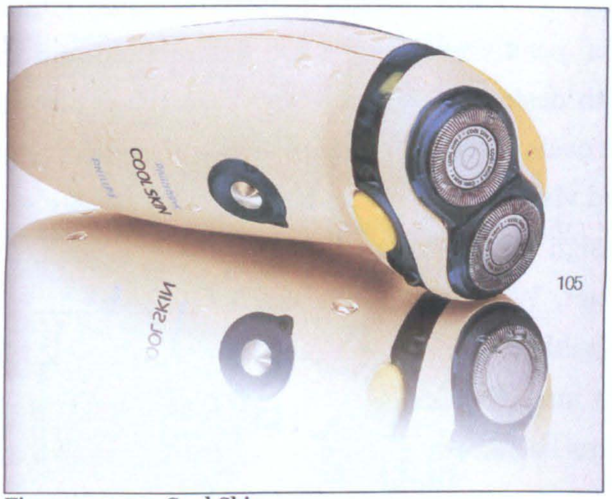


Figure 9.0-02: Cool Skin
Source: Grinyer 2001, p.105

Images play an essential role within the design process. They help communication between designers and others in expressing design concepts and in reminding designers of design elements. Furthermore, images are also used by designers to tell stories about target users. For example Figure 9.0-03, which was created to communicate the lifestyle of target users. Additionally these images can be used as survey tools to prompt users' views.

Figure 9.0-03: Images of target users.
Source: Tangerine Product Direction and Design

In developing visual design solutions, designers apply a broadly similar method. As a professional product designer I use this method and the interviews conducted with designers as part of this research confirmed they use the same approach. After a briefing phase, designers start developing functional and visual concepts for the project, and search for images to support a design theme. Typically they will search books, magazines, or the Internet. When the theme is a tangible term, it is relatively easy to find suitable images but when the theme is intangible, it is hard to find the right images. Fundamentally, people do not classify images by conceptual terms because no database provides this function.

ImageNexus encourages designers to creatively use the images it contains. For example, when they select images to show to a client in relation to a mood or emotion, they need to be very specific about the mood they are choosing, so that no ambiguity arises. In this way, the communication levels between designer and client will increase resulting in less confusion and a more appropriate design solution being provided.

A project brief is not normally only about the characteristics of the product but also includes other specifications (e.g. target market) which clients often see as more important. The three-division structure of ImageNexus helps designers to resolve this problem.

ImageNexus assists designers to locate their moods or emotions more precisely. It allows them to understand the difference between their intuitive reactions and their interpretations of images. For example, the intuitive response to the characteristics of Figure 9.0-04 and 9.0-05 based on their colour or texture could all be defined as 'original' or 'nature'; however, they are very different in their real colour/texture. If they were presented together as 'original', they would cause confusions to others. The SPECIFICATION and CHARACTERISTIC division of ImageNexus can assist designers to distinguish them.


Figure 9.0-04: Image of 'original' & 'nature' 1
Source: Digital Vision, image No. 1818035

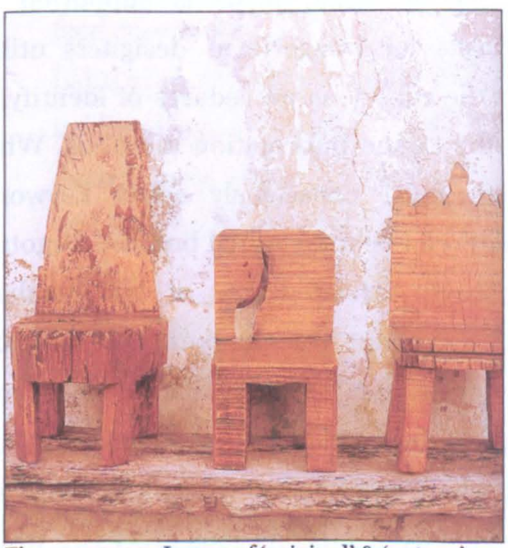


Figure 9.0-05: Image of 'original' & 'nature' 2
Source: INVIEW September 2002, p.82

ImageNexus's keywords can also inspire designers in their use of visual and verbal vocabulary both in the idea generation phase and for presentations. For example, to represent a concept of 'masculinity' which includes 'energy', 'sporty', 'technical', 'mechanical', 'animated' and so on (see Figure 9.0-06).

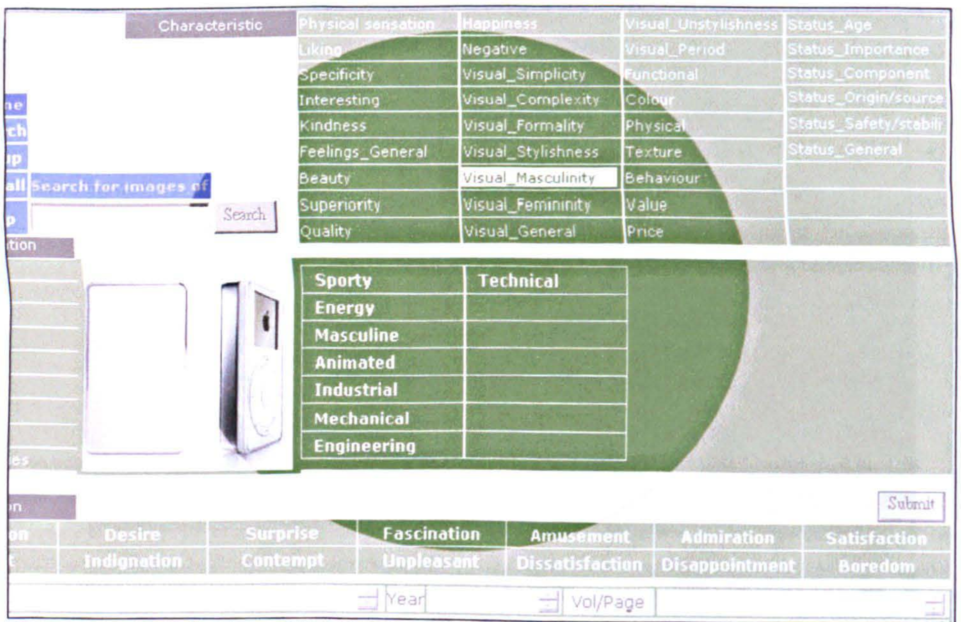


Figure 9.0-06: Interface of the CHARACTERISTIC division of ImageNexus.

The concept developed by Donald Schön (1985) of knowing-in-action and reflection-in-action (see Section 2.5.2, p.79) is supported by ImageNexus. In classifying images for ImageNexus designers utilise knowing-in-action behaviour in the conscious procedures of identifying and recoding keywords within the theme information divisions. When searching for images designers must consciously select keywords (knowing-in-action) but the results can be unexpected because forgotten images will be retrieved. Through extended use of the database reflection-in-action will play a significant role in both indexing and searching. The more familiar designers become with it, the more sophisticated will be their use of it, particularly in relation to the EMOTION information division where emotional responses to image are recorded. This sophistication results from subconscious processes which develop intuitive understanding.

The essential role of ImageNexus is to store images for designers' future use. The more effort they put into indexing the images, the better the results they will get. ImageNexus also enhances the value of images because its categories can record many kinds of messages they can convey. An image will no longer be just a digital file.

ImageNexus may also be used to store the photos from observations of product users. There are a variety of design methods which use such photos, such as visual diaries and user reactions (RSA Inclusive Design 2004, see Section 2.1.2, p.18). Although, these photos are used to record evaluation of functional aspects, they can also remind designers about users' feelings and these can be indexed in detail by ImageNexus.

ImageNexus is not only the result of understanding design methods and designer's perception of objects (product semantics) but also the use of languages in design profession. ImageNexus reduces the time and cost of searching visual support resources within the design process while enabling designers to have a better understanding of their feelings and interpretations of images. In so doing it satisfies designers' needs as identified by the following researchers:

1. Formosa (1991) noted that an insufficient flow of information leads to inadequately designed products and he believes that information could enhance the design process; in the proper environment it will feed creativity.
2. Lahti et al. (2000) indicated designers frequently search for and use information to help them to construct new knowledge related to the design topic, simultaneously searching for new information that will help to determine design constraints and produce a satisfactory design.
3. Monö (1997) commented that a designer should aim at understanding product language better in order to be able to improve his design.

This thesis has explained, the reasons designers use images in the design process, how they store and access them, the words they use in describing visual features in images, and the way images are used in communication. The research has made contribution to knowledge in two distinct areas:

1. An organised structure of image information was created for use by product designers. The information divisions provide a new method to store and search images. They reflect the information used in the product design process.
2. Linguistic theory has, for the first time, been applied in image

classification specifically for use in product design. This research demonstrates that linguistic theory can be used to classify descriptive words and so provide a valuable tool for the product design profession.

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Appendices

Appendix A
Interviews - Introductory letter

Dear Sir,

My supervisors suggested I should contact you. I am a research student at Central Saint Martins College of Art and Design, studying for a PhD related to product design.

As part of my research I am carrying out a survey to examine the role visual references play in the design process. I would like to ask you if you would be willing to take part in this survey. The interview would take no more than half an hour I realize that you are very busy, however I would really appreciate any time you can give.

During the interview, I will be asking you about the product design process and asking for your comments on visual references.

The following are the members of my supervising team. If you need more information, please do not hesitate to contact me. I will phone in couple of days to discuss the possibilities. I deeply appreciate your consideration of this matter and thank you for your time.

Your Sincerely,

Vicki Wu
Research Student
Tel 02076251041 07796128484
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Supervisor team:

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Director, Design for Ability project Central Saint Martins College of Art and Design

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Research Supervisor Central Saint Martins College of Art and Design

Martin Darbyshire
Partner, Tangerine Consultancy
Visiting Professor Central Saint Martins College of Art and Design

Appendix B
Workshop

B1. Workshop resources

There were total 288 different images collected from 8 books and 25 magazines published within 2 years (Table B.01). They were divided into 5 packs of images (see Figure B-01, 02, 03, 4, and 05).

Table B.01: Workshop resources list

Books
Industrial Designers Society of America, Innovation–Award Winning Industrial Design, PBC International, USA, 1994
Keonig, K. (ed.), Museum of our wishes, SNOECK-DUCAJU & ZOON, Germany, 2001
Kinsman, R., The Logical Art of Furniture, Fourth Estate, London, 1992
Lefteri, C., Plastic Materials for Inspirational Design, RotoVision, Switzerland, 2001
Mackenzie, D., *Green Design–Design for the Environment*, Laulence King Publishing, Great Britain, 1991
Nichols, S., *Aluminum by Design*, Carnegie Museum of Art, Pennsylvania, 2000
Rowlands, P., Jean Proure, Chronicle Books, San Farnciso, 2002
Starck, P., STARCK, Taschen, Germany, 1990
Magazines
Blueprint, July 2002-07-09
Boys toys, April 2002
Creative Review, May 2000, April 2001
DDB (design diffusion bagno), no.6, February/march 2002
Design week, 26, May 2000
Form, July/august 2002
ID(the international design Magazine), June 2001
iNview (interior industrial inspiration innovation), 19, January 2002
Light, march 2002
NewDesign, issue 1, 5, 8, 9, 10, 11, 12
Stuff, April 2002
T3, April 2000, May 2000
Tate, issue 21, 2000
The Face, September 2000
View on colour (the colour forecasting book), 20, February 2002
Wallpaper, May 2002, July/August 2002
What cell phone, may 2002

Figure B-01: Workshop images-pack A

Figure B-02: Workshop images-pack B

Figure B-03: Workshop images-pack C

Figure B-04: Workshop images-pack D

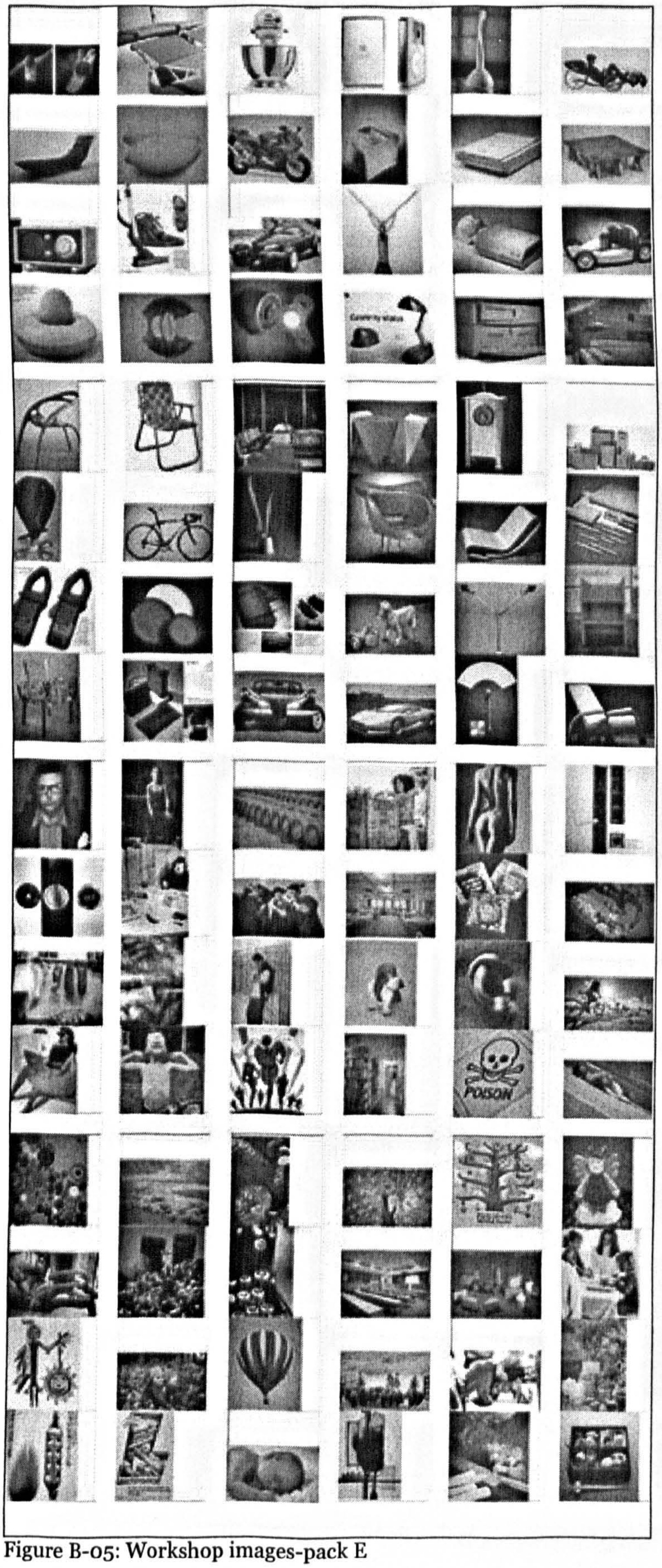


Figure B-05: Workshop images-pack E

B2. Workshop results

The following tables are workshop results. The results are presented in the order of:

1. Group 1-PRODUCT image classification results
2. Group 1-NON-PRODUCT image classification results
3. Group 2-image classification results

1. Group 1-PRODUCT image classification results

Table B.02: PRODUCT image classification results of participant A

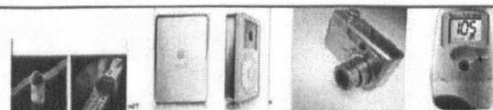
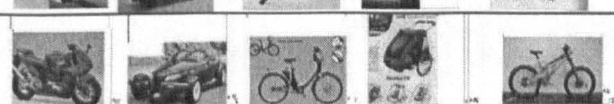
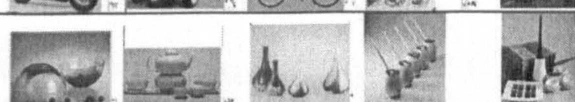
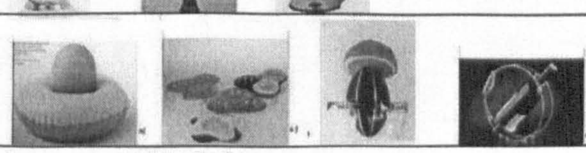
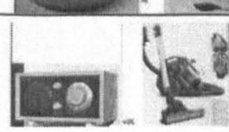
Participant **A**	
High tech small devices (use with hand)	
Furniture	
Vehicle	
Glass, ceramic, container	
Lamps	
Office	
Old forms for kitchen use	
Modern forms for kitchen use	
Home appliance	

Table B.03: PRODUCT image classification results of participant B

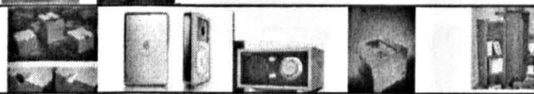
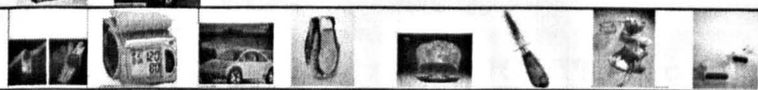
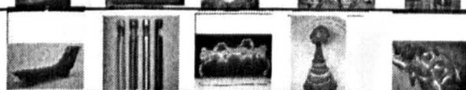
Participant **B**	
Fast moving lines	
Egg holders	
Ashtrays	
Mechanical engines	
Watches, clocks	
Reflections	
Colours mixing	
Strings	
Switches	
Baskets shapes	

Table B.04: PRODUCT image classification results of participant C

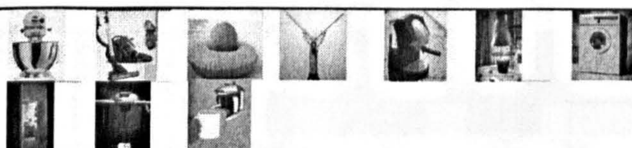
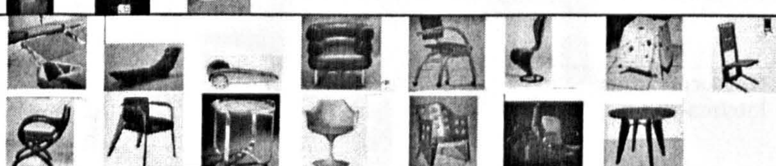
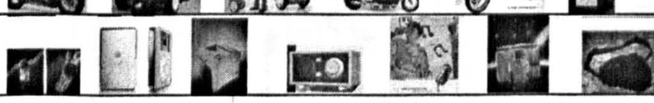
Participant **C**	
Domestic appliance	
Furniture	
Transport	
Electronic	
Lighting	
Pens	
Luggage	

Table B.05: PRODUCT image classification results of participant D

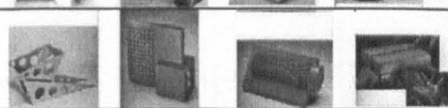
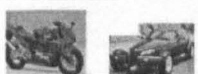
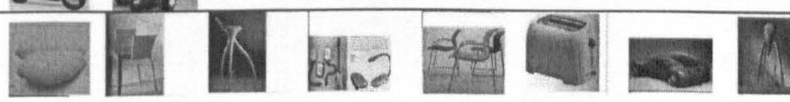
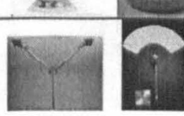
Participant **D**	
Cute	
Structural	
Simple	
Difficult	
Old	
Stylish	
Masculine	
Feminine/ organic	

Table B.06: PRODUCT image classification results of participant E

Participant **E**	
Wheels	
Life saving	
Sexy home furnishing	
Uncomfortable furnishing	
Gadgets	
Boxes	
Kitchen	
Lamps	

2. Group 1- NON-PRODUCT image classification results

Table B.07: NON-PRODUCT image classification results of participant A

Participant A	
Industry/factory business	
Cartoon	
Sports	
Music	
Business men	
Family/woman relation	
Children objects	
Publicity/ product photography	
Rooms	
Food, plants	
Nature	
Young people, individuals	

Table B.08: NON-PRODUCT image classification results of participant B

Participant **B**	
Toy	
Happy	
Architecture, external design	
Sex	
Textile design	
Light shapes design	

Table B.09: NON-PRODUCT image classification results of participant C

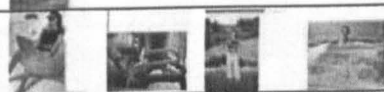
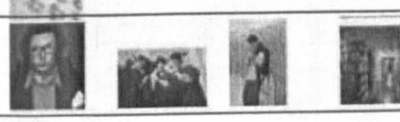
Participant **C**	
Transport	
Furniture	
Fun	
Architecture	
Related	
Art	
Pollution	
Domestic	
Retail	
Medicine	
Education	
Hospital	
Alcohol	

Table B.10: NON-PRODUCT image classification results of participant D

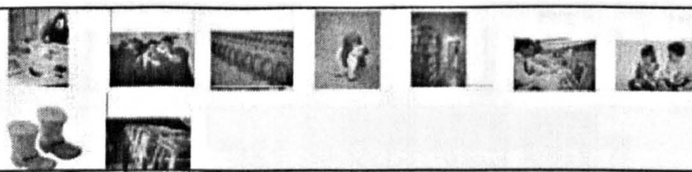
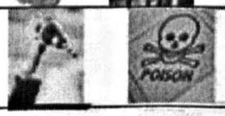
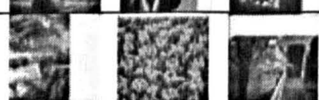
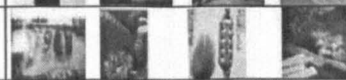
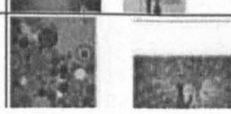
Participant **D**	
Boring	
Scared	
Childish	
Happy	
Miserable	
Active	
Static	
Virtual	
Gigantic	
Natural	
Refresh	
Lonely	

Table B.11: NON-PRODUCT image classification results of E

Participant **E**	
Collect	
Go	
Eat	
Bad	
Home	
Man	
Educate	
Cultural artifacts	
Odd but ones repeat	
Hospital	
Pattern	

3. Group 2-image classification results

Table B.12: Image classification results of participant a

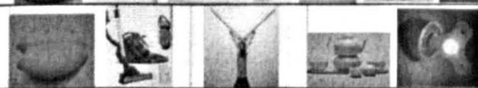
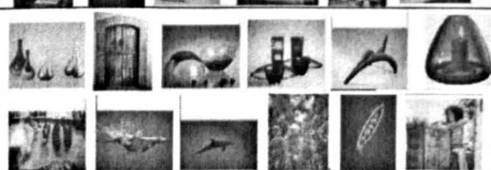
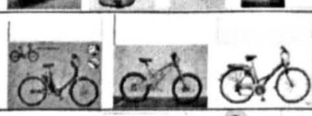
Participant a	
Novelty	
Functional and fun	
Stylish	
Action	
Japanese style	
Organic	
Child-like	
Boring	
Emotion	
Destructive	
Space	
Simple	
Masculine	
Strange	

Table B.13: Image classification results of participant b

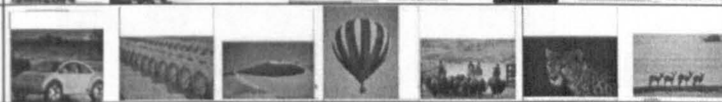
Participant **b**	
Nice for eyes	
Freedom to see	
Plastics and industrial design	
True love	
Design for evolution	
World of design	
Basic	
Wood and boxes	
Art	
Despair	
Bad influence	
Child-ness	

Table B.14: Image classification results of participant c

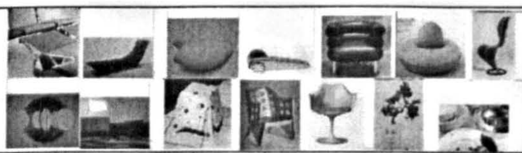
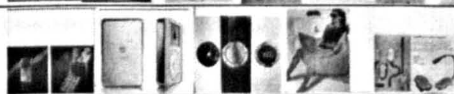
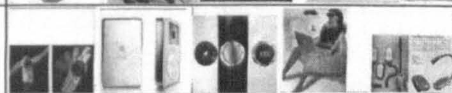
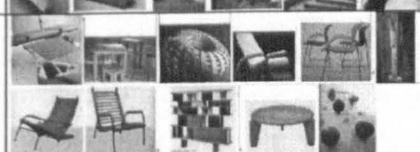
Participant **c**	
Highly designed life/contemporary	
Annoying/irritatin g object	
Wealth bourgeois life	
Institution	
Imitation	
Leisure + pleasure	
Craving of speeds	
Early adopters	
Sustain ability	
Classical context on form	
Cultural difference	
Cookery	
Multiplicity	
Desire of health	

Table B.15: Image classification results of participant d

Participant **d**	
Visuals that triggered emotion thoughts	
Poetic functional	
Just poetic	
Non-emotional products	
Male-world	
Functional & interesting	
Sweet, giving, and thought through design	
Overworked design/ 90's style	
Nature	
False reality	
Created emotion	
Uninteresting images	
Perception of time and place	
Repetition	
Practical	

B3. Workshop session 2

The second session of workshop aimed to gain data for potential categories. It was planed as a method of collecting categories members. In the end, the results were varied and difficult to analysis. Therefore, it did not include in the main study, but it is still taken as reference in this study.

Participants were asked to give their ideal members for the 13 categories (colour, material texture, form, value, style, lifestyle, character, emotion, activity, time, people, and place) (see Section 4.1.3.4). The categories were the integrated results from the interviews.

Nine participants were divided into four groups. The following 13 tables are the results of their contributions. Their responses proved Carroll's (1964: 97) statement of how individuals develop cognitive vocabulary: 'People vary in the degree to which they notice and concern themselves with the various kinds of attributes that characterise the things and events of the environment'. For example, in 'Colour' category, one group of peoples gave their classification by colour's attributes (e.g. hue, emotion, etc.) and another classified by types of colour (warm, cold, etc.) However, the results showed when they all gave the classification in same direction, they all had the same members, such as 'Texture' and 'Emotion' categories.

Table B.16: Results of 'Colour' members

COLOUR			
Hue	Red	Shade	Warm
Emotion	Green	Nature	Cold
Indicators	Blue	Sun	Bright
Race	Yellow	Light	Dark
Politics	Orange	UV	Cloudy
Gender	Violet	Water	Wet
	Ultra red	Eyeball	Texture
	Ultra violet	Dust	Happy
			Sad

Table B.17: Results of 'Material' members

MATERIAL		
In/organic	Metal	Strong
Texture	Plastic	Weak
Density	Fabric	Soft
Colour	Glass	Flexible
Rigidity	Wood	Rigid
Malleability	Ceramic	Texture
Ductility		Hard
Properties		Brittle
State		Hot

Table B.18: Results of 'Texture' members

TEXTURE		
Softness	Smooth	Smooth
Hardness	Rough	Soft
Roughness	Brushed	Rough
Stickiness	Polished	Shiny
Furriness		Hard
Greasiness		Silky
Heat		
Wetness		

Table B.19: Results of 'Form' members

FORM			
Organic	Organic	Liquid	Flexible
Geometric	Engineered	Hard-soft	Geometric
Sexiness	Cubic	Curve	Organic
Gender	Slim	Texture	Symmetric
Function	Smooth		Bumpy
			Wavy
			Pattern

Table B.20: Results of 'value' members

VALUE			
Time	Cheap	Stocks	High
Money	Expensive	Risk	Low
Emotional	Affordable	Wallet	Quality
		Comparison	Price
			Expensive
			Cheep

Table B.21: Results of 'Style' members

STYLE			
Period	Modern	Money	Trendy
Country	Futuristic	Opinion	Nice
Social	Retro	Body	Good
	Chick	Soft/hard	Modern
	Classy	Trend	Minimum
		Materials	Old
		Origin	Classic
			Mole
			Female

Table B.22: Results of 'Lifestyle' members

LIFESTYLE			
Business	Spottiness	Furniture	Rich

Family	Sedentary	Might life	Poor
Single	Workaholic	Design	Trendy
Urbanity/ rural		Architecture	Glamorous
		Fashion	Lonely
		Money	Generation
		TV	
		Art	
		Travel	

Table B.23: Results of 'Character' members

CHARACTER			
Goodness		Clothes	Good
Humour		High end low end	Motivated
Weirdness		Price	Bubbly
Intelligence		Place	Talkative
Calmness		Position	Shy
		Context	Snobbish
			Friendly
			Nice
			Bad

Table B.24: Results of Emotion' members

EMOTION			
Happiness	Happiness	Tears	Happy
Anger	Sadness	Happiness	Light
Fear	Stressed	Sadness	Dark
Jealous	Relaxed	Feelings	Sounds
Behaviour		Love	Sad
		Aging	Nice
		Hate	

Table B.25: Results of 'Activity' members

ACTIVITY			
Out/indoor	Outdoors	Sports	Moving
Type	Indoors	Job	Hopping
Place		Sex	Jumping
Time		Sleep	Running
Equipment		Dreaming	Walking
Group/solo (number)		Playing	Flying
		Thinking	Driving
		Traveling	Writing
		Hearing	Talking

Table B.26: Results of 'Time' members

TIME			
Amount	Morning	place	Early
Consciousness perceived	Noon	Position	Late
Management	Evening	Day & night	Morning
	Afternoon	History	Lunch
	Night	Future	Noon
		New/old	Dinner
		Young	Sleep
		Space	
		Dateline	
		Independent/ dependent on time	

Table B.27: Results of 'People' members

PEOPLE			
Age	Male		Old

Gender	Female		Young
Sex	Hermaphrodite		Happy
Race	Age		Fat
Hairstyle	Height		Thin
Clothes	Race		Short
Group			Tall
Disability			Heavy
Abilities			Light

Table B.28: Results of 'Place' members

PLACE			
Country	Galaxy	Towns	Box
Space	Solar system	Country	High
Enclosure	Earth	Mountains	Low
Atmosphere	Continent	Fields	Tiny
Use	Counting	Oceans	Large
	Region	Isolation	Public
	City	Weather	Private
	Village	Attitude	Nice
		Longitude	Ugly

Appendix C
Classifications

The following shows the methods used to classify the descriptive keywords before used prototype theory and the **concepts** idea was adopted (See Section 5.3.3):

Thesaurus

The workshop results showed that different words which have similar meanings might be used in describing the same image. Therefore, the first method was planed to group words associated with the thesaurus (synonyms). The categorization method was following the procedures below:

Step 1: the collection of keywords from interview scripts was listed alphabetically with number.

Step 2: each word was checked by the thesaurus. If the keywords in the list were in the thesaurus under the keyword checked, they would be cross out of the list, as shown in Table C1.

Table C1. Word with its synonyms.

1.	Absolute	340 Solid
2.	Abundant	32 Bounteous
3.	Academic	189 Intellectual,
4.	Active	110 Energetic, 204 Lively, 100 Dynamic, 394 Vigorous, 238 Nimble, 13 Animated
5.	Admirable	115 Excellent, 113, 406 Wonderful, 35 Brilliant, 265,
6.	Adult	-
7.	Aesthetic	-
8.	Affable	143 Friendly, 264 Pleasant
~~9.~~	~~Aggressive~~	-
10.	Airy	-
11.	Alluring	30 Bewitching, 24 Attractive, 41 Charming, 109 Enchanting, 377 Tempting, 16 Appealing, 17 Appetizing
12.	Ancient	15 Antique, 14 Antiquated, 391 Venerable, 18 Archaism, classical
~~13.~~	~~Animated~~	-
~~14.~~	~~Antiquated~~	-
~~15.~~	~~Antique~~	-
~~16.~~	~~Appealing~~	-
~~17.~~	~~Appetizing~~	80 Delicious,
~~18.~~	~~Archaism~~	-
19.	Aromatic	(smell)
20.	Aroused	-
21.	Artless	185 Innocent, 233 Naïve, 329 Simple, 184 Ingenuous, 330 Sincere
22.	Assertive	61 Confident, 60 Confidence, 23 Assured, 272 Positive, 9 Aggressive, 134 Firm, 26 Authentic
~~23.~~	~~Assured~~	-
~~24.~~	~~Attractive~~	-
25.	August	-
~~26.~~	~~Authentic~~	-
27.	Balanced	355 Steady,
28.	Basic	263 Plain, 329
29.	Beautiful	24 Attractive, 208 Lovely, 277 Pretty, 157 Gorgeous, 106 Elegant, 124 Exquisite, 41 Charming, 265 Pleasing, 78 Decorative, 344 Spectacular, 367 Superb, 133 Fine, 158 Graceful, 55 Comely, 288 Pulchritudinous
~~30.~~	~~Bewitching~~	

This method was abandoned firstly, because there were ambiguous words among groups. For example, 'smart' could use to mean intelligent or stylish. It is difficult to decide 'smart' should go with which meaning and if both meanings were all taken into account, the amount of results would be more than the original words. Secondly, there are words which have the same synonymous but their meaning are different, for example 'Alluring' and 'Beautiful' in Table C1. Finally, there are words found in the same group but some of them are rational words and some of them evoke feelings, for example, in Table C1, most of synonymous within ' Beautiful' are emotional words, but 'Decorative' is a rational response.

This classification method involves a lot of ambiguous boundaries; therefore, the categorisation method was reconsidered.

Questionnaire

The questionnaire was used as second method to ask people to divide the descriptive words into the 10 categories (see figure C-02) as a first step of classification. The ten categories are the information types from interview results (see Section 4.1.4). After finishing two questionnaire pilots, this method was abandoned. The questionnaire was found to be too difficult to answer by participants and it also took too long to fill in. Also it proved Vernon (1962) and Carroll's (1964) proposal that the variation of using language among people.

1.	Absolute					
2.	Abundant					
3.	Academic					
4.	Active					
5.	Admirable					
6.	Adult					
7.	Aesthetic					
8.	Affable					
9.	Aggressive					
10.	Airy					
11.	Alluring					

(1) Colour
(2) Material
(3) Form
(4) Texture
(5) User
(6) Place
(7) Activity
(8) Emotion
(9) Characteristic
(10) Value

Figure C-02: part of questionnaire layout and the 10 categories.

Appendix D
Keywords

D1. Keywords from interviews

The keywords (table D.1) were collected from 17 interviewees' descriptions of 4 products and 5 images. 'Frequency of use' represents the number of times keywords were used by different interviewees. If an interviewee used the same word several times, it was still counted as one.

Table D.2 is the list of keyword concepts collected from *Roget's Interactive Thesaurus*, First Edition (v 1.0.0) © 2004 by Lexico Publishing Group (www.thesaurus.com) in January 2004. In this table, the concepts are the original concepts from the thesaurus. The concepts presented in table D.3 are concepts which have been reduced. For example, 'bright' originally has 8 concept (Brightness, Weather action, Intelligence, Hope, Happiness, Importance, and Colour). However, only two concepts (Brightness, and Colour), which were closely related to the design process, were chosen.

Table D.1: List of keywords collected from the interview

Keyword	Frequency of use
50s	(6)
60s	(1)
80s	(3)
Adjustable	(1)
Appreciated	(1)
Attractive	(1)
Awkward	(1)
Balance	(1)
Beautiful	(1)
Bizarre	(1)
Boring	(1)
Bright	(1)
Cheap	(5)
Cheerful	(1)
Childish	(2)
Classic	(4)
Classical	(1)
Clever	(1)
Cold	(3)
Comfortable	(4)
Complicate	(2)
Confusing	(1)
Conservative	(1)
Contemporary	(2)
Cool	(4)
Cosy	(1)
Cute	(1)
Decorative	(2)
Different	(2)
Disappoint	(2)
Dynamic	(1)
Elegant	(1)
Energy	(1)
Engineering	(3)
Ergonomic	(5)
European	(1)
Exciting	(2)
Expensive	(4)
Fake	(1)
Fantastic	(1)
Fascinating	(1)
Fast	(1)
Fishable	(1)
Friendly	(9)
Fun	(7)
Functional	(5)
Funky	(2)
Genius	(1)
Geometric	(6)
Good	(6)
Great	(1)
Happy	(1)
Hard	(1)

Heavy	(8)
High quality	(5)
High tech	(4)
Horrible	(2)
Impressive	(1)
Individual	(1)
Industrial	(1)
Integrate	(2)
Interesting	(4)
Fit	(1)
Jewellery	(1)
Jumping	(1)
Loose	(1)
Low tech	(2)
Mature	(1)
Mechanical	(3)
Middle	(1)
Modern	(4)
Mystery	(2)
Nature	(2)
Nice	(16)
Old	(1)
Organic	(2)
Original	(1)
Particular	(1)
Peaceful	(1)
Playful	(4)
Portable	(1)
Pure	(3)
Quality	(8)
Real	(1)
Reasonable	(1)
Recreated	(1)
Relax	(1)
Reliable	(1)
Romantic	(2)
Safety	(1)
Satisfied	(1)
Scrappy	(1)
Semantics	(1)
Serious	(3)
Sharp	(1)
Simple	(7)
Simplistic	(1)
Simulate	(1)
Small	(1)
Smooth	(2)
Soft	(4)
Sophisticated	(2)
Special	(4)
Speed	(3)
Sporty	(2)
Sticky	(1)
Strong	(1)
Styling	(5)
Substantial	(1)
Technical	(8)
Thick	(1)
Traditional	(2)
Typical	(1)
Ugly	(2)
Uniform	(1)
Unnecessary	(1)
Valuable	(1)
Warm	(1)
Weak	(1)
Young	(2)
Total: 120	(272)

Table D2: List of keyword concepts before being reduced

Keyword	Concept
50s	
60s	
80s	
Adjustable	Changing
Appreciated	Expectation Importance (great) Desire
Attractive	Beauty
Awkward	Inability Difficulty Unsocial action
Balance	Equivalence Behaviour (good) Financial entity
Beautiful	Beauty
Bizarre	Uncommonness Abnormality
Boring	Uninterestingness
Bright	Brightness Weather action Intelligence Hope Happiness Importance (great) Colour
Cheap	Fee/price/cost Inferiority Immorality
Cheerful	Happiness
Childish	Behaviour
Classic	Superiority Commonness
Classical	Age (old) Stylishness
Clever	Intelligence
Cold	Temperature (cold) Personality quality
Comfortable	Physical change Financial quality
Complicate	Complexity
Confusing	Confusion
Conservative	Personality quality
Contemporary	Age (young) Timeliness
Cool	Temperature (cold) Personality quality Behaviour (bad) Positiveness
Cosy	Location entity
Cute	Beauty
Decorative	Decoration

Different	Difference
	Separateness
	Nonconformity
Disappoint	Disappointment
Dynamic	Force
Elegant	Stylishness
Energy	Personality entity energy entity
Engineering	Discipline/study
Ergonomic	-
European	-
Exciting	Effectiveness
Expensive	Fee/price/cost
Fake	Imitation
Fantastic	Difference
	Quantity (large)
	Superiority
Fascinating	Interestingness
Fast	Speed (fast)
	Stability
	Immorality
Fashionable	Stylishness
Friendly	Friendship
Fun	Happiness
Functional	Usefulness
Funky	Simplicity
	Abnormality
Genius	Intelligence
Geometric	-
Good	Positiveness
	Morality
	Ability
	Usefulness
	Cleanliness
	Kindness
	Realness
	Behaviour (good)
	Quantity (large)
Great	Size (large)
	Importance (great)
	Superiority
Happy	Happiness
	Fate
Hard	Texture (hard)
	Difficulty
	Unkindness
	Truth
Heavy	Weight (heavy)
	Difficulty
	Sadness
	Motion (slow)
High quality	Superiority
High tech	Complexity
Horrible	Negativeness
Impressive	Superiority
Individual	Specificity
Industrial	Business entity
Integrated	Completeness
Interesting	Interestingness
Fit	Suitability
	Health (good)
Jewellery	Merchandise
Jumping	Decoration
	Effort
	Usefulness
	Happiness
	Enthusiasm
Loose	Freedom
	Sexuality
Low tech	Experience
	Ignorance
Mature	Age (old)
Mechanical	Machine
Middle	Middle position/part
Modern	Stylishness
Mystery	Inaccessibility
Nature	Personality entity status/class
	Aliveness
Nice	Positiveness
	Specificity
Old	Age (old)
	Unusefulness

	Commonness
Organic	Origin/source
Original	First position/part
	Creating
Particular	Uncommonness
	Specificity
Peaceful	Kindness
Playful	Recreation action
Portable	Moveableness
Pure	Simplicity
	Cleanliness
	Morality
	Completeness
	Belief/theory
Quality	Manner-quality
	Status/class
Real	Realness
Reasonable	Suitability
	Intelligence
Recreated	-
Relax	Decrease
	Relaxation
Reliable	Trust
Romantic	Positiveness
Safety	Safety
Satisfied	Liking
	Relaxation
	Belief/theory
	Definiteness
	Happiness
	Personality quality
Scrappy	Unkindness
	Behavior (bad)
	Fighting
Semantics	-
Serious	Definiteness
	Importance (great)
Sharp	Texture (sharp)
	Definiteness
	Intelligence
	Immorality
	Intensity
	Stylishness
	Unkindness
	Physical change
Simple	Comprehension/understanding
	Simplicity
	Behaviour
	Ignorance
Simplistic	-
Simulate	Imitation
Small	Size (small)
	Unimportance
	Unkindness
Smooth	Texture (smooth)
	Behaviour (good)
Soft	Texture (soft)
	Weakness
	Kindness
	Body structure/condition
	Ignorance
Sophisticated	Stylishness
	Complexity
Special	Importance (great)
Speed	Speed motion (fast)
Sporty	Stylishness
Sticky	Texture
	Temperature (hot)
	Difficulty
Strong	Strength
	Personality quality
	Definiteness
	Intensity
	Physical change
Styling	-
Substantial	Importance
	Realness
	Financial quality
Technical	Discipline/study
Thick	Size (large)
	Density (thick)
	Quantity (large)

	Ignorance
	Weather entity
	Friendship
	Improbability
Traditional	Tradition/rite
Typical	Commonness
Ugly	Ugliness
	Negativeness
	Danger
Uniform	Constancy
	Similarity
Unnecessary	Unusefulness
Valuable	Importance (great)
Warm	Temperature (medium)
	Friendship
	Enthusiasm
Weak	Weakness
	Ignorance
	Sound (soft)
	Lack
	Accessibility
	Food entity
Young	Age (young)

Table D.3: List of keyword concepts after being reduced

Keyword	**Concept**
50s	
60s	
80s	
Adjustable	Changing
Appreciated	Expectation
	Importance (great)
	Desire
Attractive	Beauty
Awkward	Inability
	Difficulty
	Unsocial action
Balance	Equivalence
	Behaviour (good)
	Financial entity
Beautiful	Beauty
Bizarre	Uncommonness
	Abnormality
Boring	Uninterestingness
Bright	Brightness
	Colour
Cheap	Fee/price/cost
	Inferiority
	Immorality
Cheerful	Happiness
Childish	Behaviour
Classic	Superiority
	Commonness
Classical	Age (old)
	Stylishness
Clever	Intelligence
Cold	Temperature (cold)
	Personality quality
Comfortable	Physical change
	Financial quality
Complicate	Complexity
Confusing	Confusion
Conservative	Personality quality
Contemporary	Age (young)
	Timeliness
Cool	Temperature (cold)
	Personality quality
	Behaviour (bad)
	Positiveness
Cosy	Location entity
Cute	Beauty
Decorative	Decoration
Different	Difference
	Separateness
	Nonconformity
Disappoint	Disappointment
Dynamic	Force
Elegant	Stylishness
Energy	Personality entity energy entity
Engineering	Discipline/study
Ergonomic	-
European	-
Exciting	Effectiveness
Expensive	Fee/price/cost
Fake	Imitation
Fantastic	Difference
	Quantity (large)
	Superiority
Fascinating	Interestingness
Fast	Speed (fast)
	Stability
	Immorality
Fashionable	Stylishness
Friendly	Friendship
Fun	Happiness
Functional	Usefulness
Funky	Simplicity
	Abnormality
Genius	Intelligence
Geometric	-
Good	Positiveness
	Usefulness
	Kindness
	Behaviour (good)
Great	Importance (great)
	Superiority
Happy	Happiness
Hard	Texture (hard)
	Difficulty
	Unkindness
	Truth
Heavy	Weight (heavy)
	Difficulty
	Motion (slow)
High quality	Superiority
High tech	Complexity
Horrible	Negativeness
Impressive	Superiority
Individual	Specificity
Industrial	Business entity
Integrated	Completeness
Interesting	Interestingness
Fit	Suitability
	Health (good)
Jewellery	Merchandise
Jumping	Decoration
	Effort
	Usefulness
	Happiness
	Enthusiasm
Loose	Freedom
	Sexuality
Low tech	Experience
	Ignorance
Mature	Age (old)
Mechanical	Machine
Middle	Middle position/part
Modern	Stylishness
Mystery	Inaccessibility

Nature	Personality entity status/class Aliveness
Nice	Positiveness Specificity
Old	Age (old) Unusefulness Commonness
Organic	Origin/source
Original	First position/part Creating
Particular	Specificity Uncommonness Specificity
Peaceful	Kindness
Playful	Recreation action
Portable	Moveableness
Pure	Simplicity Cleanliness Morality Completeness Belief/theory
Quality	Manner-quality Status/class
Real	Realness
Reasonable	Suitability Intelligence
Recreated	-
Relax	Decrease Relaxation
Reliable	Trust
Romantic	Positiveness
Safety	Safety
Satisfied	Liking Relaxation Belief/theory Definiteness Happiness Personality quality
Scrappy	Unkindness Behavior (bad) Fighting
Semantics	-
Serious	Definiteness Importance (great)
Sharp	Texture (sharp) Definiteness Intelligence Immorality Intensity Stylishness Unkindness Physical change
Simple	Comprehension/understandin g Simplicity Behavior
	Ignorance
Simplistic	-
Simulate	Imitation
Small	Size (small) Unimportance Unkindness
Smooth	Texture (smooth) Behaviour (good)
Soft	Texture (soft)
Sophisticated	Stylishness Complexity
Special	Importance (great)
Speed	Speed motion (fast)
Sporty	Stylishness
Sticky	Texture Temperature (hot)
Strong	Strength Personality quality Definiteness Intensity Physical change
Styling	-
Substantial	Importance Realness Financial quality
Technical	Discipline/study
Thick	Size (large) Density (thick) Quantity (large) Ignorance Weather entity Friendship Improbability
Traditional	Tradition/rite
Typical	Commonness
Ugly	Ugliness Negativeness
Uniform	Constancy Similarity
Unnecessary	Unusefulness
Valuable	Importance (great)
Warm	Temperature (medium) Enthusiasm
Weak	Weakness Ignorance Sound (soft) Lack Accessibility
Young	Age (young)

D2. Keywords from *Colours in Context*

Table D.4 is Kuno's (1999) *Colours In Context* list of "Image words". There are 538 words which describe the colour images chosen by Kuno under 56 themes such as age, personality, sex etc.

The number of keywords in table D.5 has been reduced to 146, after a discussion with Martin Darbyshire, Tangerine Product Direction and Design. Concepts which have also been reduced from the original concepts were collected from *Roget's Interactive Thesaurus*, First Edition (v 1.0.0) © 2004 by Lexico Publishing Group (www.thesaurus.com) in January 2004.

Table D.4: Kuno's (1999) "Image words" in *Colours In Context*

Absolute	Browned	Courtly	Dull
Abundant	Burnt	Craving	Dynamic
Academic	Calm	Creamy	Eager
Acidic	Capricious	Dainty	Earthy
Active	Carefree	Damp	Easygoing
Admirable	Caustic	Dancing	Eccentric
Adult	Centripetal	Dandy	Elaborate
Aesthetic	Ceremonious	Dangerous	Elegant
Affable	Charming	Dark	Elite
Aggressive	Chaste	Dauntless	Emotional
Airy	Cheerful	Dazzling	Empty
Alluring	Chemical	Decadent	Enchanting
Ancient	Chic	Decorative	Energetic
Animated	Chilly	Deep	Enigmatic
Antiquated	Citrus	Delicate	Ennui
Antique	Classic	Delicious	Enrapturing
Appealing	Clean	Deluxe	Earnest
Appetizing	Clear	Demanding	Ethnic
Archaism	Clever	Dense	Exalted
Aromatic	Cloudy	Dependable	Excellent
Aroused	Coarse	Depressed	Exciting
Artless	Cold	Deranged	Executive
Assertive	Cold-hearted	Deserted	Exhilarating
Assured	Comely	Desolate	Exotic
Attractive	Comfortable	Developmental	Expensive
August	Comfortably warm	Devout	Experienced
Authentic	Complex	Diffident	Explicit
Balanced	Complicated	Dignified	Explosive
Basic	Condensed	Discerning	Exquisite
Beautiful	Confidence	Discreet	Extreme
Bewitching	Confident	Distant	Fanatic
Bitter	Congenial	Distinctive	Fancy
Blasted	Conservative	Distinguished	Fantasy
Blessed	Conspicuous	Distressing	Feminine
Boiled down	Cooked	Docile	Feral
Bold	Cool	Dramatic	Ferocious
Bounteous	Coquettish	Dreamlike	Fertile
Bracing	Cosmic	Dreamy	Festive
Bright	Courageous	Dressy	Fever
Brilliant	Courteous	Dry	Feverish

Fine
Fine-grained
Firm
Fit
Flavourful
Fleeting
Floral
Flourishing
Folklore
Folklorist
Foreign
Fragrant
Frail
Free hearted
Fresh
Friendly
Frozen
Fruity
Fulfilling
Full-bodied
Fully-matured
Functional
Funky
Furious
Gallant
Gaudy
Genteel
Gentle
Germinal
Glaring
Gleaming
Glittering
Gloomy
Glorious
Good-humoured
Gorgeous
Graceful
Grandeur
Great-hearted
Grim
Grouchy
Hale
Hallucinatory
Happy
Hard
Haughty
Having momentum
Healthy
Heated
Heavy
High class
High grade
High-minded
High-quality
Homely
Hopeful
Horrendous
Hot
Humane
Humanity
Humid
Humorous
Hushed

Ill-fated
Illusion
Illusionary
Immaculate
Impact
Imposing
Impressive
Incandescent
Incinerated
Incisive
Indifferent
Influential
Ingenuous
Innocent
Innovative
Inspirational
Intellect
Intellectual
Intelligence
Intensely hot
Intimidating
Invigorating
Invincible
Jolly
Joyous
Juicy
Keen
Kind
Languid
Latin
Latinate
Leaden
Leisured
Liberated
Light
Light-hearted
Limitless
Limpid
Lively
Local
Lofty
Logical
Lovely
Lucky
Lush
Lustrous
Magestic
Magical
Magnanimous
Magnificent
Masculine
Mature
Meek
Melancholic
Mellow
Melodious
Merry
Metropolitan
Mild
Milky
Miraculous
Mischievous
Misty

Moderate
Modest
Modish
Moist
Motivated
Murky
Mysterious
Mystic
Mystique
Naïve
Natural
Neat
New
Ingenuous
Nihilistic
Nimble
Innocent
Noble
Noisy
Nostalgic
Nourishing
Nutritious
Obscure
Obvious
Old
Open
Oppressive
Optimistic
Opulent
Orderly
Origin
Original
Orthodox
Outstanding
Overgrown
Overripe
Oxidized
Passionate
Pastoral
Patriarchal
Peaceful
Pensive
Perfection
Perfumed
Persevering
Pessimistic
Philanthropic
Plain
Pleasant
Pleasing
Pleasurable
Plenteous
Plump
Poetic
Polite
Pop
Positive
Powerful
Precious
Precise
Pressing
Prestige
Prestigious

Pretty
Primitive
Principled
Pristine
Profound
Progressive
Prosperous
Proud
Proud-spirited
Prudent
Psychedelic
Pulchritudinous
Punctilious
Pungent
Pure
Purified
Quality
Quiet
Radiant
Radical
Raging
Rarefied
Rational
Refined
Refreshing
Refreshing beauty
Relaxed
Reliable
Relief
Resentful
Resolute
Restful
Retrospective
Rhythmical
Rich
Ripe
Ripeness
Roasted
Robust
Romantic
Rough
Rowdy
Rugged
Rural
Rustic
Rustling
Sacred
Sad
Safe
Safety
Sagacious
Savage
Scarce
Secluded
Secret
Secretive
Self-possessed
Sensational
Sensitive
Sentimental
Serene
Serious
Severe

Sexy	Straight	Tasteful	Untouched
Shaded	Stalwart	Technical	Up-and-coming
Sharp	Stamina	Temperate	Vague
Shiny	Static	Tempting	Valuable
Shocking	Statuesque	Tenacious	Vast
Shy	Steady	Tension	Venerable
Silent	Still	Terrible	Verisimilitude
Simple	Simulative	Thick	Very moist
Sincere	Stirring	Thorough	Victorious
Skilful	Stodgy	Threatening	Vigorous
Slender	Stoic	Thrilling	Vintage
Slow	Straight	Thriving	Violent
Small	Strange	Tight	Visionary
Smart	Strong-willed	Tolerant	Vitality
Smoky	Stylish	Tough	Vivid
Smooth	Subdued	Traditional	Volatile
Soft	Sublime	Tranquil	Volume
Softened	Submissive	Translucent	Voluminous
Solemn	Substantial	Transparent	Voluptuous
Solid	Sufficient	Tropical	Warm
Sonorous	Sultry	Uncanny	Warmth
Sophisticated	Sun-drenched	Unclouded	Wavering
Sorrow	Superb	Uncultivated	Wild
Sorrowful	Supremely beautiful	Uneasy	Wise
Sparking	Supernatural	Unique	Witty
Spectacular	Supple	Unknown	Wonderful
Speedy	Sure	Unlimited	Woody
Spellbound	Suspicious	Unmistakable	Young
Spicy	Sweet	Unprepossessing	Youthful
Splendid	Sweet & sour	Unsettled	
Sporty	Talented	Untainted	
Stagnant	Tangy	Untamed	

Table D.5: List of keywords' concepts

Word	**Concept**
Absolute	Superiority Definiteness
Active	Motion
Admirable	Superiority
Affable	Friendship
Aggressive	Desire Intensity
Airy	Density Weight (light) Happiness
Alluring	-
Animated	Happiness
Antiquated	Uncommonness
Aromatic	Odor (good)
Assured	Definiteness Personality quality
August	Superiority
Authentic	Realness
Balanced	Equivalence Financial action
Basic	Importance
Beautiful	Beauty
Bright	Brightness Colour
Calm	Inaction Relaxation
Cheerful	Happiness
Chic	Stylishness
Classic	Superiority Commonness
Clean	Cleanliness Medical entity Sexuality Definiteness Completeness
Clear	Weather entity Comprehension/understan ding Freedom Law entity Texture Definiteness
Clever	Intelligence
Coarse	Immorality Texture (rough)
Cold	Temperature (cold) Personality quality
Comfortable	Physical change Financial quality
Complex	Complexity Comprehension /understanding
Complicated	Complexity
Confident	Personality quality
Cool	Temperature (cold) Personality quality Behaviour (bad) Positiveness
Dandy	Superiority
Decorative	Decoration
Delicate	-
Dense	Density (thick) Intelligence

Dignified	Importance (great)
Discreet	Caution
Distinctive	Nonconformity
Docile	Personality quality
Dramatic	Interestingness
Dynamic	Force
Earthy	Simplicity
Easygoing	Personality quality
Elaborate	Complexity
Elegant	Stylishness
Emotional	Mental sensing
Ethnic	Origin/source
Excellent	Superiority
Exciting	Effectiveness
Explicit	Definiteness
Exquisite	Superiority intensity
Fancy	Stylishness
Feminine	Sexuality
Firm	Texture (hard) Stability
Fit	Suitability
Fragrant	Odor (good)
Fresh	Age (young) Addition Effectiveness Health (good) Unpreparedness Behaviour (bad)
Friendly	Friendship
Funky	-
Gaudy	Stylishness
Gentle	Effectiveness Physical change Sociable entity
Glittering	-
Graceful	Stylishness
Grim	Hopelessness
Happy	Happiness fate
Hard	Texture (hard) Difficulty Unkindness Truth
Healthy	Positiveness Health (good)
Heavy	Weight (heavy)
Hot	Temperature (hot) Taste Anger Stylishness Sexuality
Humorous	Humor
Immaculate	Cleanliness Morality
Indifferent	Neglect/ignoring
Influential	Importance (great)
Ingenuous	Truth
Innovative	Creating
Light	Brightness Weight (light) Quantity (small)
Masculine	Sexuality
Moist	Wetness
Natural	Commonness Behaviour (good) Food entity
Nostalgic	Remembering
Obvious	Definiteness
Open	Accessibility Usefulness
	Comprehension /understanding Indefiniteness Truth
Opulent	Financial quality
Orderly	Specificity Behaviour (good)
Organic	Origin/source
Original	First position/part Creating
Plain	Simplicity Ugliness
Positive	Definiteness Usefulness
Powerful	Strength
Precious	Importance (great) Specificity
Precise	Specificity Caution
Prestigious	Importance (great)
Pretty	Beauty
Primitive	Time (early) Unpreparedness
Pure	Simplicity
Quiet	Sound (soft) Relaxation Simplicity
Radiant	Brightness Happiness
Radical	Need Difference
Refined	Stylishness Cleanliness
Refreshing	-
Relaxed	-
Rhythmical	-
Rich	Financial quality Quantity (large) Taste (good) Intensity Humour
Robust	Health (good)
Rugged	Texture (rough) Weather action Behaviour (bad) Difficulty Body structure/condition
Rustic	Location entity Ignorance
Serious	Definiteness Importance (great)
Sharp	Texture (sharp) Stylishness
Shiny	Brightness
Silent	Sound (soft) Comprehension/understan ding
Simple	Simplicity
Small	Size (small)
Smart	Intelligence Stylishness
Smooth	Texture (smooth) Behaviour (good)
Soft	Texture (soft)
Solid	Texture (hard)
Spicy	Taste (good) Immorality
Sporty	-
Still	Inaction
Straight	Shape entity Truth Sequence/order

	Food entity Commonness
Strange	Controlling
Substantial	Importance Realness Financial quality
Supple	Texture (soft)
Sure	Stability Constancy Personality quality
Sweet	Taste (good) Kindness Odour (good) Sound (soft)
Tangy	-
Tasteful	Stylishness
Technical	Discipline/study
Thorough	Completeness Definiteness
Traditional	Tradition/rite
Tranquil	Relaxation
Translucent	Colour
Transparent	Colour Comprehension/understanding
Unique	Aloneness Specificity
Vague	Indefiniteness
Valuable	Importance (great)
Vast	Size (large)
Visionary	Concept/idea
Vivid	Intensity
Volatile	Changing
Warm	Temperature (medium)
Wild	Origin/source Behaviour (bad) Intensity
Wise	Intelligence
Witty	Humour
Wonderful	Superiority
Youthful	Age (young)

Appendix E
Evaluations

E1. ImageNexus instruction

ImageNexus is an image storage database for professional industrial designers' use. It is based on the information used from images (see Figure 1). It provides categories to record images. The categories are divided into three divisions: Specification, Characteristic, and Emotion (see Figure 2).

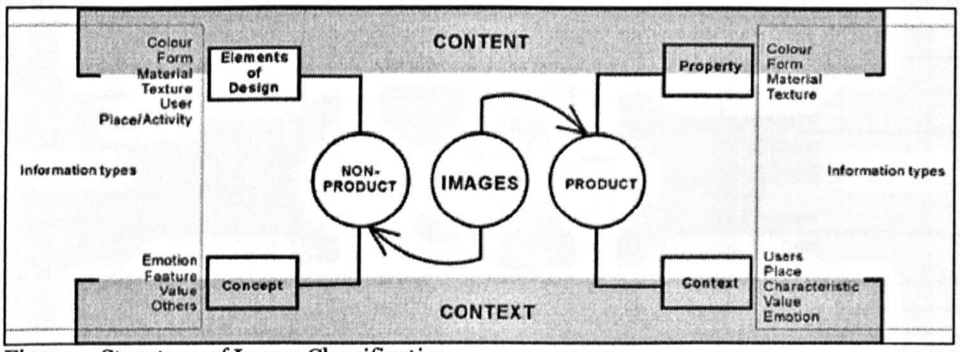


Figure 1. Structure of Image Classification

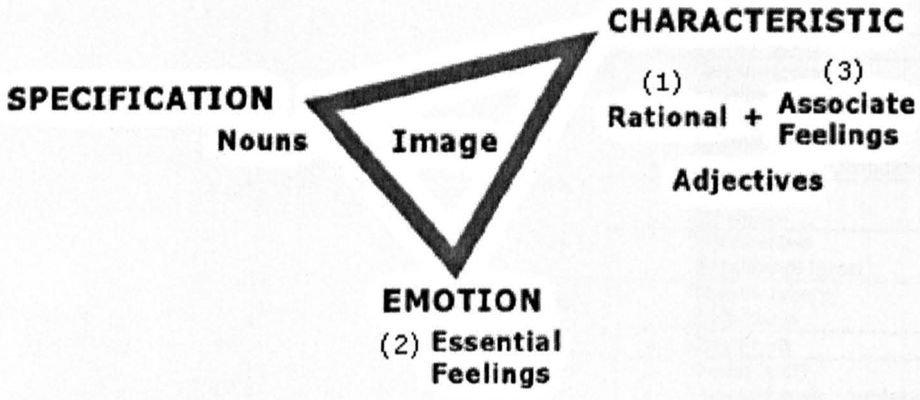


Figure 2. The three information areas of an Image

(1) Rational: indicates viewer's rational responses to the image.

(2) Essential Feeling: direct responses which are an emotional reaction to an image or a product. For example, "it is comfortable".

(3) Associate Feeling: indirect responses which are caused by a part of an image context or a product property. For example, "this function is clever".

Specification:

Specification is about product properties and market segmentations. Its categories and its keyword members are:

Material	*Colour*	*Form*	*Texture*	*Users*	*Places/activities*	*Product Field*
Steel/Iron	Violet group	Representational	Smooth	Gender	Home	Electric
Stainless steel	Blue group	Natural/organic	Rough	Male	Office	Domestic
Aluminium	Blue-green group	Man-made	Soft	Female	School	Furnisher
Copper	Green group	Verbal	Hard		Public space	Transport
Glass	Yellow group	Abstract		Age	Out door	Medical
Rubber	Orange group	Calligraphic		Under 6	Sport	
Wood	Brown group	Geometric		6-11	Water sport	
Plastics	Red group	Others		12-19	Winter sport	
Ceramics/Porcelain	Pink group			20-34	Restaurant	
Composite and	Grey group			35-49		
compound materials	White			50-64 65+		
Others	Black Others					
				Class		
				Upper		
				Uppers		
				Lower		
				Uppers		
				Upper		
				Middles		
				Middle		
				Class		
				Working		
				Class		
				Upper		
				Lowers		
				Lower		
				Lowers		

Characteristic

This division provides information about the interpretations of images. It is a construct of tangible information interpreted by the viewer. The following two tables show how the Characteristic keywords are organised. The keyword categories are marked in yellow.

Level 1	*Level 2*	*Level 3*	*Keyword*
Subjective	Feelings	**Physical sensation**	Aromatic Comfortable Emotional Fragrant Moist Relaxed Silent Wild Tasteful Spicy Tangy Tranquil Cold Comfortable Cosy Relax
		Liking	Admirable Affable Alluring Gentle Sweet Appreciated Simulated
		Specificity	Distinctive Dramatic Unique Thorough Different Individual Particular Special
		Interestingness	Precious Interesting Exciting
		Kindness	Calm Peaceful
		General	Indifferent
	Positive	**Beauty**	Beautiful Pretty Attractive Cute Fascinating
		Superiority	August Clever Dandy Excellent Exciting Exquisite Innovative Powerful Smart Wonderful Witty Wise Classic Fantastic Cool Impressive Great Genius
		Quality	Classic Good Nice High-quality
		Happiness	Cheerful Delicate Graceful Happy Fun Satisfied Recreated Playful
	Negative	**Negative**	Grim Strange Vague Awkward Bizarre Boring Disappoint Horrible Ugly Weak Unnecessary Confusing

Level 1	*Level 2*	*Level 3*	*Level 4*	*Keyword*
Objective	Physical	Visual features	**Simplicity**	Earthy Plain Simple Simplistic
			Complexity	Complex Complicated Elaborate Sophisticated
			Formality	Technical Ergonomic Semantics Geometric
			Stylishness	Chic Cool Elegant Fancy Funky Gaudy Refined Fashionable Elegant Styling Funky
			Masculinity	Animated Masculine Energy Sporty Technical Engineering Mechanical Industrial
			Femininity	Decorative Feminine Romantic Jewellery
			General	Dynamic Nostalgic Rhythmical Sporty European
			Unstylishness	Antiquated Typical Conservative Uniform
			Period	Fresh Youthful Traditional 50s 60s 80s Modern Classical
		Functional features		Friendly Open Supple Adjustable Portable Functional
		Colour features		Bright Cold Glittering Hot Light Pure Radiant Warm Vivid Transparent Translucent
		Physical features		Dense Firm Fit Hard Heavy Humorous Sharp Shiny Small Solid Still Vast Straight Middle Thick
		Texture features		Coarse Rugged Smooth Soft Sticky Hard Jumping Sharp
	Behaviour			Active Aggressive Confident Discreet Docile Easygoing Ingenuous Quiet Childish
	Value			Valuable High-tech Low-tech Quality Reasonable Reliable
	Price			Opulent Rich Cheap Expensive
	Status	**Age**		Young Old Mature Contemporary
		Importance		Dignified Influential Prestigious Serious Substantial Valuable
		Component feature		Orderly Balanced Loose Integrate Fit Scrappy
		Origin/source		Ethnic Natural Organic Original Radical Primitive
		Safety/stability		Speed Fast Safe Strong
		General		Absolute Airy Assured Authentic Balanced Basic Clear Clean Explicit Healthy Immaculate Obvious Precise Refreshing Robust Rustic Visionary Sure Volatile Real Fake

Emotion:

This information area is intended to provide users with a record of their emotional reactions to images. It consists of 14 members:

Indignation, Contempt, Disgust, Unpleasant surprise, Dissatisfaction, Disappointment, Boredom, Desire, Pleasant surprise, Inspiration, Amusement, Admiration, Satisfaction, and Fascination.

How to do "Define an Image"

The screen shot below shows the interface classifying an image. The main part of the interface contains three sets of table (Zone A, Zone B and Zone E). Each set represents one of the divisions (i.e. Specification, Emotion, and Characteristic). Within these tables, each cell is a button (see figure 3 below).

Zone A represents Characteristic categories.

Zone B represents Specification categories.

Zone C shows images.

Zone D represents keyword members of Characteristic and Specification categories.

Zone E represents Emotion divisions. Zone F represents additional notes.

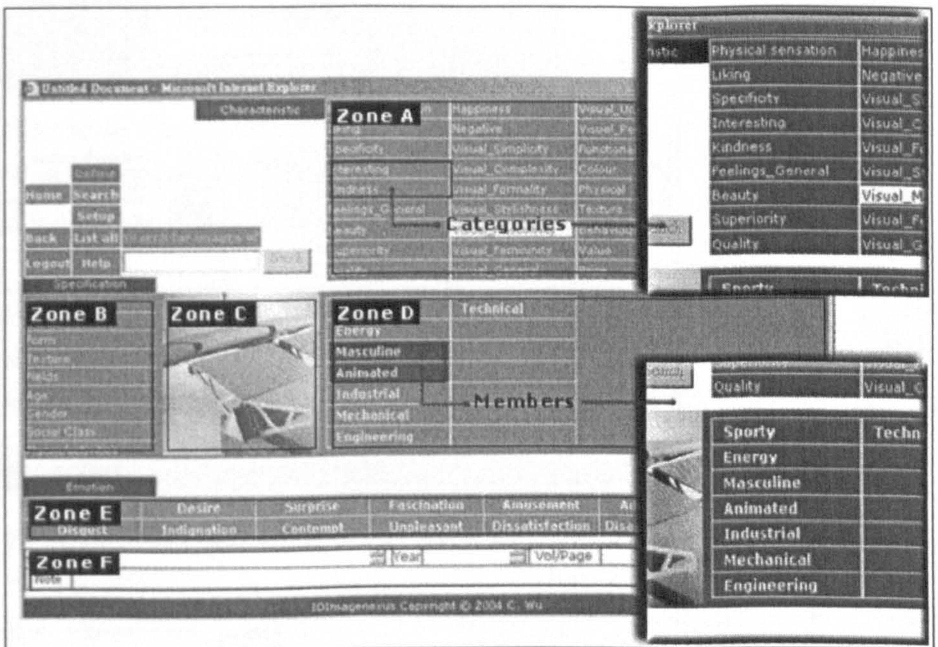


Figure 3. Screen shot of defining an image interface

How to do a "Search"

There are two ways to do an image search. One is to use the interface in the same way as the definition page; the other is to type in keywords in the Search area (figure 4). The results will be shown in the result page as in figure 5. Each result image can be enlarged, redefined, or deleted.

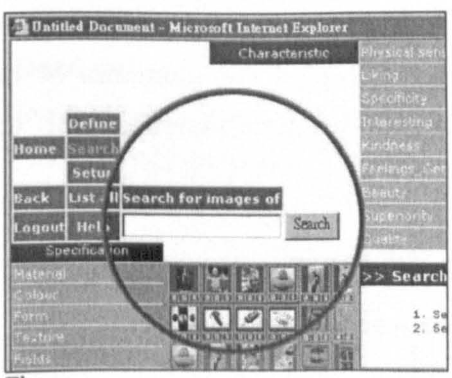


Figure 4

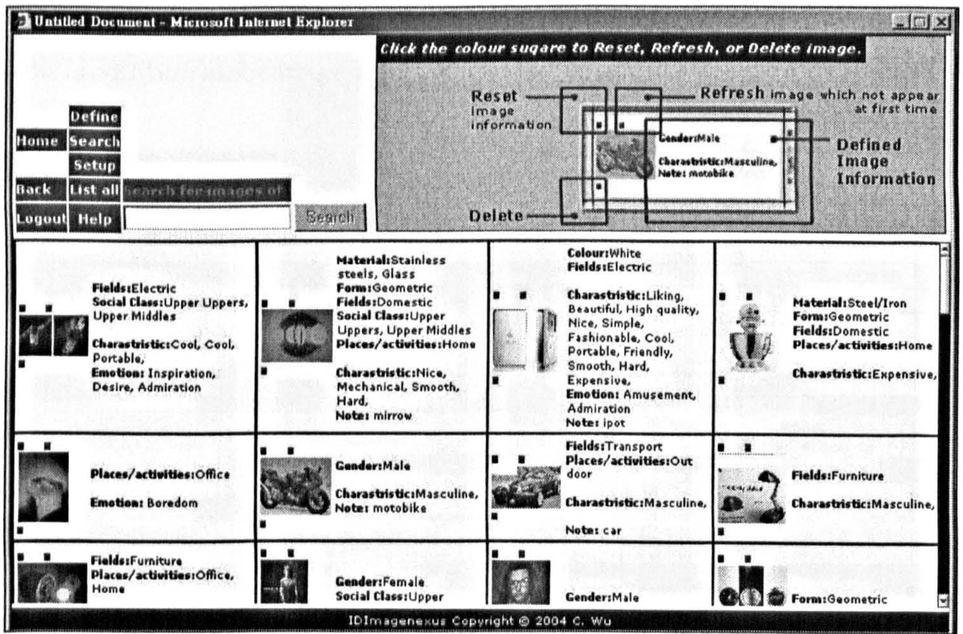
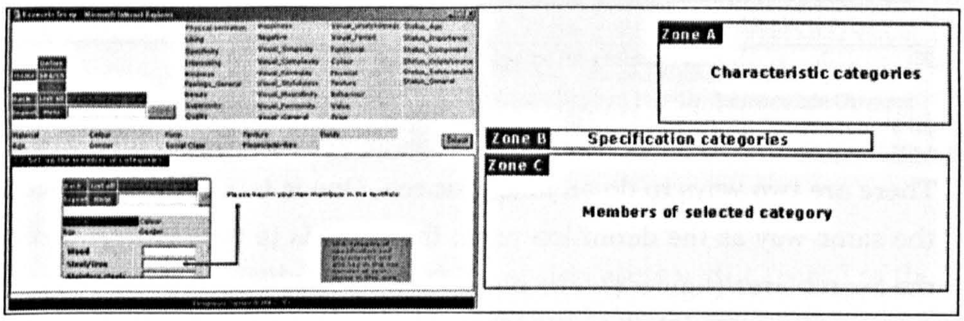
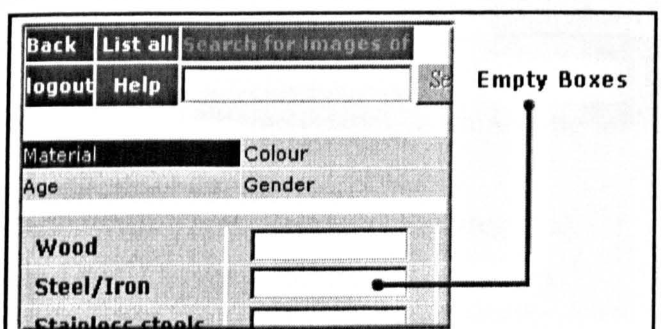


Figure 5

How to do "Add Keywords"



The "Set Up" page is for organising Specification and Characteristic divisions members. Zone A and Zone B are the categories of Specification and Characteristic. Zone C represents members of the selected category. To add new members, key new members into the empty boxes (see figure below).



E2. Evaluation phase 2 questions

Your User ID:

Please find images for **age** between **20-49 female**

How many images did you find? ________________________

Which did you use to search for the images?

□ Search box □ Specification □ Characteristic □ Emotion □ Additional Note

Please find images for "**Unpleasant**"

How many images did you find? ________________________

Which did you use to search for the images?

□ Search box □ Specification □ Characteristic □ Emotion□ Additional Note

Please find images with **at least one** of the words for "**Classic**", "**Steel**", or "**Outdoor**".

How many images did you find? ________________________

Which did you use to search for the images?

□ Search box □ Specification □ Characteristic □ Emotion □ Additional Note

Please find images for "**Warm**" and "**Stylish**"

How many images did you find? ________________________

Which did you use to search for the images?

□ Search box □ Specification □ Characteristic □ Emotion□ Additional Note

Please find images with **all** of the words for "**Classic**", "**Steel**", and "**Outdoor**".

How many images did you find? ________________________

Which did you use to search for the images?

□ Search box □ Specification □ Characteristic □ Emotion□ Additional Note

Appendix F
ImageNexus Instruction

ImageNexus is a web-based database. System requirements are:

- Windows 2000/SP/NT
- Microsoft Internet Information Service (IIS)
- Microsoft Access
- Internet Explorer 5.5+

To install:

Place the CD-ROM into your CD-ROM drive. You need to:

1. Copy the folder 'imagenexus' into: C:\Inetpub\wwwroot
2. Run aspupload.exe.
   This allows you to upload your images into the database.
   (aspupload.exe is a 30-day evaluation copy of AspUpload 3.0.0.4; You can purchase the license on http://www.aspupload.com)
3. Start using your ImageNexus at: <http://localhost/imagenexus>
   Login window is a popup window. When popup windows are blocked. Press the 'Ctrl' key then click to allow popup.
4. Please login in with:

ID: image
Password: image

Add new ID

You can have more login accounts by adding new IDs and passwords.

1. Open file: imagenexus.mdb at ..\imagenexus\access
   Note: you will need Microsoft Access to open the file
2. Open data sheet: user
3. Fill in your ID and password in column 'user_id' and 'password', and add your explanation in 'user_name'
   Note: please do not change 'user_lever'
4. Before you close it, remember to SAVE it.

Note: Please do not change other columns' detail, as this will affect ImageNexus.

Appendix G
Published paper based on this work

On the basis of this his PhD work, the author has published 3 conference papers full articles are given as follows.

1. Wu, C. and Johnston, M., (2003) 'Investigating and classifying visual references used in product design', *Proceedings of the 6th Asian Design International Conference*, Tsukuba, Japan, published in CD format.

2. Wu, C. and Johnston, M., (2004) 'The development of a visual reference database for product designers' use', *Proceedings of the 4th International Conference on Design and Emotion*, Ankara, Turkey, published in CD format.

3. Wu, C. and Johnston, M., (2005) 'The use of images and descriptive words in the development of an image database for product designers', *Proceedings of the 1st International Conference on Design and semantics of form and movement*, Newcastle, UK, pp59-69.

Investigating and classifying visual references used in product design

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Abstract: Because of improvements in technology and changes in the social environment, the role of product design is not just to provide the client/user with a functional product. It is important that the designer provides a new value for existing products. Sources of inspiration play an important role in the design process, both in defining the context for designs and in informing the creation of individual design [1].

The initial study of this research is to truly understand the role visual references currently play within the design process. Therefore, the research presented in this paper seeks to advance our understanding of how visual material can facilitate design. Firstly, it will focus on how designers use visual material within the design process, especially in order to know what sort of visual material it is. Next it will attempt to explain how the designers interpret visual material in order to understand what sort of thought process they have when they describe visual references. A series of interviews and a workshop carried out as part of this research have identified that product images form the majority of visual references used by designers as they provide more context than others images. The research also suggests the initial image context should be divided into tangible and conceptual subjects. Visual material is also used as a communication tool with others designers and clients.

The aim of this study is to develop a classification of image types and reference keywords to construct an electronic image database for professional use in product design.

Key words: *Product design, Visual language, Visual references, Classification*

1. Introduction

In this new century, designers not only work on the production of a product, but their assessment also requires them to focus on enhancing the value of the product for their client. A lot of investigation has taken place with regards to the design process, in order to enhance and develop design work. Within the design process there are a number of reasons that would affect a design outcome. However, the end product does not just depend on the design model. It is also influenced by a designer's capability, the right design tool - theory, methods and processes as well as experience and knowledge of industry. A designer's knowledge is generated and accumulated through action. Designers use knowledge to create and evaluate their work, this serves a continuous aid, helping to build on their existing knowledge.

Austen [2] has argued that within a library to support the design process there might be books, periodical and comprehensive coverage of information on existing products, and also a large collection of product samples and an extensive referral service to sources of expertise in industry and research organisations. According to Formosa [3], an insufficient flow of information leads to inadequately designed products and he believes that information could enhance the design process; in the proper environment it will feed creativity. Designers frequently search for and use information to help them to construct new knowledge related to the design topic, simultaneously searching for new information that will help to determine design constraints and produce a satisfactory design. [4]

There have been several investigations into the method of gathering appropriate resources for designers in order to improve creativity and the design solution. Most research focuses on providing user's with information to fulfilling a need. Design today is being recognised as a critical factor within industry and marketplace. Therefore, within the design process more information is needed than just ergonomics. A product databank based on today's computer technology can give designers such information easily and quickly. Most classification of products has been done by type, as in the Design Index (Appendix A). However, it is argued here that consideration should be given to categorisation on other functional bases, such as; controls, colour, material, shape, texture.

As shown in 'Design for ease of use: Product semantics and Design Education' [5], there was a significant result when using product semantics to assist in the design process. This research used 14 key words to describe products. Although those key words were mostly concerned with products functions, such as handles and buttons, this is a precedent for developing a database with descriptive keywords for visual reference.

According to Baxter [6], before the design process was put into practice, visual references were taken as a designers' approach to explore the concept. Mono [7], commented that a designer should aim at understanding product language better to be able to improve his design. If that is the case, then a visual reference based on a classification; by product language would provide designers with more inspirations.

This research present here is to show how visual references could be classified by the requirement within the design process.

2. Method

A serials of interviews and a workshop were carried out in order to understand the role visual references play within the design process and gain a perspective on dividing images into categories. The aim is to develop a dictionary of key descriptive words and construct an electronic image database for the use by product design professionals.

2.1 The Survey

The survey was based on an investigation of how product designers discuss and categorise visual design sources. It also collected information about the role visual material currently plays in the design process within practical design territory.

Firstly, it focused on how designers use visual material within the design process, especially in order to know what sort of visual material this is. The research then asked how the designers interpret the visual material in order to understand and describe visual references. Furthermore, there was a section that focuses on their understanding of product semantics. According to the literature review, product semantics is a theory about the representation of language of products from the

Table 1. The questionnaire for the interviews

The status of visual references within design process	
1	When you are given a design briefing how would you describe the design process from start to finish?
2	What sort of resources do you use at different stages in the design process?
3	What kind of information you look for within the resources you use?
4	Are there any specific resources you use to help stimulate ideas?
5	Do you use visual references and if so at which point in the process?
6	When you have all the design requirements, do you have a mental image in mind and if so can you describe them?
7	Within the design process, at which points and with who do you discuss your ideas with? And what is the emphasis within the discussion?
How they store and access these images	
8	Do you have a personal collection of visual material you use for inspiration and if so what sort of images are they? How do you store them? How do you classify them?
The status of product semantics in practical field	
9	What is your understanding of product semantics? Do you use product semantics within the design process? Yes – can you describe how? No – why do you not use them?
The word they use in describing visual feature.	
10	Questions about the images: What is your feeling and reaction?
11	Questions of the products: How would you describe the visual quality and property of this product?

1980s. The survey aims to observe whether it does or does not influences the way designers interpret the visual references.

There are in total 11 questions (Table 1). The strategy for understanding the words designers use in the describing visual features was to show designers some selected products and images. There was no specific principle for selecting the products and images, because the designers, according to the literature research, access varied products and images in order to gain experiences and knowledge. The products selected, therefore, were easy to carry to the interview and the images were selected by randomly picking the images from the book of *Notable Product Design* and the image providers (Digital Vision) (Fig.1). The survey was carried out by interviewing 17 designers based in London. Their professional experiences range from 3 years to 35 years.

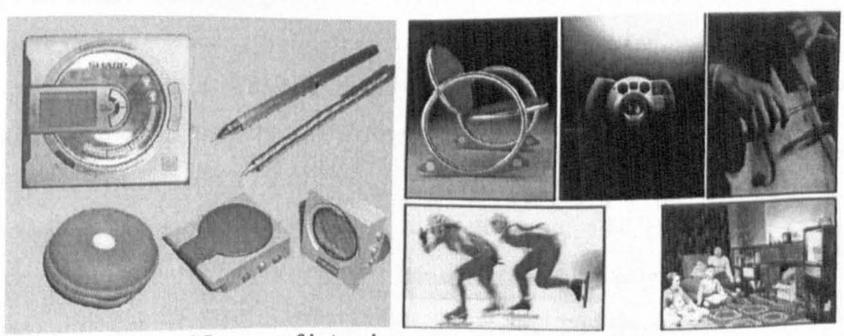

Fig.1 Products and Images of interview

2.2 The Workshop

In order to test the results from the survey, a workshop was planned. The purpose of the workshop was also to improve the understanding of what sort of information an image could deliver.

Nine MA Industrial Design students from Central Saint Martins' College of Art and Design participated in this workshop.

They were asked to classify images of product in various ways. There were 4 different packs of images, which were presented in 7x7 cm. The packs had total 96 images comprised of 48 PRODUCTS and 48 NON -PRODUCT images. In each pack 16 PRODUCT and 16 NON-PRODUCT images were the same (the definition of PRODUCT images and NON-PRODUCT images is given in the survey result described later). There were 5 students who were asked to classify the images in PRODUCT and NON-PRODUCT groups and 4 other students classified 96 images within one group.

3. Results and Discussions

3.1 The survey

The aim of the survey was to understand how designers categorise visual references.

3.11 The status of visual references within design process

There are many theoretical models of the design process to assist its effectiveness. However, when practised professionally the models will be adjusted to suit the time, area, and people. According to the responses, they all reflected that generally the design process used would differ depending on the project or clients. The results indicated that after the front-end phase there is not a big difference in activities within the design process of sketching, technical drawing and prototyping. The main issues of the front-end phase are to try and identify the problem and give it a solution, but the ways of doing this vary greatly.

How designers start the design project and what they focus on is often completely different. Some of them focus on identifying the brand value and product value. Others focus on consumer group research in order to fulfil the consumers' need.

The resources they used within the design process include magazines, books, libraries, the Internet, designers, engineers, consumers, manufactures, exhibitions, specialists, and first hand experience, not forgetting sketching, rendering, and modelling.

The information needed includes: technical, social, trade, user-product relations, competitive products, understanding of the manufacturing process; and the things that can describe value, such as consumer behaviour, styling trends, lifestyle, and technology.

According to the responses, designers use visual references in two way, one is for mood boards used to research the kind of things which enhance designers' understanding and visualisation; the other is for communicating with clients because images with words are a useful tool to present intangible design concepts.

All the responses pointed to the need for visual references which include what the environment of the product will be, where the design may go, the nature of the product, the particular audiences, size, and shape. Designers all stated that in the end the outcome visual concept will change but the main theme is still the same.

They all agreed that discussion happened all the way through the project, with your team, boss, client, manufacturer; also it could be happening with the users or friends.

Consequently, visual references are used many times within the design process, especially within the front-end phase. Mainly, designers use visual references in order to

- Communicate with client
- Study about the consumers
- Assist to express the themes of the project
- Understand the related environments
- Look for functional solutions.

These possibilities are all used to enhance the designers' visualisation of the product's design.

3.12 How designers store and access these images

According to all the responses, designers did not actually have a organised visual material collection, what they had was mainly accumulated from magazines or books, or the visual material they had from previous projects. If the materials have been used for previous project, then they are stored digitally and generally classified by project title or client.

The result indicated that when the companies interviewed they need images to assist their research, they would start with magazines, books or nowadays using the Internet. With books and magazines, they have two ways in which to do it, one is that they go through all the magazines and books quickly to find something they need or that they would use their memory to look for a specific image that they have seen before. They implied that this activity wastes time, but sometimes it could come up with new ideas when the image catches the designers eyes while they go through the magazines. Using the Internet, a technology benefit, designers use a search engine, such as Google, or image bank website to search for images by inputting some keywords or searching in the category provided by the website. However, there are always problems while searching on the Internet. Firstly, it wastes time because if you search by search engine, it could have thousands of results. Secondly, they indicated that the categories of image banks are more suitable for advertisement or graphic design than product design.

3.13 The status of product semantics in practice

Because of its ability to assist interpreting products, the survey tried to discover what designers understanding of product semantics is, and, furthermore, it tried to observe if this theory influences them when they are designing or interpreting a product or an image. The responses include:

"In terms of visual, it means what products try to do"

"Product Semantics is a visual language"

"Product Semantics is the language of product"

"Product Semantics relates to semiotics; object communicate to visual code"

"The use of visual devices to give people a way of visually reading"

"Product Semantics is the meaning of products"

"Product Semantics is a link to a culture, styling and fictional association"

However, none of them used this theory within the design process specifically and some of them were even trying to avoid it; however, they all stated that they probably use it subconsciously as it is a natural process to come out within design without knowing it. When they do use it, it is normally to deal with function. The people who were educated before the 1980s are not particularly familiar with product semantics or they do not have an idea of what the theory is. They recognize that it did not affect their works. The result also relates to the previous study by Brown [8] in which he indicated:

In all 12 out of the 34 designers polled (35.3%) acknowledged regular use of semantic thinking in the design of products. However, 17 out of the 34 (50%) designers polled in the field study indicated no regular or conscious use of product semantics in the design process.

In conclusion, most designers have knowledge about product semantics, even if their definitions vary. However, they see product semantics as a theory to explain what they do in practice and which happens mostly subconsciously. When they use it, it is often to express functionality.

3.14 The words designers use in describing visual features

The survey collected the words or language that the designers used to express information about images (see Fig.1). There was much commonality in responses when they talked about physical quality. The following points were noted:

1. The responses they gave were related to their type of work. Those working mainly in furniture design given more comment on the furniture images.
2. Age is an influence. The household picture brought back past memories for two interviewees as they were from their lifetime.
3. Although asked to talk about product quality, the *LAMY* pens indicated that where the brand is well know, brand image is of more interest.
4. Their age and design area influence their view, especially when they see the MD player, older designers were less interested in the product than young designers, therefore they did not comment much about the product.
5. The cable tidy is an interesting object. If the designers had seen the object before, their appreciation was very strong. However, even if the designer had not seen it before, they still felt it was a very interesting object.

According to all the responses, the language they used to discuss the images and/or products could be synthesised into:

1) The object + adjective

   This product is **ergonomic** design; **the handle** is very **ergonomic**.

   It is **functional**. It is designed by **geometrical form.**

2) The object + sense + adjective

   This product **looks** fun.

   It **looks** heavy. It tries to **show** quality.

   It **looks** cheap. The material **looks** warm.

3) Style

   This is **1980's design**.

   This is **Bauhaus Style**. It reminds me **Memphis.**

4) The function of product

It is **portable**. It seems you can **open it**. It is comfortable to **hold**.

5) A description/interpretation.

   It is **houseware**. It is **furniture**.

6) Cause and result

   It is a good/bad design, **because** the sign is too small.

   The colour is very strong **so** it looks very modern.

3.15 Conclusion of the survey

This indicates that designers use a lot of adjectives to describe the representation of products. They could be divided into rational responses or emotional responses, according to the attributes of the product.

All the responses are varied, however, there are some generic subjects which can be picked out. The words that designers used to describe the objects could be divided into several subjects:

Colour	**Material**	**Texture/finish**
Sound	**Time/age**	**Price**
Consumers	**Environment**	**Weight**
Function	**Lifestyle**	**Trend**

The aims of this survey were to understand the role visual references play within the design process, and observe what kind of subjects and keywords are used by designers when searching for visual references. The results indicated that designers' thinking can be influenced by their immediate surroundings. They could be influenced by any visual material that could be from magazines, books, the Internet and photographs; usually focusing on a specific subject or detail. Basically, the contents of visual references could be divided into:

1) PRODUCT images

This means the image contains an individual product or collection of products. It can also be only a detail of product or an image with specific information such as material, texture or function.

2) NON-PRODUCT images

The images in this category covered a very wide range of subject matter. Designers give the images specific definitions; using them to present a subject or theme.

In conclusion, designers use visual references in order to communicate with clients, study about the consumers, understand the related environments and assist them to express the themes of the project. They are all concerned with communicating, interpretation and understanding. The results suggests that the study of product semantics still should be involved in this investigation, as designers are all aware of it and generally confirm that it used within their design work.

3.2 The Workshop

3.21 Product Images

There were 5 students participated in classifying PRODUCT and NON-PRODUCT images separately. The categories of classifying PRODUCT images show at Table 3. The result shows:

- Even though the participants were told not to classify the PRODUCT image by the type of products and their physical properties, the categories most used were those describing the intention of the product, such as "Vehicle", "Lamps", "Home appliance" etc; this indicates that general product categories are still the main and easy way of classifying images.
- They used "vehicle" or "transport" and "wheels" to describe similar content, in the same way as "Lamps" and "lighting". Although, the definition of these words might have similarities; the imagery of these words could be very different. It also brings out the subject of classification of words in this research, because this research focuses on classifying product by a new approach not by the name of the type of product. However, "wheels" and "lighting" are not specifically product types but they also could be definitions of products.

Table 2. Result of classifying PRODUCT images (the table below shows the categories made by each participant (A-E)

A	B	C	D	E
High tech small devices (use with hand)	Fast moving lines	Domestic appliance	Cute	Wheels
Furniture	Egg holders	Furniture	Structural	Life saving
Vehicle	Ashtrays	Transport	Simple	Sexy home furnishing
Glass, ceramic, container	Mechanical engines	Electronic	Difficult	Uncomfortable furnishing
Lamps	Watches, clocks	Lighting	Old	Gadgets
Office	Reflections	Pens	Stylish	Boxes
Old forms for kitchen use	Colours mixing	Luggage	Masculine	Kitchen
Modern forms for kitchen use	Strings		Feminine/organic	Lamps
Home appliance	Switches			
	Baskets shapes			

- Although, most classifications were by type of product; the participants also used the descriptions of emotional responses to emphasise the representation of products, such as "old", "modern", cute" and "sexy" etc.
- All the categories created by the participants could be reduced into certain subjects:

  1) Product type
  2) Product form
  3) Style appearance
  4) Product type + style appearance
  5) Material appearance
  6) Colour appearance
  7) Product type + sensation
  8) Product form + sensation
  9) Function

Further analysis of the results where participants were classifying the same collection of images shows that the participants only classified the images by the appearance and characteristic when the image was not of an easily identified product (Fig.2). For example, one of the classifications of image 2 in Fig.2 was into a “feminine/organic” category; image 4 in Fig.2 was classified into “cute” and one participant gave image 3 a category of “reflections”.

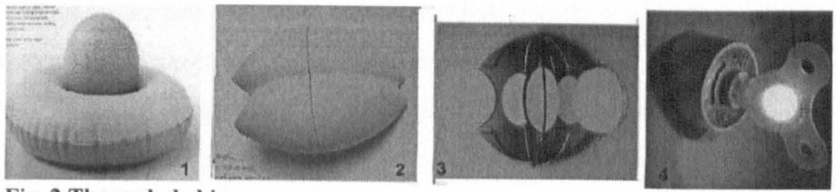

Fig. 2 The excluded images

Only one participant (B) classified the images by the context and another gave very different categories. His/her categories are neither the real product types nor the context of the images. They were named by the function of products, appearance of products, and the interaction of the products.

From the classification of the same PRODUCT images, the result indicates that:

When the category named the type of products, the images were exactly the same. And one participant was sub classified a category by perceived qualities (Fig.3). (The grid represents the number of images; the alphabet represents the participants.)

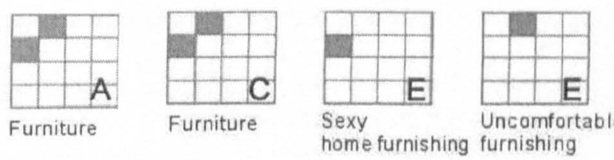

Fig.3 Classification result

3.22 Non-product Images

The result of 5 participants’ classifications for NON-PRODUCT images indicate:

- Most categories were titled by the content of the images, such as “cartoon”, “music”, “architecture” and “home” etc.
- There were only a few categories which were concerned with the emotions; such as “boring”, “fun”, “happy” and “lonely” etc.
- Unexpected categories were the product types: “transport” and “furniture” in the NON-PRODUCT section.
- The variability of the NON-PRODUCT categories was wider than PRODUCT images; and there were also more categories (54) than PRODUCT images (42).
- All the categories created by the participants could be reduced into certain subjects
  1) Emotion/Sensation
  2) Space
  3) People
  4) Object
  5) Activities
  6) Art & design
  7) Theme (e.g. nature, refresh)

Fig.4 shows that when they have the same categories, the images put into them are mostly the same but the Fig.5 shows that the same image could be put into different categories. It indicated that classifying images into named categories would more often give the same result than asking people to name a category for images.

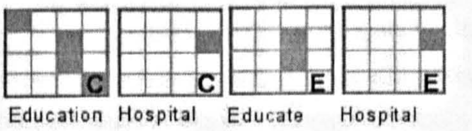

Fig.4 Classified result

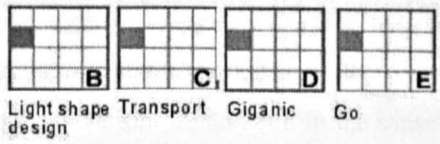

Fig.5 Classified result

3.23 Product and Non-product Images

Table 3. Result of classifying all the images together (the table below shows the categories made by each participant (a-d)

a	b	c	d
Novelty	Nice for eyes	Highly designed life/contemporary	Visuals that triggered emotion thoughts
Functional and fun	Freedom to see	Annoying/irritating object	Poetic functional
Stylish	Plastics and industrial design	Wealth bourgeois life	Just poetic
Action	True love	Institution	Non-emotional products
Japanese style	Design for evolution	Imitation	Male-world
Organic	World of design	Leisure + pleasure	Functional & interesting
Child-like	Basic	Craving of speeds	Sweet, giving, and thoughtful through design
Boring	Wood and boxes	Early adopters	Overworked design/ 90's style
Emotion	Art	Sustain ability	Nature
Destructive	Despair	Classical context on form	False reality
Space	Bad influence	Cultural difference	Created emotion
Simple	Child-ness		Uninteresting images
Masculine			Perception of time and place
Strange			Repetition
			Practical

The 4 participants in this section had to classify PRODUCT and NON-PRODUCT images together. The names of categories in this section are more about the context of images. Most of categories included PRODUCT and NON-PRODUCT images. This indicates that PRODUCT images also could be categorized by the context, but the initial way of classifying them is by their physical property.

It also indicates when images are classified by the context, in the same sort of categories; such as "child-like" and "child-ness", the images could be varied. Comparing with the NON-PRODUCT section, it shows that if the category name is a tangible description the difference of the contained images was less.

3.24 The conclusion

- The aims of this workshop were achieved in that the main categories as defended by the result of interview; such as colour, place, emotion etc. are appropriate. New subjects that might be caused by the difference in the backgrounds and experiences of the participants were added but this is to be expected.
- The words use to describe the same objects or subjects could be very different, nevertheless, there is a certain relationship between these words; for example sweet, giving and thoughtful share the same category.

4. Conclusions

According to the survey, to understand the sources of inspiration, visual references could be analysed from four different aspects (Fig.6): function, content, information and subject.

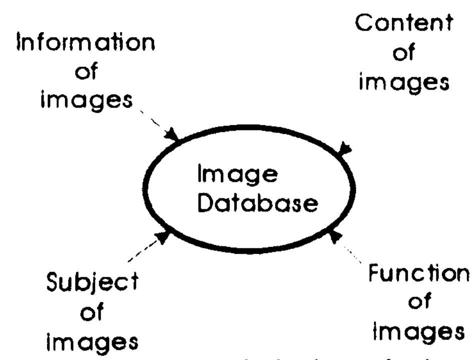

Fig.6 4 aspects of developing image database

- Function of images: reasons for using an image, which have be described in 3.11.
- Content of images: what present inside the image, there are two main groups: PRODUCT and NON-PRODUCT.
- Information of images: the information for which the image has been recorded, see 3.15.
- Subject of images: the interpretation of the information in the images, for example, colour and material are tangible subjects, and characteristic and value are conceptual subjects.

The content of images allows the visual materials used by designers to be physically divided into PRODUCT images and NON-PRODUCT images. Then, the subject matter of interpreted information may be divided into TANGIBLE and CONCEPTUAL (Fig.7).

The information about the images will be used as main categories to develop relative descriptive words in order to construct an image database for product design professional use.

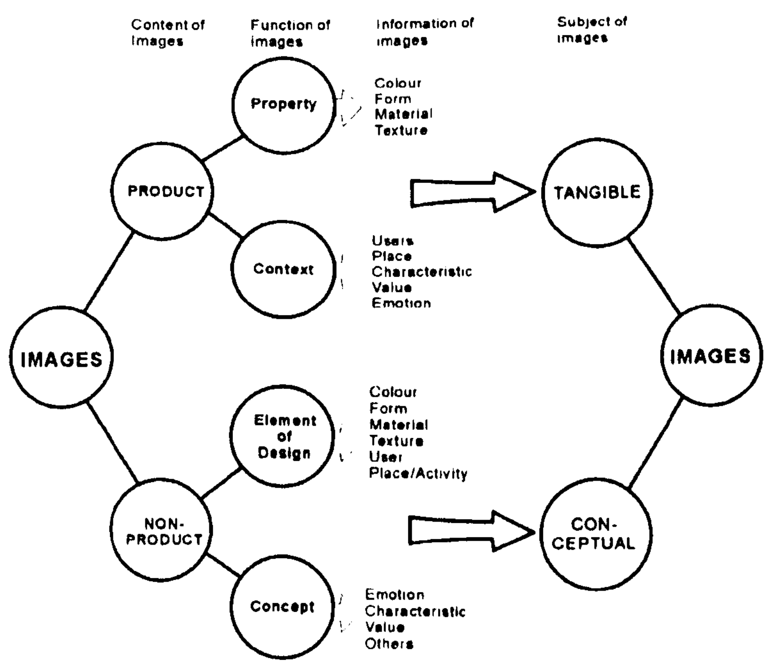

Fig 7. Structure of image classification

Acknowledgment

Very appreciate the following member participated in the survey: (It is displayed in alphabetical order)

R Ball	N Goode	J Piper
P Booth	B Gray	J Piper
P De-Ath	R Kinsman	M Sodeau
A Dunne	A Krassa	M Woods
I Ferris	R Levien	D Wythe
S Frazer	W Maskell	

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Appendix A

Product indexing:

For a number of years the Design Council maintained the Design Index, a record of some 7,000 'well designed' British consumer goods. The Index, now at Brighton University, comprises a photographic record of selected products, together with their specifications, costs, and the name of the designer and manufacturer.

The development of a visual reference database for product designers' use

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Key words:
Product design, Visual language, Visual references, Emotion, Characteristic

Abstract:
Sources of inspiration play an important role in the design process, both in defining the context for designs and in informing the creation of individual designs. The initial study of this research is to understand the role visual references currently play within the design process, in order to develop a classification of image types and reference keywords to construct an electronic image database for professional use in product design.

A series of interviews to product design professionals and a workshop were carried out as part of this research. It identified that product images form the majority of visual references used by designers as they provide more context than others images.

According to the survey, to understand the sources of inspiration, visual references could be classified from three different aspects:

1. Function of images: reasons why designers use images, e.g. communication, inspiration
2. Content of images: what is an image physically presenting
3. Context of images: additional information conveyed by the image

The information derived from the classification is then analysed into tangible and conceptual categories; for example, colour and material are tangible categories, and characteristic and value are conceptual categories. Tangible properties are readily stored in the database using standard descriptors whereas conceptual properties require keywords that identify properties of emotions and characteristics.

In summary, the research shows how a framework of keywords, which identifies the tangible and conceptual qualities of images in the database, has been developed.

Introduction

The use of information is fundamental to the design process. According to Formosa (1991), an insufficient flow of information leads to inadequately designed products and he believes that information could enhance the design process; in the proper environment it will feed creativity. Designers frequently search for and use information to help them to construct new knowledge related to the design topic, simultaneously searching for new information that will help to determine design constraints and produce a satisfactory design (Lahti et al., 2000). Even Eckert and Stacey (2000) indicated that "the source of inspiration plays an important role in the design process, both in defining the context for new designs and in informing the creation of individual designs."

There have been several investigations into the method of gathering appropriate resources for designers to improve creativity and design solutions. Most research focuses on providing users with information to fulfil a need. Design today is recognised as a critical factor in the industry and in the marketplace. Therefore, more information is needed within the design process other than for example ergonomics or engineering. The subject of this paper is an image databank based on computer technology to give designers visual access to information easily and quickly.

Previously most classification of products has been done by type, as in the Design Index (Appendix A). However, it is argued here that consideration should be given to categorisation on other functional bases, such as; controls, colour, material, shape, texture.

According to Baxter (1995), visual references were taken as a designers' approach to explore the concept within the design process. Mono (1997), commented that a designer should aim at understanding product language better to be able to improve his design. If that is correct, a visual reference based on a classification by product language would provide designers with more inspiration. The initial study of this research is to understand the role visual references currently play within the design process, in order to develop a classification of image types and reference keywords to construct an electronic image database for professional use in product design.

Survey of Designers

A series of interviews with product design professionals and a workshop were carried out as part of this research. The survey was based on an investigation of how product designers discuss and categorise visual design sources. It also collected information about the role visual material currently plays in the design process within practical design territory. The designers were shown selected products and images and their comments, reactions and descriptions recorded. There was no specific principle for the selection of products and images, because designers, according to the literature research, access highly varied products and images to gain experiences and knowledge. The selected products were easy to carry to the interview and the selected images were randomly picked from the book of *Notable Product Design* and the image providers, Digital Vision (Figure 1). The survey was carried out by interviewing 17 designers based in London. Their professional experiences range from 3 years to 35 years.

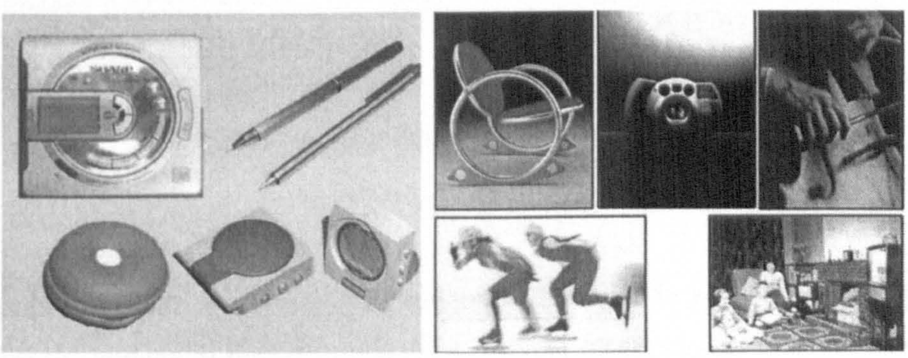

Figure 1, Products and images used for the interview

Descriptive Language

The value of an image may be enhanced by its linguistic associations through descriptions and keywords which identify and interpret its content. For this reason, the relationship between language and images will be discussed in this section.

Image language structure

Analysis of all the designers' responses showed that the language they used to discuss the images and products could be synthesised into:

1) The object + adjective

   This product is **ergonomically** designed; **the handle** is very **ergonomic**.

   It is **functional**. It is designed with a **geometrical form.**

2) The object + sense + adjective

   This product **looks** fun.

   It **looks/feels** heavy. It tries to **show** quality.

   It **looks** cheap. The material **looks/feels** warm.

3) Style

   This is **1980's design**.

   This is **Bauhaus Style**. It reminds me of **Memphis.**

4) The function of product

   It is **portable**. It seems you can **open it.** It is comfortable to **hold**.

5) A description/interpretation.

   It is **house ware**. It is **furniture**.

6) Cause and result

   It is a good/bad design, **because** the graphic is too small.

   The colour is very strong **so** it looks very modern.

Linguistic analysis shows that nouns and adjectives are the main classes used in dialog (Eckert and Stacey 2002) and this has been reflected in analysis of the designers' comments. However, the number of keywords recorded in the survey is contrary to Eckert and Stacey's observations with the range of nouns used in the survey being comparatively small, while the range of adjectives is large and open-ended.

Image descriptions

The responses showed that designers' descriptions could be divided into Subjective and Objective responses.

- Objective responses describe the tangible information in an image or physical properties of a product. They provide a general introduction to an image or a product. For example, "the handle is ergonomic", and responses are based upon fact or rational experiences and how it meets functional needs.

- Subjective responses are emotional responses and can be divided into direct and indirect. Direct responses are essentially feelings which are an emotional reaction to an image or a product. For example, "it is **comfortable**". Indirect responses are associated feelings which are caused by a part of an image context or a product property (Figure 2). For example, "this function is **clever**".

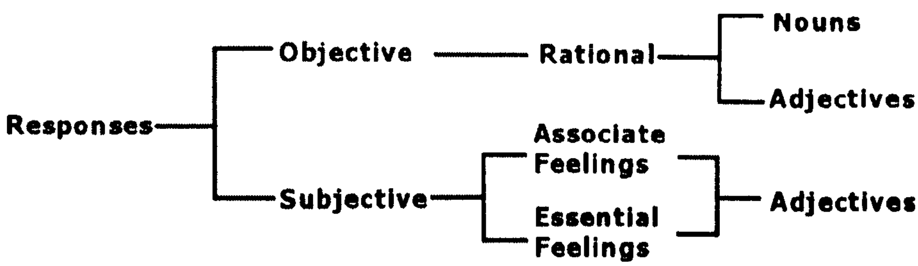

Figure 2, Classification of Image descriptions

Image Functions

The interviewees stated that anything can be a source of inspiration. However, images function not only as inspiration sources, but also as an essential medium within the design process.

According to the responses, using images is a powerful way to express complex ideas quickly to a non-designer. The reasons for using visual references within the design process are to:

- Communicate with clients
- Understand consumers
- Assist in expressing the themes of the project
- Understand the related environments
- Look for inspiration or functional solutions.

These possibilities are all used to enhance the designers' visualisation of the product's design. These possibilities also relate to Eckert and Stacey's (2002) statement that "previous designs and other sources of ideas furnish a vocabulary both for thinking about new designs and for describing designs to others."

Image Content

The focus of this research is a visual database for use by product designers and in this context images can be split into PRODUCT and NON-PRODUCT:

1) PRODUCT images

   This means the image contains an individual product or a collection of products (Figure 3). It may also only contain details of a product or an image with specific information such as material, texture or function.

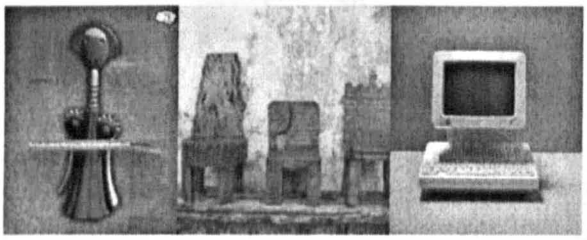

Figure 3, Product Images

2) NON-PRODUCT images

   The images in this category cover a substantially wide range of subject matter (Figure 3) such as users, environments, and art works. Designers give the images specific definitions and use them to present a subject or a theme.

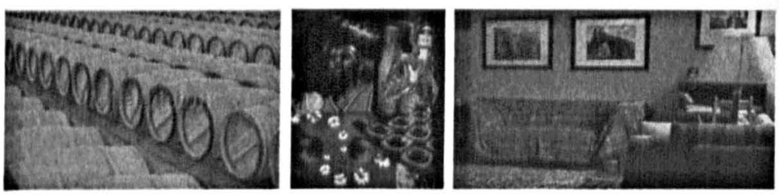

Figure 4, Non-Product Images

The survey also indicated that information used from images includes product properties such as materials, product context such as values, design elements such as colours and image concept such as emotions. This information has been classified and represented in Figure 5 below.

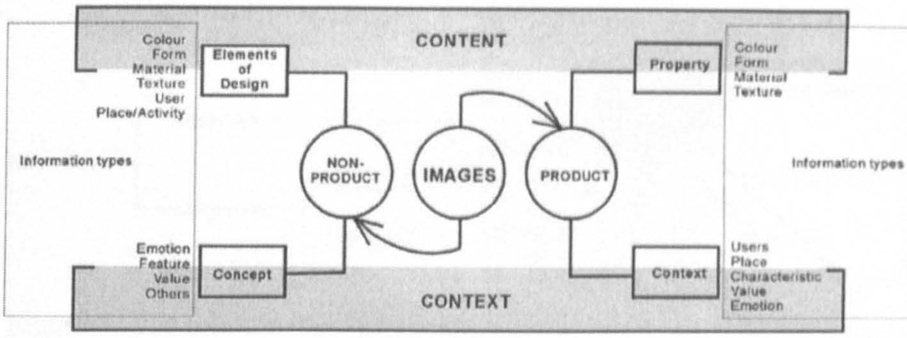

Figure 5, Structure of Image Classification

The information derived from the classification may also be grouped into tangible information and conceptual information (Figure 6). The diagram shows that tangible information is about product properties such as colour, form and so on and product market segmentations.

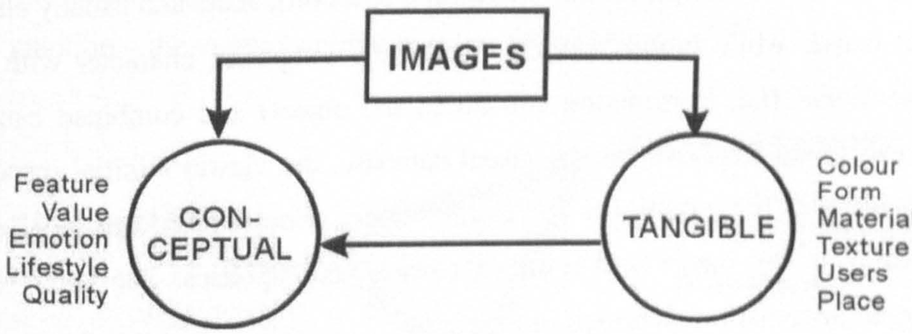

Figure 6, Classification of Image Information

This information is typically used in a design brief and hence can be seen as forming a product specification. The term "SPECIFICATION" (see Figure 9) has therefore been adopted to describe tangible information about the context of an image.

Conceptual information, however, is a construct of tangible information interpreted by the viewer. Observations from the interview with designers indicated that the interaction between an image and a designer's view can be represented as Figure 7. A viewer can receive information not only about the properties of an image, but also about its representation, because images of objects already have some interpretation attached to them in the way they have been created (Ecker and Stacey 2000). The emotional reaction of the viewer to the image will be influenced by this interpretation.

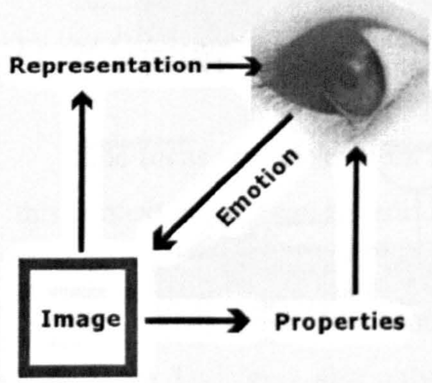

Figure 7, The relation between an image and a viewer

Desmet (2002) proposed the concept of affective states (Table 1) to understand the relationship between a person and an object. He divided these into emotions and moods, emotions being intentional (i.e. the observer's reaction), acute and usually elicited by an explicit cause, while moods having a relatively long-term character with essentially non-intentional (i.e. information content in the object) and combined causes. In the context of image analyses for the visual database, the viewer's initial responses to an image will be the emotional responses, while more considered analyses of the information in the image will result in the moods responses. The latter will use the conceptual information identified in Figure 6.

	Intentional	Non-intentional
Acute	**Emotion**	**Mood**
Dispositional	**Sentiments**	**Emotional traits**

Table 1, Differentiating affective states (Source: Desmet (2002), *Design Emotions*)

Combining Figures 2 and 6 into Figure 8 demonstrates that conceptual information embraces not only the subjective data but also some objective. The objective responses included are Features and Lifestyles, while Value, Quality and Emotion are the subjective responses.

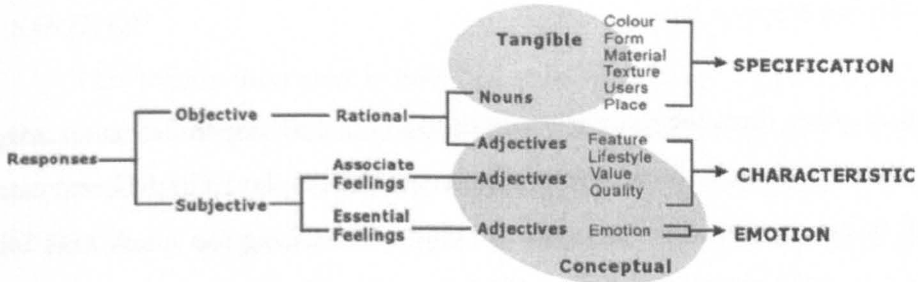

Figure 8, The relationship between Image information & Image descriptions

Figure 8 also shows that the totality of information derived from an image may be grouped into three areas. SPECIFICATION information is objective, tangible information. CHARACTERISTIC information is subjective, conceptual information which may be identified by Desmet's affective state of Mood and includes Features, Value, Lifestyle and Quality. EMOTION information is Desmet's affective state of emotion – the viewer's initial response to an image.

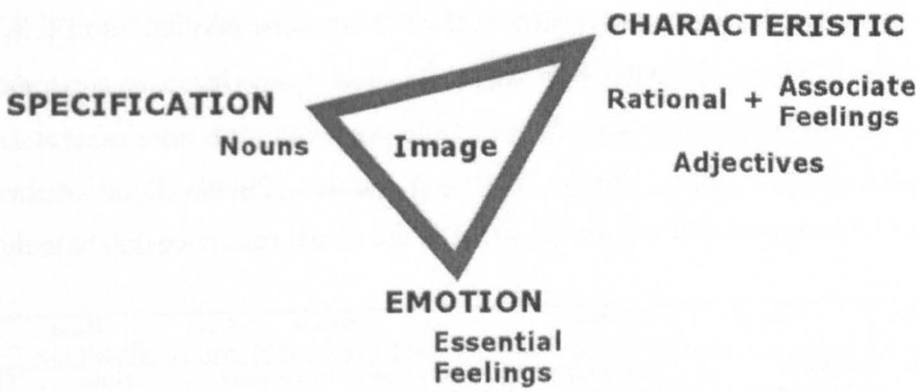

Figure 9, The three information areas of an Image

Cupchik (2000) explained that industrial design objects have stimulus oriented and response oriented perspectives; stimuli are provided by the content of objects and the observer responds to these. According to this, SPECIFICATION and CHARACTERISTIC areas provide the information eliciting the EMOTION responses.

Classifying Keywords

Keywords form the main element used in the database to define an image. They will be grouped within the three information areas and displayed in different categories in the visual reference database. In order to avoid users taking too much time when selecting keywords, and to avoid confusion, the keywords will need to be clearly understandable.

SPECIFICATION

This information area covers product properties and market segmentations. The categories were derived from selected research sources. Categories include: Colour, Form, Material, Texture, Users, Places/activities and Product fields (Table 2). The members of Colour, Form, Material, and Texture were selected from studies by Flurscheim, 1983, Manzini, 1986, Wong, 1993, Gasson, 1974, Bevlin, 1977, Lefteri, 2001, and Danger, 1987. Members of each category were selected by their distinguishable visual quality and general descriptive terms. For instance, plastics could be divided into PP, ABS, Acetate and so on , however, the generic descriptor 'plastics' was selected as a member. Members of Users, Places/activities, and Product field were selected from market research data groupings (Kotler, 2000, Doyle, 1998, and Lambin, 2000). Some of these may not familiar to designers and will be modified as the visual reference database develops.

Categories	Material	Colour	Form	Texture	Users	Places /activities	Product Field
Members	Steel/Iron	Violet group	Representational	Smooth	Gender	Home	Electric
	Stainless steels	Blue group	Natural/organic	Rough	Male	Office	Domestic
	Aluminium	Blue-green group	Man-made	Soft	Female	School	Furnisher
	Copper	Green group	Verbal	Hard	Age	Public space	Transport
	Glass	Yellow group	Abstract		Under 6	Out door	Medical
	Rubber	Orange group	Calligraphic		6-11	Sport	
	Wood	Brown group	Geometric		12-19	Water sport	
	Plastics	Red group	Others		20-34	Winter sport	
	Ceramics/Porcelain	Pink group			35-49	Restaurant	
	Composite and compound materials	Grey group			50-64		
		White			65+		
	Others	Black			Class		
		Others			Upper Uppers		
					Lower Uppers		
					Upper Middles		
					Middle Class		
					Working Class		
					Upper Lowers		
					Lower Lowers		

Table 2, Categories and members of SPECIFICATION

EMOTION

This information area is intended to provide users with a record of their emotional reactions to images. Because most images are product images and the vocabularies to express emotions so varied, the emotion keywords adopted are taken from Desmet's (2002) study of product emotions. It includes 14 members: Indignation, Contempt, Disgust, Unpleasant surprise, Dissatisfaction, Disappointment, Boredom, Desire, Pleasant surprise, Inspiration, Amusement, Admiration, Satisfaction, and Fascination.

CHARACTERISTIC

For this information area 120 keywords were selected from the interviews. Many words were often repeated such as ***friendly, nice, ergonomic,*** and ***technical*** etc. From a linguistic perspective, the representation of the meaning of a word is called a '**concept**' (Seiler and Wannenmacher 1983). 'A **concept** for a kind of entities is information in the mind that allow us to discriminate entities of that kind from entities of other kinds (Löbner, 2000: 20). In order to classify keywords effectively, they were firstly categorised by their concepts which were taken from Roget's Interactive Thesaurus. Usually, a word has more than one concept so the criterion for choosing a concept was general use. For example, ***fantastic*** has concepts of **difference**, **quantity**, and **superiority**; **superiority** was selected.

Furthermore, there are a few words whose concepts are not the same in the thesaurus when used in contemporary verbal communication (e.g. ***awkward*** is not suitable as the concept of **inability, difficulty**, and **unsocial action,** when using it to describe a product or design.) Categorising words by their concepts assists in grouping them together, as a method of clarifying their meanings. For example, **classic, fantastic, genius, great**, and **impressive** are in the same keyword category and share the concept of **superiority**.

The keywords were split into Subjective and Objective, using the definition from Collins English Dictionary:

- Objective:

  1. existing independently of perception or an individual's conceptions. 2. undistorted by emotion or personal bias. 3. of or relating to actual and external phenomena as opposed to thoughts, feelings, etc

- Subjective:

  1. belonging to, proceeding from, or relating to the mind of the thinking subject and not the nature of the object being considered. 2. of, relating to, or emanating from a person's emotions, prejudices, etc. 3. relating to the inherent nature of a person or thing; essential. 4. existing only as perceived and not as a thing in itself.

They were then grouped into second levels such as positive and negative under subjective; physical and behaviour under objective. The sub-levels were then developed by manipulating the keywords into natural groups. As a result, there were ten subjective categories and 22 objective categories (Table 3 & Table 4). Some words which were ambiguous in that they could either be Subjective or Objective were re-categorised after the categories had been designed.

Heading / Level 1	Level 2	Level 3	Keyword
Subjective	Feelings	Physical sensation	Cold, Comfortable, Cosy, Relax
		Liking	Appreciated, Simulated
		Specificity	Different, Individual, Particular, Special
		Interestingness	Interesting, Exciting
		Kindness	Peaceful
	Positive	Beauty	Attractive, Beautiful, Cute, Fascinating
		Superiority	Classic, Clever, Fantastic, Cool, Impressive, Great, Genius
		Quality	Good, Nice, High quality
		Happiness	Happy, Fun, Cheerful, Satisfied, Recreated, Playful
	Negative	Negative	Awkward, Bizarre, Boring, Disappoint, Horrible, Ugly, Weak , Unnecessary, Confusing

Table 3, Categories of subjective keywords

Heading / Level 1	Level 2	Level 3	Level 4	Keyword
Objective	Physical	Visual features	Simplicity	Simple, Simplistic
			Complexity	Sophisticated, Complicate
			Formality	Ergonomic, Semantics, Geometric
			Stylishness	Fashionable, Elegant, Styling, Funky
			Masculinity	Energy, Sporty, Technical, Engineering, Mechanical, Industrial
			Femininity	Romantic, Jewellery, Decorative
			General	European, Dynamic
			Unstylishness	Typical, Conservative, Uniform
			Period	50s, 60s, 80s, Traditional, Modern, Classical
		Functional features		Adjustable, Portable, Friendly, Functional
		Colour features		Pure, Warm, Bright
		Physical features		Small, Middle, Thick, Heavy
		Texture features		Sticky, Hard, Soft, Jumping, Smooth, Sharp
	Behaviour			Childish
	Value			High tech , Low tech, Quality , Reasonable, Reliable
	Price			Cheap, Expensive
	Status	Age		Young, Old, Mature, Contemporary
		Importance		Substantial, Valuable, Serious
		Components		Balanced, Loose, Integrate, Fit, Scrappy
		Origin/source		Original, Natural, Organic
		Safety/stability		Speed, Fast, Safe, Strong
		General		Real, Fake

Table 4, Categories of Objective keywords

Appropriate categories were tested against another collection of keywords which were taken from Kuno's *Colours In Context* (1999) list of 'Image words'. This represents the characteristics of colour images and expresses the characteristics of 56 themes; such as space, animals, beverages, family, friends, and so on. The other reason for adopting Kuno's work on colour is that attitudes embodied in colour such as age, personality, sex, size and so on (Danger, 1987) are almost the same as the information types used in the images' Context (see Figure 5). 'Image words' have, therefore, been used as part of the essential keywords for the system.

Carroll (1964: 97) discussed how individuals develop cognitive vocabulary: 'People vary in the degree to which they notice and concern themselves with the various kinds of attributes that characterise the things and events of the environment'. In order to make the collection of keywords more suitable for the product design professional, the list was reduced from 538 to 146 words through subjective analysis of common usage by working with my one of my supervisors, Martin Darbyshire, director of Tangerine Product Direction and Design. While this process will have eliminated words which might be used by some designers, the database will allow new words to be entered as required and hence enable personal sets of words to be established.

"It is undeniable that words have "meanings" that go above and beyond the scope of linguistic creativity which can be achieved. They often carry the weight of a person's own experience" (Bouillon and Busa, 2001: 8). Also Trask's (1995) chapter "Variation in language" addressed geographical variation, community variation, educational background variation, and sex and gender, which affect the use of vocabularies. The choice of vocabulary is highly variable, even when people try to deliver the same concept. It is therefore impossible to define an absolute set of keywords. This system focuses on providing organised, design oriented image storage and providing a well-structured image context relationship with products is of greater importance than the keywords. As the keywords can be expanded later the prototype of the database will provide an initial set of keywords in each category.

Table 5 and Table 6 show the current range of 'Image words.' Basically most keywords can fit into the categories. Words such as *positive* have been used as the names of categories. Words such as *warm* could also be included in the category of **Physical sensation** as well as **Colour features** and will be added later into appropriate categories as the system develops.

Heading / Level 1	Level 2	Level 3	Keyword
Subjective	Feelings	Physical sensation	Aromatic Comfortable Emotional Fragrant Moist Relaxed Silent Wild Tasteful Spicy Tangy Tranquil
		Liking	Admirable Affable Alluring Gentle Sweet
		Specificity	Distinctive Dramatic Unique Thorough
		Interestingness	Precious
		Kindness	Calm
		General	Indifferent
	Positive	Beauty	Beautiful Pretty
		Superiority	August Clever Dandy Excellent Exciting Exquisite Innovative Powerful Smart Wonderful Witty Wise
		Quality	Classic
		Happiness	Cheerful Delicate Graceful Happy
	Negative	Negative	Grim Strange Vague

Table 5, Categories of subjective "Image word"

Heading / Level 1	Level 2	Level 3	Level 4	Keyword
Objective	Physical	Visual features	Simplicity	Earthy Plain Simple
			Complexity	Complex Complicated Elaborate
			Formality	Technical
			Stylishness	Chic Cool Elegant Fancy Funky Gaudy Refined
			Masculinity	Animated Masculine
			Femininity	Decorative Feminine
			General	Dynamic Nostalgic Rhythmical Sporty
			Unstylishness	Antiquated
			Period	Fresh Youthful Traditional
		Functional features	Functional	Friendly Open Supple
		Colour features	Colour	Bright Cold Glittering Hot Light Pure Radiant Warm Vivid Transparent Translucent
		Physical features	Physical	Dense Firm Fit Hard Heavy Humorous Sharp Shiny Small Solid Still Vast Straight
		Texture features	Texture	Coarse Rugged Smooth Soft
	Behaviour		Behaviour	Active Aggressive Confident Discreet Docile Easygoing Ingenuous Quiet
	Value		Value	Valuable
	Price		Price	Opulent Rich
	Status	Age	Age	
		Importance	Importance	Dignified Influential Prestigious Serious Substantial
		Component feature	Components	Orderly
		Origin/source	Origin/source	Ethnic Natural Organic Original Radical Primitive
		Safety/stability	Stability	
		General	General	Absolute, Airy, Assured, Authentic, Balanced, Basic Clear Clean Explicit Healthy Immaculate Obvious Precise Refreshing Robust Rustic Visionary Sure Volatile

Table 6, Categories of Objective "Image word"

Conclusion

The software application of the visual reference database is being developed using the structure of the three information areas: SPECIFICATION, EMOTION, and CHARASTERISTIC and will provide the product design professional with an image storage tool.

The database holds the potential to reduce the time designers spend at the concept design stage of the product development. It will also subconsciously assist designers in achieving Mono's (1997) statement that a designer should aim at understanding product language better to be able to improve his design. It will also be able to function as a cognitive database to assist designers in better understanding the target user of the product being designed.

Work on the database has generated great interest from designers and a prototype is on the test. Its development and the evaluation will be the subject of future paper.

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Appendix A

Product indexing:

For a number of years the UK Design Council maintained the Design Index, a record of some 7,000 'well designed' British consumer goods. The Index, now at Brighton University, comprises a photographic record of selected products, together with their specifications, costs, and the name of the designer and manufacturer.

The use of images and descriptive words in the development of an image database for product designers

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The development of image database, ImageNexus, was based on the role images play within the product design process and information within the database was structured in three divisions: SPECIFICATION, CHARACTERISTIC, and EMOTION. The three divisions construct a model of the information which an image conveys. ImageNexus allows designers to creatively use their images and also to locate images moods or emotions more precisely. This paper presents the evaluation results of ImageNexus.

1 Introduction

Images are a very important element in many design activities, e.g. graphic design, architecture design, fashion design and product design.

Product designers use images to assist in exploring design concepts before the design development proceeds (Baxter [1]). Also many product design methods involve images, for example, mood board development, user photo diaries, and 'The Visual Inconsistency Search' (Jones [2]). Images are used as references, inspiration material, communication material or for presentations.

Any image can be used in the design process not only those of products. However, they are all used to define the context for designs and to inform the creation of individual design (Eckert & Stacey [3]).

Coates [4] stated that products convey three different kinds of information that can be classified in order of the degree of freedom they permit the designer: essential information, collateral information, and discretionary information.

He explained that:

- Essential information is the product's very reason for existence, e.g. a watch indicates time.
- Collateral information exists alongside essential information to supplement it. It is always optional. Coates indicated that the designer has more discretion in shaping sources of collateral information, as long as it does not hinder the effectiveness of any essential information, e.g. the numbers on a watch face.
- Discretionary information refers to the designer's freedom to have a product created. Coates indicated that whether or not a product conveys essential or collateral information, it always conveys discretionary information. Discretionary

information in a product is a means of broadcasting personal values, beliefs and attitudes, e.g. iMac conveys a brand value more than its essential information.

'Discretionary information' is the important information conveyed by products which represent brand names and the visual image of a corporation. According to Mooij [5], a product's 'association network' also relates to: the product's attributes, users, place (occasions, moments, moods when using the product) and value.

When searching for an image, designers might need to represent any of these qualities. A literature review and series of interviews (see below) were carried out to identify the information needed for an image database and to collect keywords for the database development [6,7]. Pilot interviews were held with product design professionals in Taipei and MA product design students at Central St Martins College of Art and Design.

2 Image Information

In 2001, a survey was conducted of 17 professional product designers whose experience ranged from 3 to 35 years in London. Its focus was on the use of images throughout the design process.

Analysis of the designers' responses showed that product design is used to establish the value of a product and its brand, as shown in Fig. 1. Product value may be divided into physical and context. The physical value is represented by a product's format and features while function and characteristics are represented by the product's context value. The format is the product's physical properties such as colour, material, form, and texture. The function is the product's purpose which is a requirement of the product's users and where it is needed.

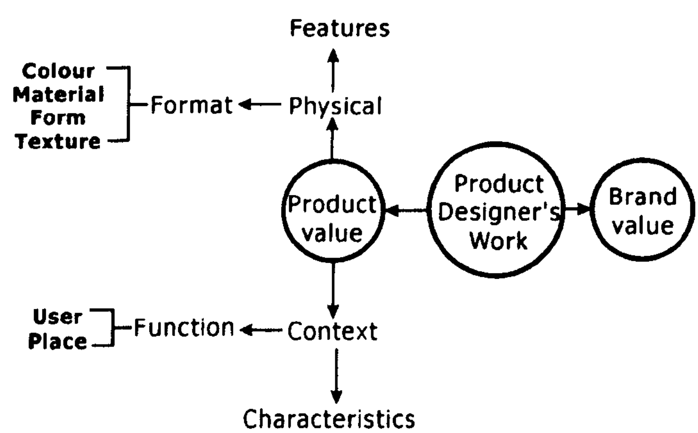

Fig. 1. A model of product designer's work as identified from the survey.

The information represented in Fig. 1 reflects the work of both Coates and Mooij. The survey confirmed that images serve a vital role in the design process and identified various ways in which designers store and retrieve them.

2.1 The Three Divisions

The research showed images convey three different kind of information. Which have been grouped under three divisions named: SPECIFICATION, CHARACTERISTIC, and EMOTION.

SPECIFICATION. Its information is about product properties and market segmentations. In this information division, the categories are: Colour, Form, Material, Texture, Gender, Age, Class, Places, Activities and Product Field.

Colours, Forms, Materials and Textures are the visual properties of products and the physical design elements. The categories of users', Gender, Age, Class, Places, and Activities, are the market segmentations used to define users. The product field is included because product types forms a fundamental way of classifying images.

EMOTION. This information division is intended to provide users with a record of their emotional reactions to images. Most images are product images and the vocabularies to express emotions are very varied, so in order to provide an appropriate number of keywords to include different emotions. Desmet's study [8] of product emotions was adopted. It includes 14 members: Indignation, Contempt, Disgust, Unpleasant surprise, Dissatisfaction, Disappointment, Boredom, Desire, Pleasant surprise, Inspiration, Amusement, Admiration, Satisfaction, and Fascination.

CHARACTERISTIC. This information division is a collection of descriptive words used to express the context of images. It includes 33 categories which were classified from words collected from the survey interviews.

2.2 The relationship between the three divisions

This three division model allows designers to define the relationship between an image's' qualities and its physical properties. This combination records what designers see and how they perceive an image (see Fig. 2).

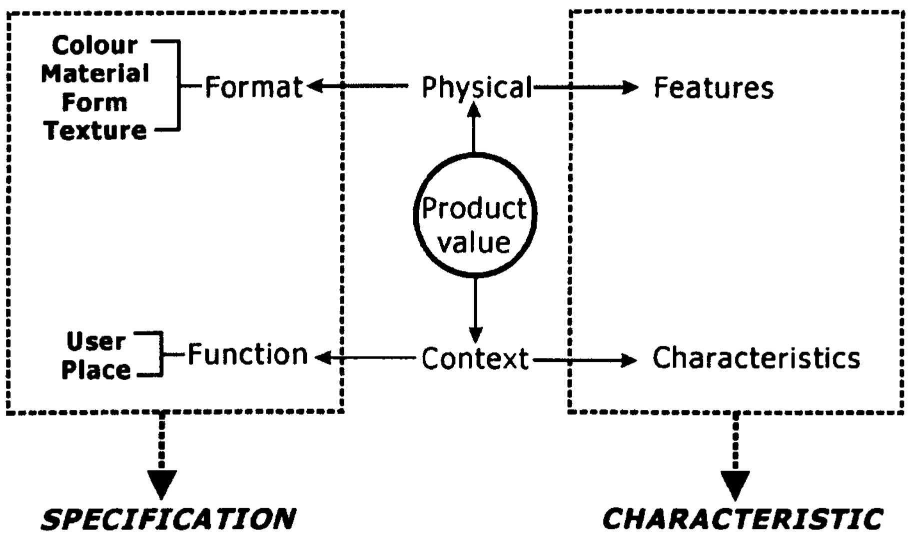

Fig. 2. The work of design with the divisions.

In addition, the categories within the CHARACTERISTIC division encourage designers to look more carefully at an image. For example, a "cheap" product could be one whose 'value' is cheap or whose 'price' is cheap; a "cold" image could be one whose 'physical sensation' is cold or whose colour/form is cold. As designers become more familiar with these distinctions, the better they understand what their perceptions are.

This three-division structure demonstrates the relationship between images and viewer, and also the relationship between properties and qualities. It assists designers in organising images more accurately.

3 ImageNexus

3.1 Introduction

The structure of ImageNexus is shown as Fig.3. There are three functions included: Define, Search, and Set-up.

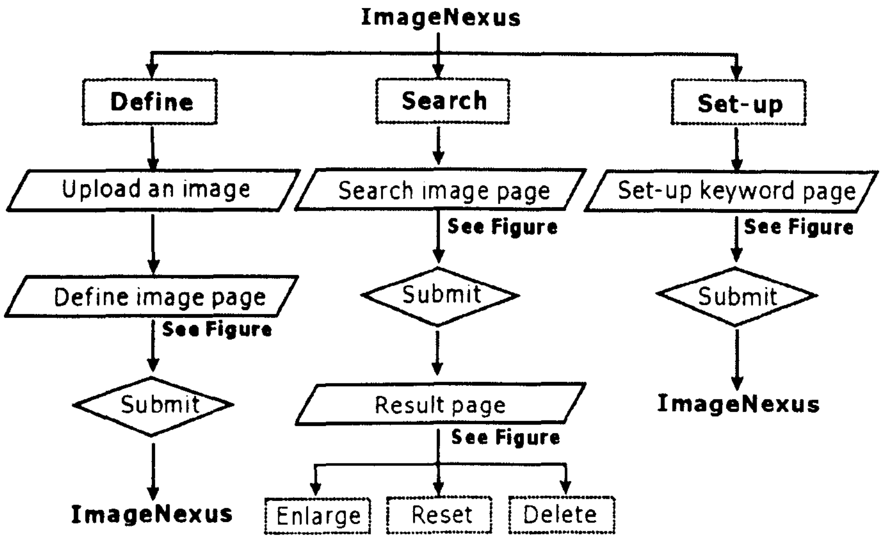

Fig. 3. ImageNexus structure.

The define and search pages have the same design as Fig.4. The screen's five areas, are:

- Zone A

  This contains categories of the CHARACTERISTIC division. When one of the categories is selected, its members will show up in Zone D.
- Zone B

  This contains categories of the SPECIFICATION division. When one of the categories is selected, its members will be shown up in Zone D.
- Zone C

  The image is shown in Zone C.
- Zone D

  This shows one category's members when one of the categories of the SPECIFICATION or CHARACTERISTIC division has been selected.
- Zone E

  This shows members of the Emotion division.
- Zone F

  This is designed to allow users to add additional information about an image, such as the source of the image.

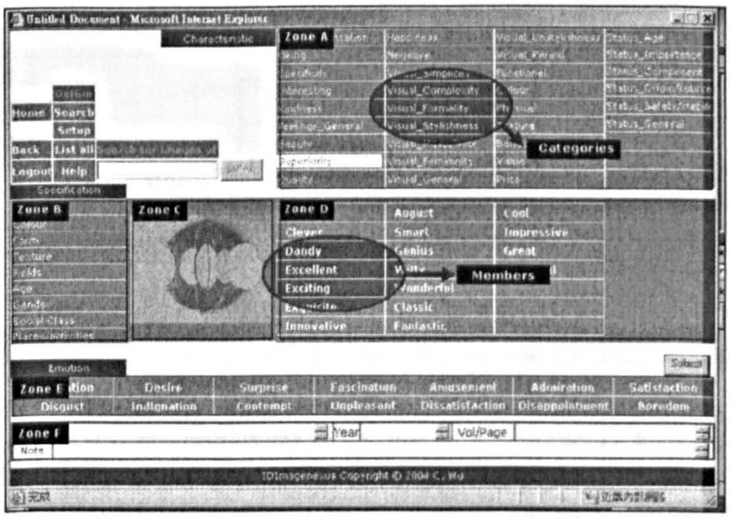

Fig. 4. Interface format of define page.

When a category is selected, ImageNexus uses different colours to show the category's state. As shown in Fig.5, when the category of SPECIFICATION or CHARACTERISTIC is shown in dark green, it means its members have been selected to define the image. But when the category of SPECIFICATION or CHARACTERISTIC is shown in white, it means the category's members are now shown in Zone D.

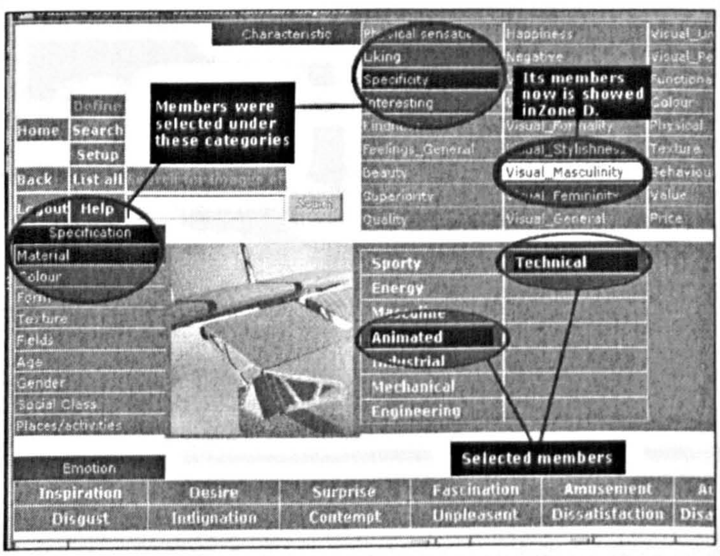

Fig. 5. Selected categories and members.

3.2 Methods of evaluation

In order to examine the usability of ImageNexus and test the understanding of the use of the three-division model to define images, usability tests and expert review were used. Web Design for Business [9] suggests that usability tests need between five and ten people who are representative of intended users of the site, but are not familiar with the project, for an hour. These users should be asked to try to achieve certain goals which are typical of the user goals the site has been designed to facilitate.

Therefore it was decided to run an evaluation workshop with five to ten people who had product design backgrounds. At the outset of the research the pilot and main interviews showed that both professionals and MA student designers use similar design processes. However, it was decided to carry out the usability workshop with MA students, who had had at least one year of prior professional experience. In these tests no significant variations were recorded between the student group's responses and these of five professional product designers who agreed to act as 'expert examiners' working from their offices.

3.3 Aims of evaluation

The aims of the evaluation were:

- To evaluate the user's understanding of the design of the database interface;
- To evaluate the user's understanding of the system structure;
- To evaluate the user's understanding of the three divisions and the categories;
- To evaluate the value of the database.

In order to achieve these aims a questionnaire was included with tasks in the evaluation workshop.

Table 1. The questionnaire questions.

Q1	Introduction to ID-Imagenexus is Clear/ Not clear
Q2	The three divisions of image information are Adequate/ Inadequate
Q3	The information provided for defining an image is Good/ Sufficient/ Poor
Q4	Which division is the most useful to define images? Specification/ Characteristic/ Emotion/ Additional Notes
Q5	Is the characteristic division comprehensible to you?
Q6	Is it easy to find the right keyword?
Q7	Is it a useful application for you?
Q8	Which division did you use the most to define a search? Specification/ Characteristic/ Emotion/ Addition Note/Search Box
Q9	Was it easy to define a search?
Q10	Was the search result sufficient?
Q11	What kind of additional information would you need to better understand the divisions?
Q12	What additional categories or members do you suggest adding?

3.4 Participants and procedure

Eight postgraduate students and five professional designers participated in the evaluation. Five students attended the workshop (Fig.6) and one professional designer also participated in the same format. The other three students and four professional designers evaluated the system via the Internet and their evaluations were obtained by email and telephone. The times they spent on the system were recorded each time they logged in and out. The participants were:

- Five MA Industrial design students at Central Saint Martins College of Art & Design (CSM), UK
- Three MA Industrial design students at Sheffield Hallam University (SHU), UK
- Five professional product designers

MA Students workshop (CSM). This took around 2 hours. Five participants were asked to define the images provided for up to 90 minutes, to search images and to complete questionnaires. A brief induction was given before the workshop started. Instructions were provided on both screen and paper. The database was operating on a remote host and each participant was given a unique identity number in order to record their results separately. As a reward, each participant was offered a copy of the system when the research is finished.

MA Students (SHU). These participants evaluated the system via the Internet but otherwise their procedures were the same as the evaluation workshop with CSM MA students

Professional Product Designers. Professional product designers were treated as expert evaluators. They were able to try the system and complete their evaluation within a month. Each was given the ImageNexus web address and a unique identity number.

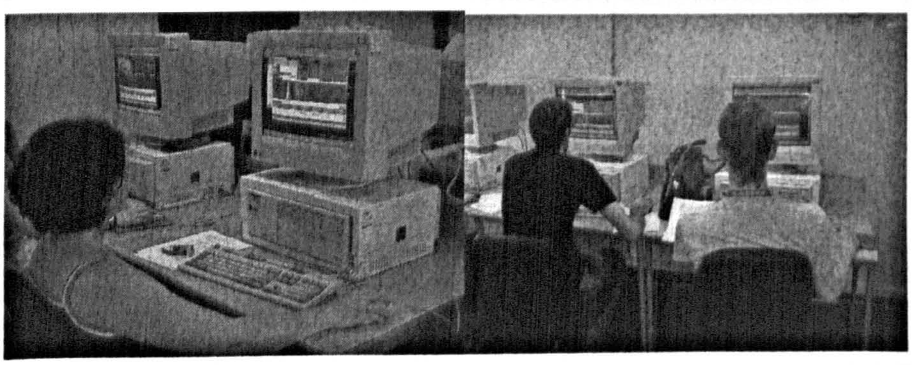

Fig. 6. Workshop photographs.

3.5 Analysis

The overall of the evaluation questionnaire are shown in Fig. 7.

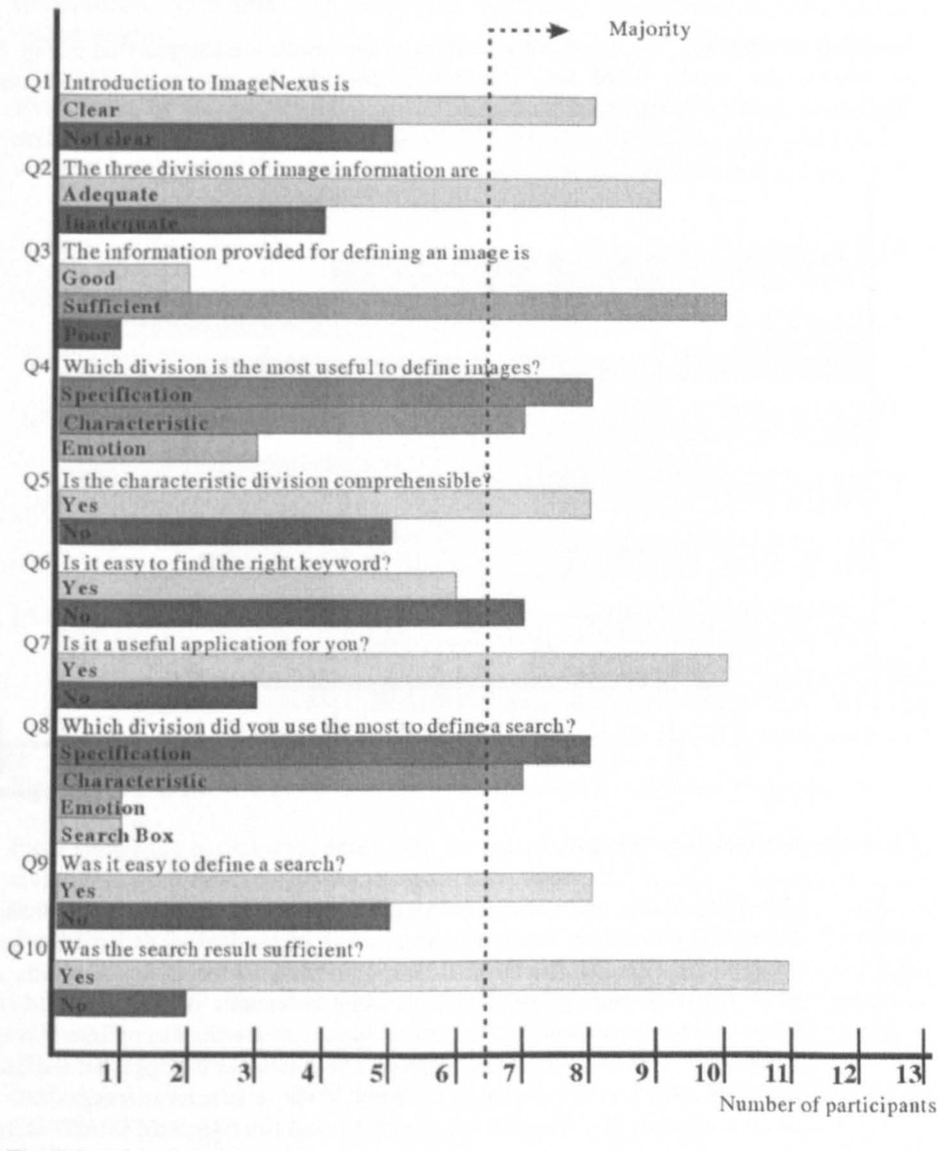

Fig. 7. Results of closed questions.

Analysis of the responses has been divided into two sections: (a) Usability evaluation; (b) Evaluation of the image classifications. Usability evaluation covers the first two aims of the evaluation which include evaluating the design of the system interface and the participants' understanding of the system structure. Evaluation of the classifications of image information focuses on the participants' understanding of the categories and the three divisions, and analyses the value of the database.

Usability evaluation. The questions covered and the results are summarised in Fig. 8. As shown, the results listed for 'Question 3' include the results of 'Good' and 'Sufficient' because 'Good' and 'Sufficient' are positive results.

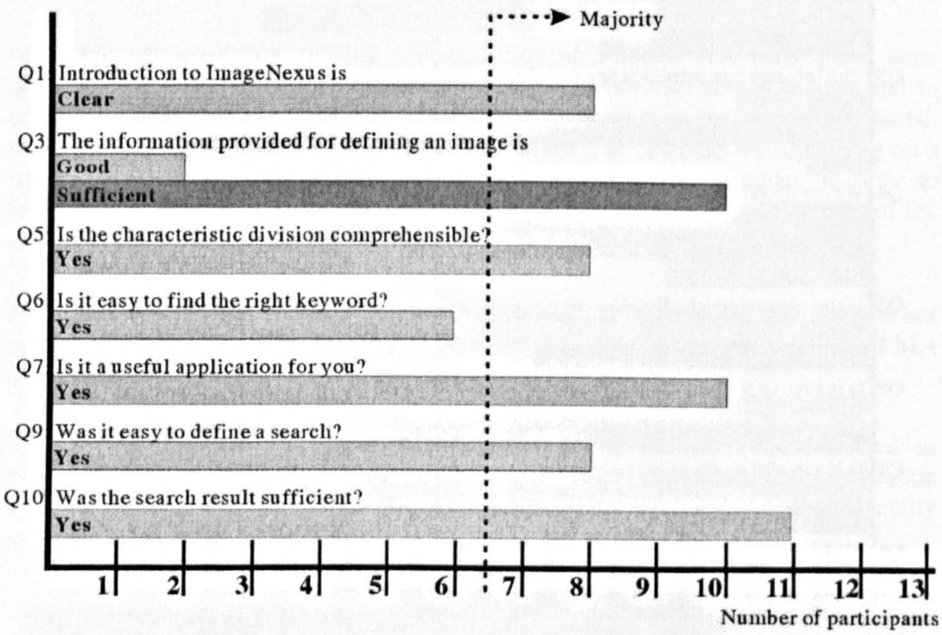

Fig. 8. Result of usability evaluation.

Fig. 8 shows the participants agreed that ImageNexus is understandable, useful and sufficient. However, comments from individual participants included: introduction was too complex, the EMOTION division was unnecessary, the database needs a considerably simpler and more usable interface. Most comments were anticipated or can be incorporated in a future version. For example, one of the major comments was that the "introduction" was too long and complex. The participants suggested the use of images to explain and demonstrate the procedures; fewer words, more images.

The major comments on the question "Is it easy to find the right key word?" were about the number of categories and keyword members, and most student participants indicated that there were too many of them. The participants said they would need to personalize the categories and keyword members for further use. However, one of the professional 'expert' evaluators thought that the depth of information would help designers look more deeply at the image. The system would assist them in evaluating images more carefully before showing them to their clients.

There were only 3 participants who did not think it was a useful application. One (student) gave the reason of having to personalise the category members; one (student) did not have any idea how it could be used and what it was for; one (professional A) claimed that the he/she found only some keywords were useful to define images.

Evaluation of image classification. This section includes evaluation of the users' understanding of categories and the three information divisions and evaluating the value of the system. The questions covered and the results are summarised in Fig. 9.

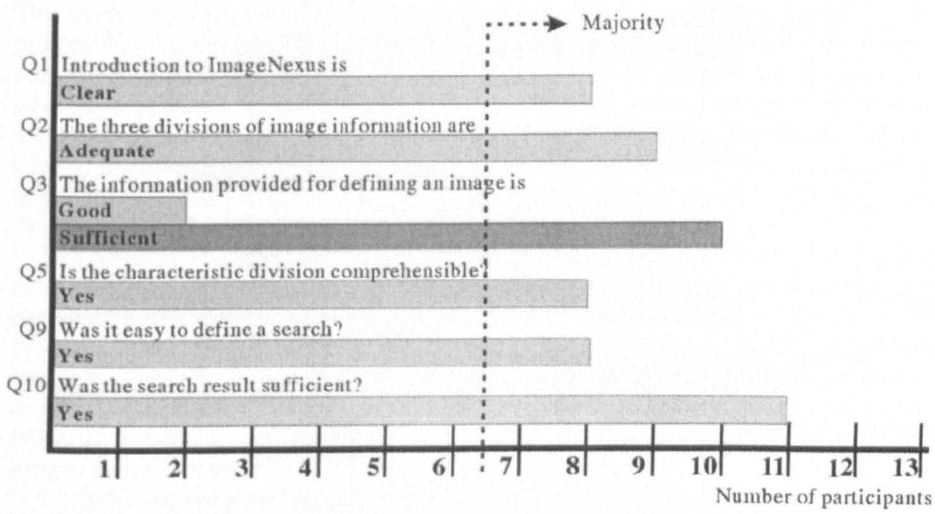

Fig. 9. Results of the understanding of the three information divisions and categories.

Fig.9 shows the participants agree with the classification of image information. Their comments were the same as the previous discussion, that too many categories meant that time would be needed to remember where a keyword was. There were no disagreements over the information structure for an image.

The suggestions were mostly about the interactive functions with the database, such as having a "date of entry in database", and a "list by" option, such as list by "material" etc. Furthermore, only 3 out of 13 participants indicated that the names of CHARACTERISTIC categories were confusing and not comprehensible. The confusion was caused by there being categories within the SPECIFICATION and the CHARACTERISTIC divisions sharing the same name, e.g.Colour.

Fig. 10 shows the results of two different groups. Comparing Fig. 7 and 10, it shows that SPECIFICATION was seen as the most useful division both in defining and searching images. CHARACTERISTIC is the second most popular one.

However, the CHARACTERISTIC division was the most useful for professionals and the SPECIFICATION division was the most useful for students.

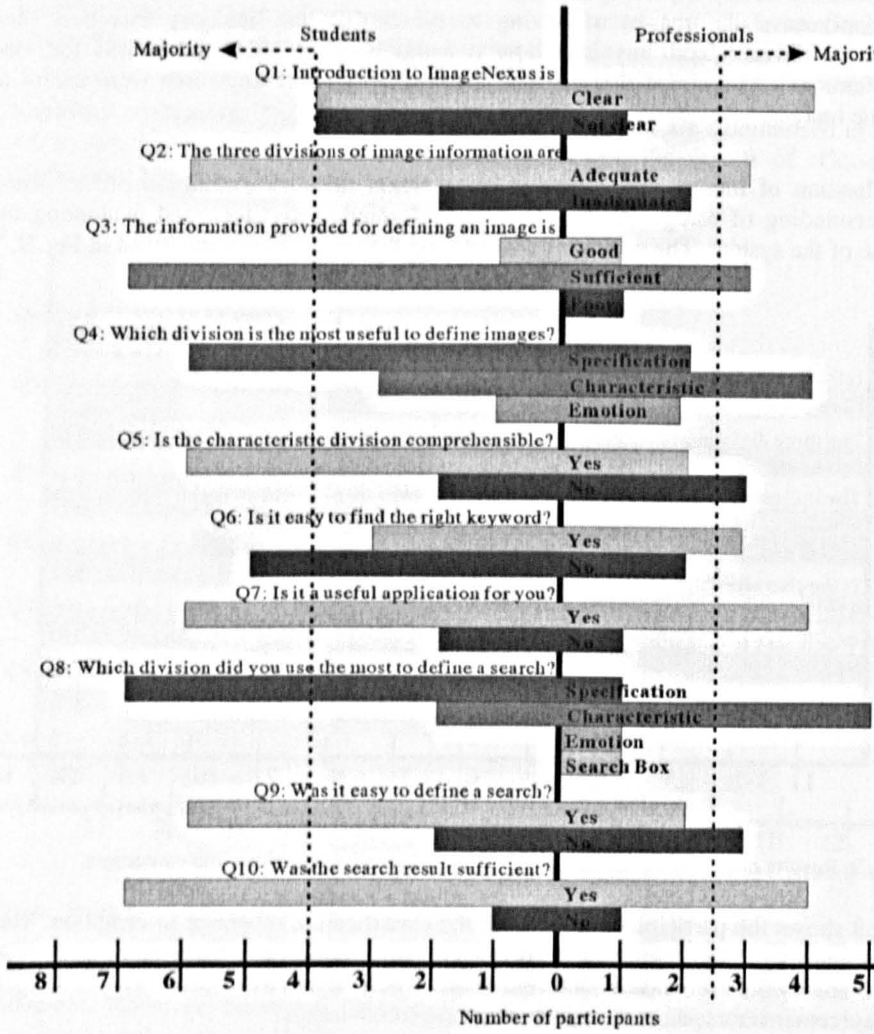

Fig. 10. The results of two different groups.

Discussion. The results show that the database was accepted and appreciated. Although there were comments on the number of keyword members, it did not affect the value of the system.

It was anticipated that participants would need to personalise the keyword members. The set-up page has provided the function for participants to organise their own members. One issue to arise here is that the 'default' members may need to be made changeable, because the original option was that the users could only add new members into each category, they were not allowed to delete default members.

To improve the usability of the database would require experts (such as an interface designer and a programming engineer) to participate in the development. This would allow the issues raised to be addressed and more functions to be added.

It was anticipated that because the evaluation focused on participants' understanding of the system, first time users could feel intimidated by the large number of keywords. The feedback comments from students confirmed this but not from professional designers.

3.6 The usage of ImageNexus

Product designers search images for inspiration or for communicating with others. The results from the interviews indicated that designers have a mental concept of the images they search for. Generally, they go through magazines or books for images they need. In recent years, their image searching has relied more on the Internet. The advantage of these methods is that the resulting unanticipated images can provide designers with inspiration; however, according to the survey, the frequency of this kind of inspiration is low. The disadvantage is that designers need to spend a lot of time either browsing magazines or books that they have seen before, or checking over thousands of images on the Internet.

ImageNexus was set up to assist product designers in organising their image collection most effectively for their use. As a result, ImageNexus not only provides designers with a means of storing their images, but more importantly also helps them to extend their image mapping with words. For example, when they search for 'beautiful' images, the system would show them other associated words: 'attractive' or 'fascinating'. This function assists designers to have further insights into their projects, because it indicates other possibilities. It helps to define where a design project theme can go and stimulates creative thinking.

ImageNexus not only allows designers to use their images productively, but also has no effect on their enjoyment of browsing magazines or books with a cup of tea/coffee. ImageNexus assists designers in organising their images for future use. It does not replace the need to find new images by an established methods.

The value of ImageNexus grows for users with extended use as they understand more fully the structure and experience the associations they make. As one designer said, the real value of ImageNexus is when it has a large number of images.

4 Conclusion

ImageNexus encourages designers to creatively use the images it contains. For example, when they select images to show to a client in relation to a mood or emotion, they need to be very specific about the mood they are choosing, so that no ambiguity arises. In this way, the communication levels between designer and client will increase, resulting in less confusion and a more appropriate design solution being provided.

A project brief is not normally only about the characteristics of the product but also includes other specifications (e.g. target market) which clients often see as more important. The three-division structure of ImageNexus helps designers to fulfill these requirements.

ImageNexuse assists designers to locate their moods or emotions more precisely. It allows them to understand the difference between their intuitive reactions and their interpretations of images. For example, the intuitive response to the characteristics of Fig. 11 and 12 based on their colour or texture could all be defined as 'original' or 'nature'; however, they are very different in their real colour/texture. If they were presented together as 'original', they would cause confusions to others. The SPECIFICATION and CHARACTERISTIC division of ImageNexus can assist designers to distinguish them.

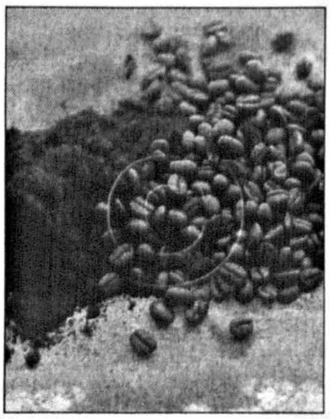

Fig. 11. Image of 'original' & 'nature' 1 (Source: Digital Vision, image No. 1818035)

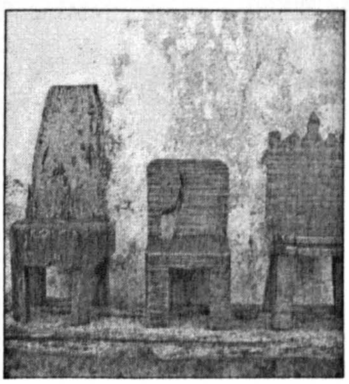

Fig. 12. Image of 'original' & 'nature' 2 (Source: INVIEW September 2002, p.82)

ImageNexus's keywords can also inspire designers in their use of visual and verbal vocabulary both in the idea generation phase and for presentations. For example, to represent a concept of 'masculinity' which includes 'energy', 'sporty', 'technical', 'mechanical', 'animated' and so on (see Fig. 13).

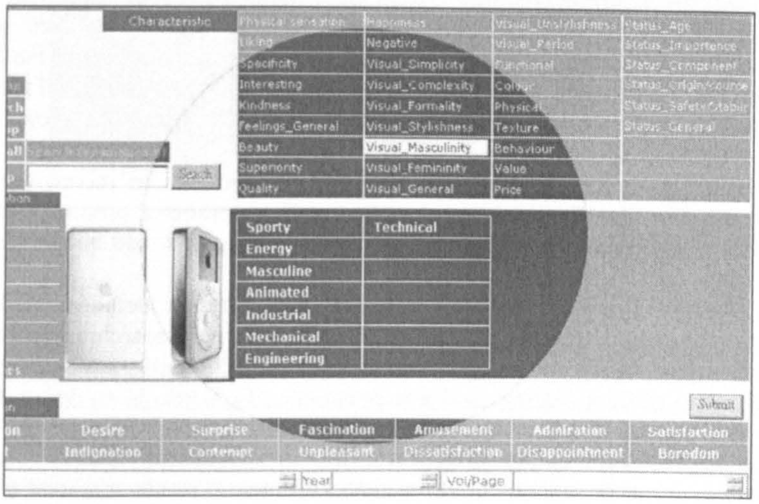

Fig. 13. Interface of the CHARACTERISTIC division of ImageNexus.

The concept developed by Donald Schön [10] of knowing-in-action and reflection-in-action is supported by ImageNexus. He indicated that the work of the professional practitioner reveals in its recognition, judgments and skill, a pattern of tacit knowing-in-action. Knowing is ordinarily tacit, implicit in the patterns of action and in the feel for the involved events. Reflection-in-action is the unexpected outcome of knowing-in-action and is a subconscious result. In classifying images for ImageNexus designers utilise knowing-in-action behaviour in the conscious procedures of identifying and recoding keywords within the theme information divisions. When searching for images designers must consciously select keywords (knowing-in-action) but the results can be unexpected because forgotten images will be retrieved. Through extended use of the database reflection-in-action will play a significant role in both indexing and searching. The more familiar designers become with it, the more sophisticated will be their use of it, particularly in relation to the EMOTION information division where emotional responses to image are recorded. This sophistication results from subconscious processes which develop intuitive understanding.

The essential role of ImageNexus is to store images for designers' future use. The more effort they put into indexing the images, the better the results they will get. ImageNexus also enhances the value of images because its categories can record all possible messages they can convey. An image will no longer be just a digital file.

ImageNexus may also be used to store the photos from observations of product users. There are a variety of design methods which use such photos, such as visual diaries and user reactions [11]. Although, these photos are used to record evaluation of functional aspects, they can also remind designers about users' feelings and these can be indexed in detail by ImageNexus.

Recording moving images of a consumer's behaviour or a product's mechanical movement, for example, is common as part of the design development process. However, when designers store a moving image, it is normally used to record movements in order to investigate ergonomic or functional detail. Furthermore, classifying a moving image for future use requires defining the content of the 'movie' e.g. 'washing machine operation' or 'sequence of using a mobile phone'. This is different to the core purpose of ImageNexus which has been developed as a tool to assist designers in recording their responses to images not to record the images' content. As it is also the case that designers will remember a product's movement when they see it again it was decided that moving images should not be included in the ImageNexus specification.

ImageNexus is not only the result of understanding design methods and designer's perception of objects (product semantics) but also will make searching visual support resources easier within the design process while enabling designers to have a better understanding of their feelings and interpretations of images. In so doing it satisfies designers' needs as identified by the following researchers:

- Formosa [12] noted that an insufficient flow of information leads to inadequately designed products and he believes that information could enhance the design process; in the proper environment it will feed creativity.
- Lahti et al. [13] indicated designers frequently search for and use information to help them to construct new knowledge related to the design topic, simultaneously searching for new information that will help to determine design constraints and produce a satisfactory design.
- Monö [14] commented that a designer should aim at understanding product language better in order to be able to improve his design.

4.1 Indications for future work

Current image database improvement. In order to provide a better version, ImageNexus could be improved by working on:

1. Additional information categories

   Additional information categories could be added to the database, such as:

- Brands: in recent years branding has become increasingly central to design. For example Gobe [15] stated that sensory design is the new branding power tool. It is one of the main concerns in marketing a product and as the interview results indicated, the front-end phase of the design process is heavily involved in marketing strategy. Designers are required to use visual aesthetics in enhancing brand value for their clients. Fig. 14 shows how images can be used to reinforce and enhance the perceived value of a corporation.

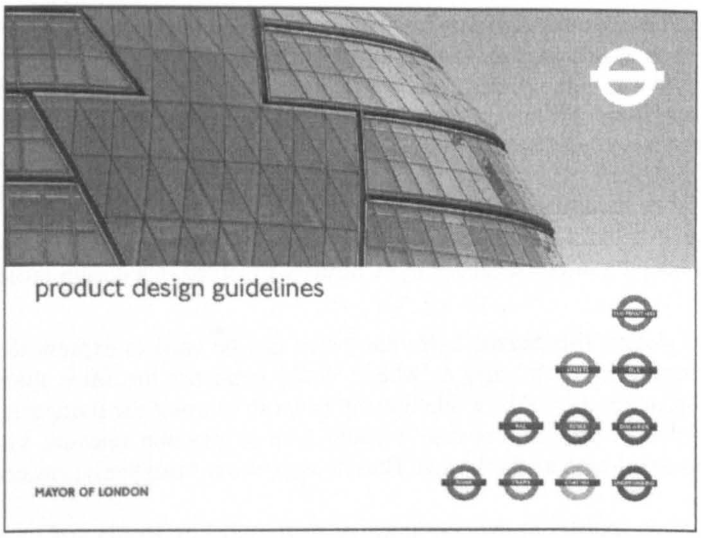

Fig. 14. Example of images used in enhancing a 'corporate image'-1. (Source: Tangerine Product Direction and Design)

- Size/weight of product: size and weight are also part of a product'sphysical properties. As the alarm clock in Fig. 15 shows, it is hard to tell how big the clock is from the image. A category to record size/weight would help designers' perception of the product's reality.

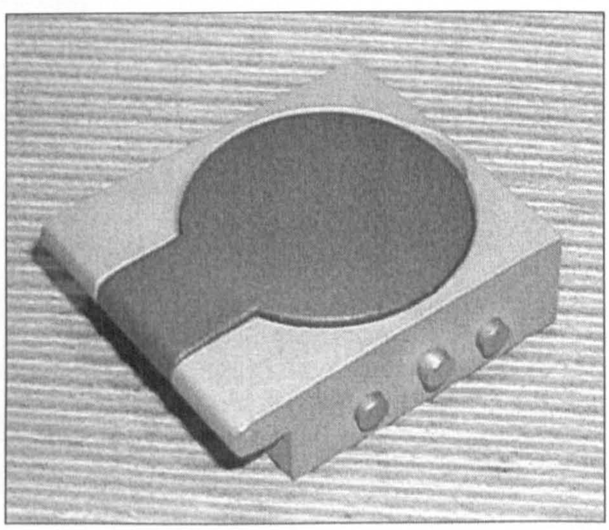

Fig. 15. An alarm clock. (Volume: 4x3x1 cm, weight: 400g)

- Sounds: sounds are an important part of a product, for example, the different click sounds on a keyboard represent different qualities/materials. Furthermore, for safety or the human factors, sound is a requirement of certain products, for example kettles require sounds as alarms to warn of water boiling. Sound is also attractive to people, and new information technology could help make recording sound easier. However, the question remains of how to search sounds, and what sort of keywords to use.

2. Additional function of interaction

A mood board function that allows designers to move images onto a design board would make the image database more directly involved in a design project.

Product design thesaurus. Different words can be used to express the same things. For example, a 'circle' and a 'wheel' could represent the same things. A product design thesaurus would be a relationship network to assist the thesaurus method in the product design process because it could help to develop relevant visualisations. It could be developed as the Visual Thesaurus at www.visualthesaurus.com (Fig.16). In Fig. 16:

The word appears in the centre and is surrounded by words and meanings that are related to it.

Clicking on any word can transfer it to the centre and consequently see the words and meanings related to it.

Rolling over a circle can show its definition and usage examples.

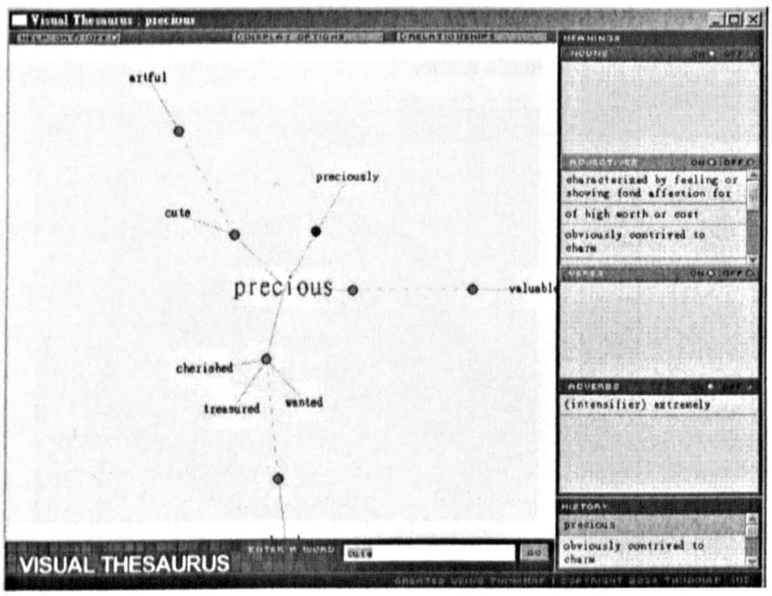

Fig. 16. Image of the Visual Thesaurus. (Available from: www.visualthesaurs.com, Nov 2004)

The difference between a product thesaurus and a visual thesaurus would be that the links between words are defined by the words' visual form, function, and meaning. See Fig. 17 for example.

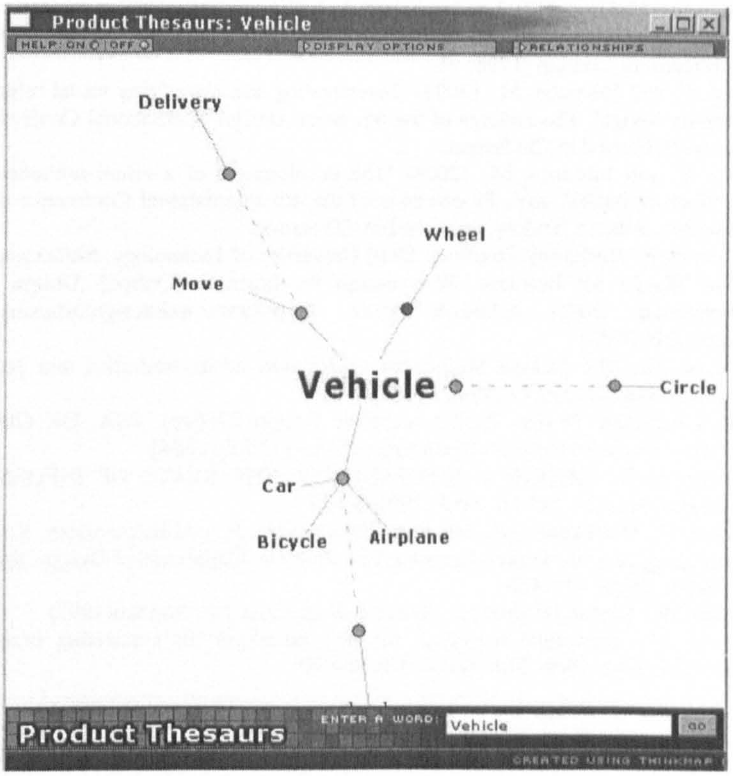

Fig. 17. The prototype of product thesaurus.

The product/object appears in the centre and is surrounded by the word's meanings, functions, and shapes that are related to it (Fig.17). Rolling over a circle can show its connection relations. The difference in a product design thesaurus is that the relationship between words is connected not only by meanings but also by functions and shapes. In addition, the words can be presented with images or links to relevant image databases. The visual thesaurus and other developments described would further enhance the value of ImageNexus to Product Designers as a creative and efficient tool.

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