How Information Retrieval Systems Impact on Designers’ Searching Strategies
within the early stages of the design process

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ABSTRACT

The purpose of this research is to investigate the influences that Information Retrieval Systems such as online Search Engines and Databases have on designers’ early searching strategies. The study involves the observation of designers transforming early design language into query ‘keyword’ language for the operation of Information Retrieval Systems and how this transition causes a shift in early design exploration. This transformation is referred to in this research as the CLASS activity; Converting Language from Abstract Searching to Specific.

Findings show a common pattern across the activity of both professional and advanced student designers. Information Retrieval Systems are seen to drive the searching process into specific, explored domains rather than stimulate an ‘abstract’ broad investigation. The IR systems are built upon categories that are created to manage the information content. It is these categories that require a person to use defined keywords and query sentences to operate the Information Retrieval Systems. The findings suggest that using Information Retrieval Systems prior to defining the scope of a design problem causes designers to prematurely focus on specific searching.
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STATEMENT OF ORIGINAL AUTHORSHIP

The work contained in this thesis has not been previously submitted for a degree or diploma at any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signed:

Date: 16.02.2006
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To my husband Matthew whom this thesis is dedicated to and would not have existed without his persistence and understanding with me during my studies.
CHAPTER 1

1.0 THESIS OVERVIEW
1.1 INTRODUCTION

Designers are influenced by the world that they live in. The information available to designers is everywhere. In an age congested with information, the process of searching becomes highly important. Information Retrieval Systems present a way of managing and networking documented information. Designers use these systems alongside other means of searching such as sketching, talking and note taking to assist in clarifying and expanding a design problem. As a designer travels through this early searching process, he or she is absorbing new information and analysing its value. However, the act of searching also plays an influential role over the direction in which a designer adopts. Therefore, the aim of this research is to investigate the impact on industrial designer’s early searching strategies with a primary focus on the use of Information Retrieval Systems.

1.2 THESIS OUTLINE

This research followed the outline which is illustrated in figure 1. Firstly, literature was researched and reviewed on the two main areas relative to the research problem. The first being the subject of Industrial Design covered in chapter 2.0 which explores literature on design activity; information handling within the design process; and designers early searching. The second subject investigated was Information Retrieval Systems found in chapter 3.0 which defines an Information Retrieval System; information classification within an IR system; the operational searching practices; and an IR system’s limitations. The resulting information from the literature review informed a pilot study which gave an understanding of how to test the investigated area. A study was then conducted considering the designer/Information Retrieval System relationship and the effects from their use. Findings were then extracted, analysed and reflected upon and recommendations made.
How Information Retrieval Systems Impact on Designers' Searching Strategies within the early stages of the design process

**INDUSTRIAL DESIGN**
- Information in the Design Process
- Rational Problem Solving
- Reflection in Action
- Designers Early Information Handling
- Searching in Design
- Searching Strategies
- Design Language
- Language in Categories

**INFORMATION RETRIEVAL SYSTEMS**
- Definitions of IR Systems
- IR Systems and Classification
- Language in Classification
- Product Classification
- Limitations of Classification
- Naming
- IR Systems and Searching Practices
- Information Literacy Defined
- Planning and Implementation of IR Searching Practices
- Limitations of IR System Searching Practices
- Language Limitations
- Converging Searching Limitations

**DATA COLLECTION**
- Pilot Study (Testing & Review)
- Qualitative Experiments
- Gather Generated Data

**ANALYSIS & FINDINGS**

**SIGNIFICANTS & DISCUSSION**

**CONCLUSIONS & RECOMMENDATIONS**

Figure 1. Research Approach
1.3 BACKGROUND AND MOTIVATION

This topic first was of interest to me when I initially observed industrial designers being limited by the title of designs. I noticed student designers in particular restricting themselves to existing ideas if a design problem was associated directly to an existing design. For example, if a design project was introduced to a group of students, and an existing design was provided for disassembly and redesign, the designers were seen viewing the existing product as the scope of the problem and would begin to refer to the design problem as a *kettle* redesign or *water filterer* redesign. However, the project was to look at the existing product and question its function and purpose and improve the overall end user's experience. It appeared that by using a product's given label such as *kettle* caused the designer to think that it had to have a spout on one side, a handle on the opposite side and a volume of water contained in the middle. This greatly limited the generation of ideas of the designer. Following this observation, a greater attention was given to the importance of broad design language and the activities that affect the way a designer views a design problem. Through the use of the Internet and other searchable databases, I realised that researching depended on keywords which differed to that of designer’s visual communication and broad referral of design problems. Information Retrieval Systems became a focused area of interest and the activity that is required for its operation. Therefore a research question was designed to guide this study.

1.4 RESEARCH QUESTION

The question to guide the research is: *How do Information Retrieval Systems impact on designers searching strategies within the early stages of the design process?* The question demonstrates the two areas of interest: Firstly, the early interaction between designers and Information Retrieval Systems and secondly, the impact on searching strategies prior, during and after IR system usage. This thesis has explored these two areas in relation to each other through a review of literature which is as follows.
CHAPTER 2

2.0 INDUSTRIAL DESIGN
2.1 INTRODUCTION

Design is a process of creative decision making. It is an activity that involves applying “imagination and constructive forethought to practical problems” (Cross and Cross, 1995). Many definitions of what design is have attempted to lay bare its fundamental properties for universal clarity. The essence of design is broadly defined by Heskett (2002) who builds the notion that it is a capability of a human to “shape and make our environment in ways without precedent in nature, to serve our needs and give meaning to our lives”. Both definitions from Cross and Heskett are impartial to every design profession due to their broad nature. More depth can be found at the level of an individual design discipline where specific properties are mentioned. Industrial design in particular is a profession of continual problem solving within the areas of products, systems and artefacts, all for the built environment. These areas mentioned are reflected throughout the industrial design definitions made by constitutions and organisations that stand for the promotion of the profession.

The International Council of Societies of Industrial Design (ICSID, 2005) state that “Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles. Therefore, design is the central factor of innovative humanisation of technologies and the crucial factor of cultural and economic exchange”. The Design Institute of Australia (DIA, 2005) view the role of Industrial designers to “develop and prepare products for manufacture with particular emphasis on those aspects that relate to human usage and behaviour”. The Queensland University of Technology (QUT, 2005) philosophy of the Industrial Design course is to “educate industrial designers to play a leading role in the design and development of products or systems in our changing environment”. These definitions demonstrate the many facets of the industrial design field. They also make aware of the designers’ need for information.
Design projects require knowledge of many topics such as user needs, social trends, manufacturing techniques and innovative technology. Every project varies and requires knowledge in different fields. Schön (1991) states that “each design problem is essentially unique”. Designers face multiple and varying design problems in every new project. Therefore, when they are presented with a design problem which is unknown or vague they must have access to a vast amount of information in order to become informed.

Although designers source information throughout the entire design process, it is within the early stages of the design process (further defined in section 2.2) in which this research has a primary focus. This chapter reviews the current literature that focuses on the industrial design process and the activity of information handling and searching that occurs throughout.

2.2 INFORMATION IN THE DESIGN PROCESS

Definitions for the design process have been developed over the years describing the activity that occurs through designing. Influences are drawn from technical systems and problem solving techniques through to an approach of reflection and of construction. Two main ideas that adopt these perspectives are explored within this section. They represent views that see design either as a process of logical, systematic problem solving or an non-linear progression of reflection and decision making. Insight into how designers think and act is essential to understand the activity of how information is handled within the design process.

2.2.1 Rational Problem Solving and Reflection in Action

Increasingly since the early 1960s, designers have grown in awareness of the need for design methodology “to be defined clearly in order to create a foundation of processes that could reinforce the design structure of practices insuring quality design” (Dorst and Dijkhuis, 1995). A problem solving approach utilising positivist ideals was formulated by Simon in 1981, focusing
on the problems and the process of design. In 1983 Schön developed the Reflection In-Action theory based on constructionist ideals seen practiced by professionals including the field of design.

Dorst and Dijkhuis (1995) define the approaches into two distinct terms which are “problem setting” and “problem solving”. The perspective adopted by Schön is concerned with “problem setting”. Understanding the design problem and to reflect on potential actions and decisions. When designers are defining a given problem, they bring to the design table past experience and learnt knowledge. This knowledge can contribute to the familiarity of the presented problem. Designers continually refer to previous ideas, experiences, collected information and generated materials as well as reflecting on previous stages of the design. Schön points towards the beginning of the design process and the clarity of the problem.

Simon on the other hand associates the design process strictly as a “problem solving” approach. This approach depends wholly on a search process looking towards the end goal. The solution can only be found through searching the appropriate information and selecting the most appropriate paths. This method suggests a linear process which is confronted with information cross-roads. When information is found, a designer judges its worth and constructs decisions based on what is available. The idea of ‘searching’ is evident in the design process however Simon focuses only on one aspect of the activity. His idea focuses on finding the conclusive solution using the accessible information. In his writings, Simon (1998) talks about searching processes within design as “processes for gathering information about problem structure that will ultimately be valuable in discovering a problem solution”.

Dorst and Dijkhuis (1995) connect both Simon and Schön’s approaches by suggesting that the work of Schön “can be seen as a reaction to (Simon’s) problem solving approach, specifically made to address some of the blind spots and shortcomings Schön perceived in mainstream methodology”.

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With particular attention to design, Schön (1983) states that: “problems are actively set or ‘framed’ by designers, who take action improving the current situation”. Therefore, designers are controlling an outcome, setting a problem through the decisions they make. He says that designers are ‘decisive orientated’. This suggests that designers make decisions which in turn guide them through the design process.

Schön and Simon vary in their perspectives in regards to searching either reflective or progressive, however they both highlight the importance of searching broadly within the problem setting stage of the design process. This is to encourage decisions to be based on quality information and to be informed about the issues relating to the proposed design. To look at this activity further, a question is presented: What strategies do designers use to search for information and knowledge to guide their design decision?

### 2.2.2 Designers Early Information Handling

Studies concerning information handling by individual designers within the early stages of the design process include Baya and Leifer (1994), Ullman, Herling and Sinton (1993), Popovic (1994) and Visser (1994).

The objectives of Baya and Leifer’s study are to answer the questions dealing with the different activities that designers perform with information and their information management behaviours. In their paper, they sort the information activities into three groups which consist of “generate, access and analyse” (Baya and Leifer, 1994). They build the notion of an “information space” which these three activities modify. The “information space” is described as the design requirements which may change through the use of either activity.
Below are descriptions of the three terms Baya and Leifer (1994) founded their research of designers information searching:

**Generate**
Information generated from an unidentified source such as writing, drawing or talking can alter the information space, this action is known as the “Generate” action.

**Access**
Within or outside the information space, information can be gathered through reading, listening and observing which constitutes the action of “Access”.

**Analyse**
The representation or form of information can change through the action “Analyse” where the information classification has altered. To “interpret, to negotiate, to organize, to calculate and to reason”, are all actions that are capable of changing a fragment of information through analysis.

By utilizing these defined activities Baya and Leifer were able to judge which activities were being performed, when and briefly for what reason. Demonstrated within their study is a distribution graph outlining the time spent searching through information whether that be generating, accessing or analysing. The overall study time of was broken down into percentages. Designers spent 51 percent of their time generating information, 28 percent accessing information and 21 percent analysing information. The most dominating activity was to generate information through activities such as sketching and talking. The result was that designers spent over half of the design process within the conceptual phase allowing for the erratic activity jumping between generate, access and analyse.

From their study, Baya and Leifer (1994) also point out that “the computational tools of today are good at representing information at the qualitative and quantitative level, but are poor at representing and dealing with information at unlabelled and associative levels”. They define unlabelled
“being the subject of a piece of information which is an idea or concept that has no name” (Baya and Leifer, 1994). This comment derived from the limitations of their research analysis programs. The conceptual data (namely the initial concept sketches and portrayed ideas) that was generated within the studies remained unclassified due to their vague, broad nature.

This highlights the problem of managing concepts or designs that are ‘unlabelled’, that is not yet given a title and therefore cannot be classified and in turn cannot be associated with other designs. Unidentified designs remain undocumented due to the computational systems that require a label in order to process an entity into a category.

**2.3 SEARCHING IN DESIGN**

Searching is both reflective and progressive as demonstrated by Schön & Simon. Designers are both remembering and learning throughout the process of searching. Early within this activity, the design direction is shifting as the problem definition is clarified. Gero (1996) explains that searching “is akin to changing the problem spaces within which decision making occurs”. Searching involves learning and “learning implies a restructuring of knowledge” (Gero, 1996). As a designer questions a design problem, he or she is open to influence. “Design creativity depends on the quality of the knowledge that is available to the designers” (Popovic, 1994). Popovic highlights that the quality of knowledge influences a designers creativity. However it is the process of searching in the space of knowledge that is in question. Does the act of searching shape the designer’s mindset concerning a design problem?

Firstly, where is the origin of knowledge? Knowledge can be gained from “research, technical knowledge, experience, or expertise” (Stoll, 1999). The area of research is unique to the other three areas as it is a form of external reference whereas the others are internal. Therefore, for the purposes of this research, these areas of knowledge have been summarised into two areas:
internal and external. Internal being the knowledge that is owned by a person and available to them through reflection. External is knowledge that is not yet known and is required to be sought after through research. Designers use strategies to search through these areas of knowledge to gain a holistic view of the problem at hand. These searching strategies will now be discussed.

### 2.3.1 Searching Strategies

Searching strategies are activities that allow a designer to explore through the various domains of information and knowledge. These strategies alter as the design process evolves. A study carried out by Ho (2001) focuses on both “expert and novice designers searching strategies” throughout the industrial design process. He states that “designers often decompose an ill-structured design problem into well-structured sub-problems” through procedure of problem decomposition. By doing so, designers can solve each sub-problem and later “synthesize the solutions together” (Ho, 2001). Designers achieved problem decomposition through the use of their searching strategies.

Searching strategies enable a designer to explore inside and outside of the design criteria while being unlimited by real life constraints. This is to assist in expanding the scope of a design problem and to broaden the prospects of future concepts. Strategies to search internal knowledge include visual thinking, brainstorming, reflecting, storytelling and discussing. It is common for two or more searching strategies to occur simultaneously and in short intervals next to each other. Designers can reflect on internal knowledge to generate new information such as a concept sketch.

External knowledge can be searched through the activity of ‘research’. Unlimited access to external knowledge and information is important for a designer. Lack of research confines the designer’s decision process upon their own opinions from what they have previously learned or experienced. “With the increased awareness for the necessity to elicit user needs beyond the functional, design research is becoming more established” (Bruseberg and McDonagh-Philp, 2002). The importance of research within the design
process is to aid in comprehension of areas that will influence the designer and the design direction. With the ever expanding level of knowledge, tools have been provided to assist in the management and retrieval of published information. Information Retrieval Systems (Chapter 3) allow people to search through external knowledge however uses of such systems require a level of understanding of the operational strategies based on query terms and keywords. Both searching strategies and operational strategies use language as a communication medium. The importance of language will now be discussed.

2.3.2 Design Language

The design process is a “reflective conversation” (Schön, 1983). Any conversation requires a language. Designers communicate with the design process using a design language. Poggenpohl, Chayutsahakij and Jeamsinkul (2004) point out the need for a common design language as terms currently exist with multiple meanings. They state that currently “lacking a formal structure, design as a discipline has no orderly reference to its resources or tagging for its research”. They propose a database of basic defined terms in relation to the design fields. The language discussed in their research is based wholly on verbal elements. However the design language referred to within this research is both verbal and visual. Initially, when a designer is introduced to a new design problem, he or she must refine the brief (MacMillan, Kirby, Spence and Simon, 2002). They put it into their own words by deconstructing the problem. Sketches are also a means of communication. Rodgers (2000) states that “designers produce sketches…to communicate with themselves and with others”. They are appropriate for expanding solution possibilities as they are not restricted to words.

Early design language differs to that of general verbal communication. Not only does it use visual input but it also uses broad abstract expressions. For example, designers are encouraged to not title the design problem with specific headings as these confines their brainstorming and direction. By maintaining a vague or widely encompassing language, they do not restrict
themselves by focusing on existing ideas and methods. The problem setting stage of the design process is where the initial thrust is made in a particular direction, whether that direction is focusing on criteria given, user requirements and/or personal interpretation. At this stage, broad exploration through searching strategies is necessary to branch out the scope of design.

2.3.3 Language in Categories

Looking at language at a category level, definitions exist at two primary positions. According to Rosch (1978) categories are constructed by “hierarchical organisation of language to describe the world”. They are built upon natural (basic) categories and superordinate (specific) categories in which the former being less abstract and more comprehensive. An example of natural (basic) categories is the term ‘Transport’. It is a description that contains a collection of more specific entities. The entities that are housed under the term ‘Transport’ are superordinate (specific) categories such as a particular brand of car. Natural (basic) categories are abstract in nature with little description. Natural categories can exist within themselves constructing a multi layer hierarchical structure. The levels found at the superordinate categories are highly specific and contain detailed terms. Designers’ language and searching strategies both reflect levels of abstract and specific. These two levels of communication are used throughout the design process however, this research attempts to question whether focusing on specifics (superordinate categories) affects designers searching strategies.

Ho (2001) within his study, uses a scaling system which he refers to as the “levels of abstraction” when observing designers searching strategies. The levels of abstraction refer to the levels (0-3) in which the designers deconstruct a problem into sub-problems. Ho (2001) defines the levels, “the problems at level 0 are more abstract, such as problems regarding the whole system, while those at level 3 are better structured such as sub-problems of design details”. The levels of abstraction are outlined below:
Levels of abstraction
0 = System,  
1 = System and Subsystem,  
2 = Subsystem, and  
3 = Design Details.

Similar to Ho’s study, this research will observe industrial designers searching strategies using a variation of these levels. The terms used to code the observed searching strategies will be referred to in three categories which are:

Levels of searching
1 = abstract,  
2 = general, and  
3 = specific.

These terms are constructed both on Rosch’s definitions and Ho’s study. Using the structure that searching (like language, problems and knowledge) can be categorised in a hierarchical manner and deconstructed into sub-categories. The term ‘Abstract’ would represent searching at the whole category level, ‘General’ being both category and sub-category searching, and ‘Specific’ signifying the searches done at the detailed sub-category level.

“Throughout the early stages of the design process industrial designers are encouraged to maintain an abstract mindset when understanding the design problem so as to expand the possibilities when searching and generating initial ideas” (Francis, 2004)


2.4 SUMMARY

This chapter has provided an overview of information and searching within the design process highlighting the field of industrial design. Two perspectives of design activity were reviewed. This outlined that designers are both reflective and progressive in their actions. The two thoughts taken from Schön and Simon drew attention to designers need for searching. Designers use reflective practices to learn and expand their thinking throughout the design process, as well as they are influenced by the outcome of information searching and the availability of resources. Within design activity literature, designers are described to handle information in three ways:

1. “generate” new information,
2. “access” existing information; and
3. “analyse” the gathered information (Baya and Leifer, 1994).

It was found that although designers sporadically used all three activities throughout the design process, they spend the majority of their design time generating information. As designers explore information they generate a design language which consists of both verbal and visual data. This design language is generated from “designers searching strategies” (Ho, 2001). These searching strategies assist in expanding the scope of a design problem and allow a designer to explore an abstract, broad line of thought.

Design language is used within many applications for example to communicate ideas or to work through a problem. Information Retrieval Systems are tools which also operate on language, however designers’ language differs to IR systems operational language. It is important to understand the issues relating to the searching tools available for designers today. The next section takes a look at the Information Retrieval Systems in which designers use to source design related information and the differences between IR system and designer searching strategies.
CHAPTER 3

3.0 INFORMATION RETRIEVAL SYSTEMS
3.1 INTRODUCTION

Information Retrieval Systems originated from three types of “traditional” classification systems. These are the Dewey Decimal System, the Universal Decimal Classification, and the Library of Congress Classification (Brenner, 2000). All were used to classify the subject content of documents into a manageable order within a library of knowledge. Brenner (2000) states that traditional systems such as these operate on a “deductive method beginning with dividing the knowledge into broad categories. Each category is then subdivided and those groups again separated into smaller more detailed units”. As the world of information grew in quantity, these classification schemes were modified and used as an underlay for computerised databases that soon became networked and thus creating online Information Retrieval Systems.

Chapter 3 first sets out to define the term Information Retrieval Systems. It outlines how IR systems are based on hierarchical organisations and the limitations that users face when operating these systems. Attention has been focused towards the relationship between designer and Information Retrieval Systems and the contributing forces that impact on designers searching strategies.

3.2 DEFINITIONS OF IR SYSTEMS

Definitions are at large concerning Information Retrieval Systems. The purpose of IR systems according to Chowdhury (2004) is that they are “designed to retrieve the documents or information required by the user community”. Lancaster (1979) states that “information retrieval encompasses all activities involved in the storage and retrieval process from the time a document is indexed for input to the system until it is retrieved and delivered to a user in response to a request made to the system”. Robertson (1979)
states the purpose of IR systems is to satisfy a request and need for information within an unknown area of knowledge. They are not designed to answer questions however are to aid a user in doing so. Gerrie (1983) agrees to this idea as she points out “the general purpose of an IR system is to assist a client in the selection of documents that may contribute to the solution of some problem or anomalous state of knowledge”.

IR systems have now progressed to encompass more than just documents. With the inclusion of animations, audio files, technical drawings through to fully modelled Computer Aided Design (CAD) files. Because of this extended capacity to manage information in all forms, the term Information Retrieval now relates closer to its contents than before. Hert (1997) offers examples of the content in which one can expect to find within an IR system such as “full text, images, video clips, hypertext, and various combinations of these”.

IR systems operate wholly on the process of searching. They cannot solve a task but assist the progress of finding a solution. As IR systems are not defined as an end solution to any question, it is laid in the hands of the user to “construct searching practices” in order to successfully operate these systems (Grassian and Kaplowitz, 2001). Searching practices are the techniques that govern the search results of a researcher. For example is using a particular IR system over another or using a certain search query technique. Another example would be to expand the searchable scope of a problem by predetermining the initial keywords to be used in querying the IR systems. These searching practices are a researcher’s approach using information literacy skills (Further defined in Section 3.4).

Searching practices differ to designers searching strategies as they relate to research; retrieving external knowledge from IR systems. Design searching strategies are in place to expand a designer’s perspective of a problem. IR systems require alternative searching practices for their operation. Therefore two questions are asked:

- What are the differences between the two approaches?; and
- What searching activities are compromised if both conflict?
To answer these questions, both approaches need to be defined. As the purpose of designers searching strategies has been previously outlined (Section 2.3) the following section will firstly review the internal classification infrastructure of an IR system and then will outline the operational searching practices.

### 3.3 IR SYSTEMS AND CLASSIFICATION

Society is saturated with forms of classification systems that require people to order the world into information. Computers, repositories, databases and research tools all utilise categorisation to manage data content. More commonly used for information management is Information Retrieval Systems which assist in the storage and retrieval of information through keyword searching. However, as these systems operate on categories or labelling, one must question the purpose and method of classifying in order to understand the *searching practices* that are required to be undertaken to search through the classified data.

#### 3.3.1 Language in Classification

Classification is structured on categories which are labels or titles. This in turn directs the research questioning to the creation of titles through language. Winograd and Flores (1987) states that “in looking at the impact of the computer, we find ourselves thrown back into questions of language - how practice shapes our language and language in turn generates the space of possibilities for action.” Language, and the way one labels objects is a method of classification. Classification depends on levels of distinction or a point of difference. Therefore, if a particular entity within a category was being described and it was to be differentiated from other entities in the same category, *specific* properties of the entity would have to be highlighted.
“Classification is a process of grouping. It involves putting together like entities and separating unlike entities. The characteristics of entities are used as a basis for determining the likeness or unlikeness between them” (Kumar, 1979). However, the properties that one person may use to distinguish a product may differ to another persons perceived properties of that same product.

### 3.3.2 Product Classification

Buchanan (2001) sets out to distinguish the properties that make up a product by deconstructing a product into four elements concerning its *exterior attributes* in which people associate them with. These are form, function, materials and manner (Figure 2). “Manner serving as the distinctively human efficient cause that separates artificial products from natural products” (Buchanan, 2001).

![Figure 2. External view: the elements of products (Buchanan, 2001)](This figure is not available online. Please consult the hardcopy thesis available from the QUT Library)

These attributes are seen to be at a specific category level. For example, if a product was described with these four attributes in mind, a specific description of that product would be achieved. A person could presume what the product was without knowing the products name.

He goes on to demonstrate how designers deconstruct products from an *internal view*. This internal view is offered with the classification of a product into three additional elements pertaining to its experience values. Instead of exploring form from “an external perspective as shape or visual pattern,” Buchanan (2001) regards form as a “synthesis of what is useful, usable, and
desirable – that is, the content and structure of performance, human affordances, and product voice” (Figure 3).

**Figure 3.** Internal view: the form of product experience (Buchanan, 2001)

These three elements would be classified at the abstract level as they do not define a specific product but the purpose and need of the product. Using these three elements to define a product would allow a purpose definition to be constructed rather than a physical description. The definition would be a category that contained the described product along with similar designs.

Buchanan’s internal and external perspectives of a product’s properties demonstrate the many elements in which the product can be classified under. Classification of a product within IR systems should look at the many facets of a product’s properties. It should offer users, with differing searching perspectives, the ability to search all elements whether specific or abstract.

Rosch (1978) looks at a different concern as she states that “categories are not mutually exclusive (an object can belong to more than one category to different degrees), i.e. they are fundamentally ambiguous”. This suggests the limitations that are posed on existing categories and their lack of ability to guarantee containment of complete individual objects. For example, if a product or piece of information is sorted under many categorise, then it would be assumed that that product or information would easily be found. However, due to content being categorised under many categories, searching language has to become more specific to discard the unwanted products and information.
3.3.3 Limitations of Classification Naming

Linguistics and cultural histories are seen to be the two most influential forces that cause category naming to be the way it exists today. Malt and Sloman (2003) suggest that “perception of stimulus properties by individuals interacts with linguistic and cultural histories, but their interaction is constrained by structure in the stimulus space.” The stimulus space being that of the person's environment. An example showing how categories alter or even do not exist within different cultures is given within a comparison of two subjects from an English and Chinese speaking background. The English speaker utilises the one name (chair) for both a large, foam seat for one person and also for a wooden seat. However, in context of the Chinese culture, a stuffed seat (which seats only one person) owns the same name of a stuffed seat for multiple people. Again, in English, this multi-seat would be classed as a sofa. Malt and Sloman (2003) makes aware the naming of categories is limited in regards to the comparison of cultures where some categories never existed or vaguely are represented with multiple titles that can confuse a category contents.

The ambiguity of category naming can become confusing if not implying directly to an objects given name. Barrett (1999) gives an example of this with the idea of ‘white products being kitchen appliances' that are now available in black and ‘black ones being audio-visual appliances' which now come in a range of surface finishes and colours. Even the word design has lost its meaning; it has transferred from a specific name to an abstract category of mixed professions which is utilised beyond the traditional applications. ‘The word design is a generic term, a portmanteau word covering everything with the shaping of industrially produced material culture over the last 140 years.’ Therefore one can assume that the process of naming lasts up to the introduction of a new product or system that should fall within that specific category yet causes discrepancies within the rules of categorisation.

If category names are not sufficient for their content, then users will learn to exclude their searches only to specific terms describing superordinate entities.
If information is searched holistically on what the researcher understands it to be, then they will not search the unknown or will discard the unclear.

For professionals which require efficient retrieval of quality information, unsatisfactory categories containing valuable data are either ignored or overlooked in the searching process. Bearman and Petersen (1990) examined the Art and Architectural (AAT) thesaurus in which they raise problems within retrieval in existing data entry and retrieval systems. They mention the unusual category listings through object naming and suggest an alternative form of categorising. They state that:

“Since the majority of terms in the AAT are object names, and since it is apparent that descriptions of objects of art and architecture often contain multiword phrases that combine nouns and adjectives (designating material, style, technique, and function, among others), and that these phrases occur in infinite combinations, it was decided to provide the building blocks of these descriptions in the form of facets”.

They list the facets as:

- “Associated Concepts;
- Physical Attributes;
- Styles and Periods;
- Agents, Activates;
- Material; and
- Objects.”

This is interesting as the object no longer is constrained by its physical description or its proper name but now also belongs to a discipline, function, event or process. Classification has limitations as it is based on an evolving language. Categories can misrepresent their content such as ‘white goods’ or they can become saturated with cross-referenced content from other categories. This means that searching practices of IR systems initially use abstract searching followed by highly specific terms to eliminate and sort through categories of managed information. Searching practices will now be discussed.
3.4 IR SYSTEMS AND SEARCHING PRACTICES

Classification is used to manage the content of Information Retrieval Systems. Searching practices are the operations in which users adopt to retrieve information from the IR systems content. These searching practices may have been developed by users through the general experience of IR systems or through gained knowledge of Information Literacy.

3.4.1 Information Literacy Defined

The Council of Australian Universities Librarians (CAUL, 2001) defines Information Literacy as “an understanding and set of abilities enabling individuals to recognise when information is needed and have the capacity to locate, evaluate, and use effectively the needed information”. The Australian Information Literacy Standards (ANZIIL, 2004) clearly lists the abilities of an information literate person, which are to:

1. Recognise a need for information;
2. Determine the extent of information needed;
3. Access the needed information efficiently;
4. Evaluate the information and its sources;
5. Incorporate selected information into their knowledge base;
6. Use information effectively to accomplish a purpose;
7. Understand economic, legal, social and cultural issues in the use of information;
8. Access and use information ethically and legally;
9. Classify, store, manipulate and redraft information collected or generated;
10. Recognise information literacy as a prerequisite for lifelong learning.

Information Literacy skills are learnt skills that enable a researcher to control and manipulate an information environment for their benefit. These skills are used to search a variety of media formats such as books, journals, audiovisual sources, library databases, the Web etc. An understanding of
Information Literacy prepares a researcher for investigating IR systems. As all professions require quality, specific information, such skills enable efficient retrieval of relevant data. For the purposes of this research, the list developed by ANZIL (2004) concerning the abilities of a researcher with an understanding of information literacy can be ordered into four major stages of the researcher’s experience. These four stages describing the activities mentioned in ANZIL (2004) list will act as a framework for the research analysis to follow. They outline the stages in which a researcher moves back and forth when carrying out a search. They are:

1. The Preparation Stage;
2. The Searching Stage;
3. The Research Stage;
4. The Analysis and Application Stage.

1. Preparation Stage
The Preparation Stage is recognising the information need and understanding the IR operational searching practices (Points 1 and 10 of ANZIL’s list is encompasses in this stage). For example, a researcher must become aware for the need of new information and have an understanding of the searching skills required to achieve access to the information desired.

2. Search Stage
The Search Stage is the period of time in which a person explores the research problem searching through their own internal knowledge. They may spend time defining the information scope, developing a research question or statements and/or expand their terminology that describes the research problem through developing searching keywords and query statement (Point 2). For example, a person sets the scope of the problem to be researched.

3. Research Stage
The Research Stage is the implementation of searching practices in order to located appropriate material (Points 3 and 8). For example, a person has the
ability to access and retrieve the needed information efficiently, ethically and legally.

4. Analysis and Application Stage
The Analysis stage and the Application stage have been merged into one because if information has been selected for application, then it was deemed valuable at the analysis stage. However, for the purposes of clarity, the two properties of stage 4 are outlined below:

4a. Analysis Properties
The Analysis properties are to evaluate the retrieved information and assess the value of each piece of information to the research scope. A review of the searching practices would also take place (Points 4 and 5). For example, information and its sources are evaluated and selected relevant knowledge is extracted and received by the researcher.

4b. Application Properties
Finally, the Application properties are to apply the selected information to the research problem and present it in a scholarly, concise manner (Points 6, 7 and 9). For example, the retrieved, selected information is managed and used effectively to serve a purpose.

As there are many facets to Information Literacy, this research exclusively focuses on the searching practices that are used for design navigation. As this study is concerned with the process of using IR systems within the early design process, a closer investigation has been made into the planning and implementation of these searching practices. Searching practices are seen as a tool of Information Literacy and will be referred often throughout the research study.

3.4.2 Planning and Implementation of IR Searching Practices
Once a need for information has been established, a researcher with information literacy skills will begin planning the scope of the research.
Following this, they will establish core research areas possibly from a research definition. Keywords may then be extracted with the IR searching practices in mind. Depending on the research scope, these keywords may represent categories of the core areas identified which are broad and cover a lot of ground. They are only primary terms that would be to test the information content of an IR system. New keywords would be generated or collected within the process of searching. A researcher may begin knowing exactly what information is needed. Others may begin with an idea and are open to be lead by the process of searching.

The searching practices required for IR systems may vary depending on the system used. Two examples are given on the Internet and Online Databases discussing basic searching practices and advanced searching practices.

**Basic Searching Practices**

The Internet is one form of IR system and according to Ackermann and Hartman (2001) there are ‘two basic ways to find information on the World Wide Web: one can browse directories by subject, or one can search by keywords in search engines.’ Search engine databases are created by computer programmes such as robotic systems that automatically search and renew sites, whereas directories are created and maintained by people. Directories are smaller in nature compared to Search Engines because of manual information categorisation. Directories store their content under existing generic titles in which you can search by selecting a main category and then its sub-classes. Ackermann and Hartman (2001) suggests that “browsing a directory requires that you think categorically about the subject you are researching…many directories have simple keyword-searching ability for just this reason”. He goes on to comment that “directories, or subject catalogues, are topical lists of selected Web resources that are arranged in a hierarchical way”. This means that the subject categories are classed from broadest (general topics which almost cover everything) to most specific (specialised information on one particular topic).
Search engines on the other hand cover immense fields of information due to its automatic data searches. However the large amount of information capacity results in vast quantities of data at all levels of quality. Search engines commonly use natural language searches which are word and phrase sentences. According to Ackermann and Hartman (2001) *Keyword* searching or *word* searching was created to help people retrieve information, without knowing prior to the search, a category in which the information could be found. Although natural language is commonly used to search Internet based systems, some exist that cater for advanced searching practices.

**Advanced Searching Practices**

Advanced searching practices are supported by a range of IR systems. These practices are commonly used to search online databases containing scholarly data such as journals. According to Chowdhury and Chowdhury (2001), there are six primary types of searching practices which are Word and Phrase search; Boolean search; Truncation; Proximity search; Field or Meta Tag search; and Limiting search. All of these practices use a combination of techniques that search the content of IR systems using query keywords and operational symbols. A common approach is to firstly expand the potential information results by using Boolean keywords and other additive techniques. Following this, searches within searches or new queries using elimination techniques are used to extract relevant information.

Overall, both practices involve an expanding and contracting process of searching. Exploring abstract categories of information and then converging to specific keywords in order to extract appropriate material.

**3.5 LIMITATIONS OF IR SYSTEM SEARCHING PRACTICES**

Searching practices benefit users of IR systems in ways of information navigation. Information Literacy is essential for understanding the process of information handling and to be better equipped for finding information relevant
to the research area. However, the process of searching IR systems using searching practices does have its limitations.

3.5.1 Language Limitations

Language is a communication tool however the natural communication alters when a person operates an IR system. Godby and Reighart (2001) suggest that through their study, they found that the search terminology differs to that of the terminology found in published articles. Winograd and Flores (1987) also agree with this notion in commenting on vocabulary shifts when using search tools, they say “we operate in their terms and turn to them for predictions”. This suggests that IR systems are not yet intuitive. They require a person to alter their natural activity of communication in order to interact with information search tools. “In order to become aware of the effects that computers have on society we must reveal the implicit understanding of human language, thought, and work that serves as a background for developments in computer technology” (Winograd and Flores, 1987). The person or method in which information is categorised sorts it in a way in which researchers must retrieve it using an elimination process. This is based on keywords and operators which in themselves are specific entities. In relation to professionals such as designers who need to maintain abstract thinking through early searching, the process of generating keywords and communicating in specific terms is limiting.

3.5.2 Converging Searching Limitations

Computers are useful in classifying data however cannot follow the thought process of a human. Cooley (1988) suggests that there is a gap between the abilities of computer searching to human thinking. “The computer excels in analysis and numerical computation, the human mind in pattern recognition, the assessment of complicated situations and the intuitive leap to new solutions. If these different abilities can be combined, they amount to something much more powerful and effective than anything we have had before”.

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From the problem setting activity (as defined by Schön), designers may define the problem into many complex situations or possibilities however this explorative thinking is then required to be formulated into computational wording for the operation of IR systems. Winograd and Flores (1987) are also aware of the problems created by IR systems which are “the result of forcing our interactions into the narrow mould provided by a limited formalized domain”.

Winograd and Flores (1987) puts forth the idea of the possibility of computer tools designed to utilise “objective, background-free language” and that if this is possible one must “limit their domain to those areas in which the articulation can be complete (for given purposes)” for example industrial design. In doing this, one can implement a design language that is within context. Another suggestion by Winograd and Flores (1987) is to create a system that “allows us to interact as though we are in a conversation with another person who shares our background”.

“Computers have a particularly powerful impact, because they are machines for acting in language. In using them we engage in a discourse generated within the distinctions set down by their programmers. The objects, properties, and acts we can distinguish and perform are organised according to a particular background and pre-understanding” (Winograd and Flores, 1987). Language is necessary to search current IR systems. However, in the context of IR systems classification structure, are users search queries affected by this hierarchical make up? If so, would this affect designers’ early abstract searching strategies?

3.6 SUMMARY

Information Retrieval Systems offer many benefits to designers as they provide broad information that is informative and valuable to design problems. IR systems are defined as a tool to assist in the journey of finding a solution;
however they are not “problem answer systems” (Robertson, 1979). This means that a user is required to either prepare a strategy for searching or progress through the action of browsing. Accessibility through networks either online or web based, both have benefits and disadvantages. Web based IR systems being the most accessible and easiest to use however issues are found in its quality, quantity and short lived information. Online IR systems are now becoming more accessible through free databases, which now are also networked through the Internet. Others include prescriptive databases found in companies or educational institutions. The efficiency of such systems improves with a user’s knowledge of its operational searching practices.

The asset of quality information at the fingertips of individual designers is invaluable however issues still remain with the influence of such systems on the design process. If IR systems are defined as a tool to assist in finding an answer to a problem, then the influence that has been observed with designers must derive from IR systems operational requirements, categorisation and indexing of its contents or designers preparation and searching techniques.

Designers are open to influence when interacting with IR systems. Whether this influence is substantial enough to cause concern, it is the purpose of this research to investigate this issue and highlight the effects on searching strategies of designers. Therefore the following study was designed to investigate the impact on the activity of designers searching by using IR systems.
CHAPTER 4

4.0 STUDY
4.1 INTRODUCTION

From the literature review, it was noted that users of IR systems are influenced by information whether that information is valuable or insignificant to their searching. It also shows that when people use Information Retrieval Systems, they must alter their language in order to search the systems. This was suggested by Ackermann and Hartman (2001) that browsing IR systems causes a shift in thinking towards categorical subjects on the subject being researched. If the information and the language used to retrieve the information can influence a user, then the searching process also is in question. It is the influence on designers searching process in which this research is concerned with.

This chapter outlines the study preparation including the research aim, study objectives and methodology. The research study will be introduced. This will be followed by the data collection section detailing specifics on the profile of participants, research methods, and finally the criteria it will be judged against.

4.2 STUDY PREPARATION

The purpose of the research is to investigate whether Information Retrieval Systems impact on designers searching strategies within the early stages of the design process. This leads onto further questioning of how such categorical research tools can influence design activity and effect early design direction.

4.2.1 Objectives

To achieve the research aim, objectives were structured to guide the investigation. Based on the structure of Grounded Theory where all data presents itself and new findings arise from the data, these objectives are to first observe and capture the data in a natural environment. These were:
To observe any searching changes when designers prepare and utilise information retrieval systems.

To record designers adopted search strategies, keyword / concept generation methods and brainstorming exploration techniques when dealing with a given design problem.

To introduce a reference librarian to the design process to see whether this complements or hinders designers searching.

To gain general appraisals from student and professional industrial designers experience with information retrieval systems and whether new tools and techniques would be welcome for future research.

To understand what specific activities or factors are influencing designers searching strategies when operating IR systems.

Overall, the main objective was to investigate the design activity of designers interacting with Information Retrieval Systems with findings driving the study.

4.2.2 Grounded Theory

The study approach that was selected to gather the data was constructed on the methodology offered by Grounded Theory which was co-founded by Glaser and Strauss (1967) and later further developed by Glaser (1992), Strauss and Corbin (1990) and others. The analysis stages outlined by Glaser (1992) act as a guide for managing the collected data however two of these stages were used for the observation data. These stages are as follows:

**Data Collection**

Data was collected through the study in forms of sketches and notes. The study was also captured through a video recording that was necessary to document the design language being used to interact with the IR systems.

**Note-Taking**

Throughout the studies, keyword notes were taken to record the occurring design activity being observed. These notes were only to prompt recollection.
of the current activity at the time being observed. The following stage (coding) being an analysis stage was then easier to work through. The remaining stages of the Grounded Theory were applied to the analysis of the study.

Grounded Theory is explicitly emergent, meaning it does not use hypothesis testing. The findings are discovered through the analysis of the data and are not forced. This methodology approach was adopted for the research as the initiation of the investigation was inspired by an observation that was not understood and therefore the testing had no assumptions or hypothesis. The selection of Grounded Theory was based on its flexible methods and the ability to achieve qualitative data relevant to the design situation being observed in a natural environment. The Grounded Theory approach was applied both to the collection and analysis of the data. The data collection was methods of quick note-taking while study was being conducted and basic observation of designers’ activities. The analysis of the data would reveal further findings as later discussed in Chapter 5.0.

4.3 DATA COLLECTION

The tools, methods and procedures selected to gather the information needed for the research investigation are outlined in this section.

4.3.1 Study Equipment and Setting

Study
The study was conducted within an environment, that of a natural design space containing access to one computer networked to academic databases as well as having access to the Internet (Figure 4).

Firstly, an information sheet was provided at the beginning of each study which can be found in Appendix A. Included within this document is a design brief and hypothetical scenario also supplied to the participants to read. Both
participants were provided 5 - 10 minutes time to become familiar with the hypothetical design scenario, the setting and the design brief.

It is important to note that in any design project, a designer would expect a design brief and would be placed into a design scenario to understand the needs of the client, manufacturers and end users etc. Therefore, these provided documents were not asking the designers to perform anything out of the ordinary tasks, providing a common recording ground for the research.

To capture the data generated within the studies, sketch paper and pens were also provided. Such notes and visual data were collected at the end of each study to demonstrate what the participants were searching. The study was captured through a digital video recorder with an inbuilt microphone to document the audio data for future transcriptions. This recorder was positioned behind the designers to reduce any interference to the design process. Finally, a researcher was present at all times to answer any questions from the participating designers and librarians similar to a client.
being present at an initial design meeting. The researcher however did not directly interact with subjects unless asked.

Within the study carried out by Cross and Cross (1995) information that had been researched prior to their study and relating to their experiment topic was provided to their subjects when required. However, in the case of this research, no further information was provided to the participants as the aim of this study was to observe research being generated through the act of searching.

**Scenario / Design Brief**

A hypothetical scenario was provided to the participants suggesting that a potential client, representing the city council was proposing a research project to the designers. Below is an extract of the scenario (Appendix A).

“A client representing the Local City Council has approached your design consultancy wishing to develop several design concepts for a new storage system for non-motorised transport devices.”

The client requested the designers to explore the proposed design brief which focused on the development of a new public storage device/system for non-motorised transport devices. The purpose of this scenario was to select an abstract category in which the participants could search broadly within.

Within the brief, aims and requirements were outlined, which is common in any given brief. It stated that a maximum of 1 – 1.5 hours had been allocated for research and preliminary ideation in order to demonstrate to the client the convincing benefits of integrating an industrial design consultant throughout the design process.
4.3.2 Profile of Participants

Recruitment Criteria

Participants were selected on their experience in either:

- industrial design senior studies (advanced design students);
- industrial design practices of over 3 years (recent graduates or practicing designers); or
- advanced information searching (reference librarians).

This enabled the research to look at a basic cross section of student and professional industrial designers including experts dealing with information management and retrieval.

Screening / Sorting of Participants

The selected participants were finally categorised into three main groups for the purpose of the study. This was to observe the differences between searching strategies for student designers, recent graduates and practicing designers. The total number of participants observed within the study concluded at 20. These groups are detailed further below:

Group 1 - Student Designer + Student Designer

Advanced industrial design students (3rd and 4th years only) which were selected to participate within the study had little industry experience. They were required to have a good understanding of the industrial design process and the many methods and tools available to them in searching through knowledge and information. Therefore, pairs of students were grouped together in order for observations to be made on the searching activities that occurred between pairs of advanced industrial design students. Group 1 is to make up the majority of groups investigated within the research study with a total of 14 students.
**Group 2 – Recent Design Graduate + Recent Design Graduate**

Recent graduates had completed their design degrees and had gained experience in industry. They also had a good understanding of the design process and most likely had an awareness of the methodologies that their companies had adopted. Again, these designers were paired into groups to participate in the research studies. Group 2 was a minority group taken from the study totalling 2 participants.

**Group 3 – Professional Designer (+5yrs) + Reference Librarian**

The studies involving Group 3 were focusing on exposing the outcome of combining the experts’ knowledge in the fields of both Industrial Design and Information Retrieval Searching. Therefore, when an expert industrial designer was paired together with a reference librarian, it was to see whether the expert in IR systems would be able to expose further useful resources and searching techniques that the industrial designer was not aware of. It was also to investigate whether the designer, with the aid of a reference librarian, improved their design searching strategies through the introduction of advanced information literacy skills. This group was made up of two professional designers and two reference librarians.

If the problem lay with designers’ ability to find information due to a lack of information literacy, then the combination of both searching strategies of an industrial designer with the skills of the reference librarian should improve the searching experience. If not, the problem lay with the process of searching IR systems using specific keywords.

**4.3.3 Research Methods**

A series of methods were used to act as a cross-examination approach as suggested by Jordan’s (1999) usability evaluation methods. When a finding was supported by three or more research methods, a triangular support framework surrounded the result and therefore was accepted. The research
methods and procedures selected for the studies are outlined in this section. These were:

1. co-discovery method,
2. talk aloud protocol,
3. video and audio recording,
4. collected notes and
5. expert appraisals.

The Co-discovery Method

The benefits of utilising the Co-discovery method was to encourage participants to engage in the searching experience openly in groups of two. Allowing two participants to work together allowed one video recording to capture the activity of two designers within the provided 1 hour time frame. The groups with designers paired together (as found in Groups 1 & 2) was expected to share work loads as they both understood the design process. Therefore, activities were captured on two varying activities at the same time.

The participants found in Group 3 provided valuable insight into the effects of combining the knowledge of professionals in Industrial Design and IR system operation. Therefore, over a period of 10 studies, 20 participants would be observed and tested allowing a sample cross section of industrial designers to be compared.

Talk Aloud Protocol

Participants were asked to talk aloud throughout the duration of the study. This was to encourage the participants to verbalise their actions when exploring (in pairs) so to justify any direction shifts. The benefit of the participants explaining their searching decisions during the study would be to capture in real time their processes of generating design language. This was to show how they translate this language into operational keywords for navigating IR systems contents. This method also allowed the participants to express any frustration or confusion with the searching process.
highlighted the issues that hindered the designers when exploring through information and knowledge.

**Video and Audio Recording**

Video and audio recordings are invaluable to observing design activity. Captured video footage provided data on verbal discussions and comments, facial and body expressions, visual thinking, tools selection (e.g. IR systems) and time stamped searching activities. This allowed the study to be revisited and analysed in line with a time frame demonstrating the activities that occurred at certain intervals. Participants were made aware of the videoing of the study and that selected video clips would be drawn from the recordings to indicate research findings.

**Collected Notes and Sketches**

The participants were also prompted to record keywords, phrases, definitions and paragraphs along with sketches and any other collected materials that they utilise or generate throughout the design study. These notes acted as a record for the designers to reflect on during the study. On completion of each study, all notes were gathered and bound as a point of reference of the activities that occurred and were later used as evidence to demonstrate the design direction undertaken by the participants. These generated data is evident throughout chapter 6.

**Expert Appraisal Method**

The expert appraisal was included at the end of Group 3’s study. The professional industrial designer and reference librarian participants were able to provide valuable feedback from an expert perspective reflecting on their searching experience.
4.4 SUMMARY

Overall, the main purpose of the methods and procedures was to observe the participants exploring the design problem generating data through searching as they would naturally in a realistic industrial / student design project. This allowed the designers to develop material such as sketches, notes, search histories and video / audio data through their searching strategies and to see how IR systems influenced this.

The groups selected for the study was to observe the differences between the searching strategies of industrial designers from various levels of experience. They also provided an insight into the impact of introducing advanced information literacy skills through the pairing off of professional designer and librarian.
5.0 ANALYSIS
5.1 INTRODUCTION

Throughout the 10 studies recorded, the data collected was sorted into a visual layout for ease of analysis (Figure 5). Within this chapter, the data has been analysed in three main parts. These are:

1. Video and Transcriptions;
2. Search Histories; and
3. Visual Thinking.

Figure 5. Collected data organised into a visual study clip ready for analysis

The grounded theory was selected to guide the analysis of the research study based on its emerging theory process that allows the findings to come from
the data as it is being analysed. The stages of the Grounded Theory will first be discussed, followed by the analysis of the collected data from the study.

5.1.1 Grounded Theory for Analysis

The data was analysed according to the Grounded Theory methods suggested by Glaser (1992) which consisted of note-taking (Section 4), coding, memoing, sorting and finally writing up the data. Following, is the approach in which the collected data was managed and examined according to qualitative procedures.

The stages suggested by Glaser were used to analyse the collected information, these were applied as follows:

**Note-taking**
Brief, keyword notes were taken to quickly document a significant activity or situation that could later be recalled and revised.

**Coding**
It was necessary to record the studies using video to capture the occurring design activity and language being used by the designers. This data then was able to be revisited and coded. Each study was again explored and keywords describing a situation or a design activity occurring at the time were used to act as conceptual headings. Sometimes the data generated from the note-taking became codes as they showed significant points in the study. Initially the first set of data was coded entirely so to search for ideas or cores which allowed findings to be extracted from the data. Once the conceptual headings marked as codes were highlighted they were left and later built on if there were any similarities in following studies. The coding stage was revisited throughout the analysis of the research study.

**Memoing**
Memoing is the core focus of Grounded Theory in which it is the stage that allows the write-up of theories of the codes and the comparison and
relationships between the codes as they emerge. They are notes to ones-self and allows ideas and new concepts to be documented and theories to be expanded on.

**Sorting**
Sorting is collecting all the emerging theories from the memos and sorting and further comparing the studies together. At this stage, core threads and findings have been identified and are being established with greater foundations as each study is visited.

Grounded Theory is a widely accepted research methodology and was useful in gathering and analysing data from observations made on the interaction and design activities that passed between designer and IR system. Following is a detailed analysis of the analysed data from the research study.

### 5.2 VIDEO AND TRANSCRIPTIONS

The first stage of analysis of the collected research material was to view the digital video recordings of each study. The video footage was transcribed and sorted into video clips. The analysis of this data is outlined in this section under the headings defined by Grounded Theory.

#### 5.2.1 Note Taking

The *initial notes* briefly recorded points on designers’ discussion and verbal communication amongst each other, what occurring activity was taking place, and what material was being generated. The notes were taken as lists in the form of keywords and sentences. These keywords were used to group the activities into abstract and specific categories. For example, activities that were recorded; a designers’ initial language used when reading the design brief or when they began explaining a sketch to their co-participant. These notes were brief and were generally used to document the overall study first-
hand. They were expanded on and added to in greater depth within the following stages.

5.2.2 Video Managing with Coding

The study recordings were viewed again with more of an interest on collecting video clips that represented important or interesting footage of designers searching. At this stage, most of the original files were carried across for analysis as the analysis methods were evolving as new data was becoming evident. Each snippet of video was allocated a period code according to its time location to the main recording to aid in managing the ever growing files of footage.

As each study was conducted under a period of one hour, the snippets were related back to the original files total time to maintain chronological order. An example of the time snippets is given below which relates to in more detail in Table 1 under the column ‘captured period’:

00:01:25 – 00:02:25
01:00:00

(Snippet period over the total study time)

Snippet Name: Redefining the Design Brief

Each snippet was given a name relating to the main design activity that was occurring in the captured period. This was a general interpretation of what the designers were doing in regards to the design project for example the words ‘Existing Designs’ was used to describe the designers focus on current design solutions at that time. The general naming of each activity can be seen in table 1, along with the period of time it was taken.

From these viewings of the video, occurring activities were then observed and noted and it was evident that there were three areas of interaction conceptually being: creating information, operating IR systems and information use. At this stage, an investigation into additional literature was
undertaken to cross-reference these activities that were occurring. From the studies of Baya and Leifer (1994), three categories were identified and defined as: Generate, Access and Analyse (Section 2.2). Their research was taken as Collected Data as suggested by Grounded Theory that all information is relevant information. The three headings describing information handling activities were not used to formulate the research results but were found to be inline with the studies findings. As the findings already described such activities, the headings or labels were absorbed into the coding and are reflected within the findings of the study. Within this period of analysis, each clip was also related to when the designers were utilising Information Retrieval Systems as shown with an asterisk as shown in Table 1.
Table 1 Example of an early analysis of designers interchanging searching activities.

<table>
<thead>
<tr>
<th>Clip No.</th>
<th>Activity Interpretation</th>
<th>Captured Period (Total: 00:54:24)</th>
<th>1st VIEWING OF VIDEO</th>
<th>2nd VIEWING OF VIDEO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User Focus</td>
<td>00:00:18 - 00:01:22</td>
<td>Generate</td>
<td>Access</td>
</tr>
<tr>
<td>2</td>
<td>Problem Definition</td>
<td>00:02:02 - 00:02:45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Existing Designs *</td>
<td>00:02:49 - 00:03:13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>User Activity</td>
<td>00:03:11 - 00:03:54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Expand Possibilities</td>
<td>00:03:55 - 00:04:00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Classification</td>
<td>00:04:20 - 00:04:52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Research Delegation</td>
<td>00:04:56 - 00:05:34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Plan Research</td>
<td>00:06:14 - 00:07:02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Initial Sketch</td>
<td>00:09:00 - 00:09:13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Design Properties</td>
<td>00:09:48 - 00:10:45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Brainstorming</td>
<td>00:12:30 - 00:13:10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>User Market *</td>
<td>00:14:40 - 00:02:45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Justifying Research*</td>
<td>00:16:23 - 00:16:35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>User Observations</td>
<td>00:16:54 - 00:17:45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Social Acceptance</td>
<td>00:18:17 - 00:18:55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Social Importance</td>
<td>00:19:02 - 00:20:22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Initiating Research *</td>
<td>00:22:12 - 00:23:53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Database Intro *</td>
<td>00:25:55 - 00:26:34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Searching *</td>
<td>00:34:32 - 00:34:58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Findings *</td>
<td>00:36:33 - 00:37:34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Recording Results *</td>
<td>00:38:41 - 00:39:05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Example Results *</td>
<td>00:43:20 - 00:44:02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Specific Navigating *</td>
<td>00:49:05 - 00:50:35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Keywords Used *</td>
<td>00:51:17 - 00:51:24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Expanding Keywords *</td>
<td>00:52:22 - 00:53:03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The analysis data that resulted from these observations were of great interest. These observations confirmed through repeated patterns across the studies that designers were being affected by the use of Information Retrieval Systems (further explained in Chapter 6).

The asterisk marked keywords also showed that they became more concerned with ‘accessing’ and ‘analysing’ data rather than ‘generating’ new information when operating databases. For example, clips 1 – 17 demonstrated that the participants were mostly focusing on the ‘generate’ stage with some reference to the ‘access’ and ‘analyse’ stages. However once the subjects began to searching the IR systems using keyword queries, their searching turned towards the ‘access’ and ‘analyse’ stages with no reference to the ‘generate’ stage. Although this method of data analysis was helpful in highlighting the direction that the designers were taking, it showed little reason in how and why the designers were being influenced by IR systems. It did not demonstrate the impact that this shift would have on further exploration in the early stages. Further cross examination with detailed transcriptions was necessary to look at the reasons what was causing the design shift found in the studies.

5.2.3 Capturing Design Language through Video Memoing

A major stage of the research analysis was the capturing of the designers language through viewing the video records and generating brief memos concerning the dialogue that was unfolding. According to Grounded Theory, memos allow a researcher to note down possible theories and findings and over time build on them as other studies are revisited.

It was necessary for each video clip to be transcribed (samples of transcriptions are provided in Appendix B) in order for the design activity to be followed and captured. Through recording the design language along with the occurring searching activities, a greater understanding of the designers’ searching strategies was achieved. With the use of transcriptions, designers’ conversations and design direction were tracked in relation to their ‘keywords’
and ‘concept sentences’. These keywords and sentences were grouped under the banners abstract concepts, general concepts and specific concepts. These terms were modified from the research of Rosch (1978) who states that language is built on abstract or superordinate categories. Within this research, both categories are used to classify keywords of designers’ sentences to highlight and record the direction they are discussing. Abstract and superordinate categories are defined in greater depth in section 2.3.

Table 2 illustrates keywords extracted from the video data. Using Rosch’s definitions of categories, these keywords were sorted under the terms abstract and specific.

Abstract concepts contain broad or non-descriptive keywords which the designers generated throughout the study. For example: The sentence ‘a system to get you around’ would be found in the abstract concepts because it is a vague description of a broad category. This could be a category of a public or private system, motorised or non-motorised, land structured or sea travel, moving around in a park or travelling internationally, the list is endless.

Specific concepts are certain groups of keywords that were found at a defined level. A specific concept would be a property that exists in abstract or general concepts. For example a ‘Bus’ could be a ‘system to get you around’ as well as a form of ‘public transportation’.

Through the video memos, it was found that as both abstract and superordinate categories are opposite scales to each other, another category was required to cater for the keywords that could not be defined at either at an abstract or superordinate level. General concepts were used to group the keywords that were more descriptive and defined than abstract concepts yet less than specific concepts. General concepts such as ‘Public transportation’ give more depth and meaning. They are still categories that contain more in-depth entities however they provide more information than abstract concepts.
Table 2. Example of categories grouping Abstract, General and Specific keywords generated by designers through studies.

<table>
<thead>
<tr>
<th>KEYWORD CATEGORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract Concepts</strong></td>
</tr>
<tr>
<td>Vague Descriptions (system, device, tool, unit, object)</td>
</tr>
<tr>
<td>Non-motorised Transport Devices</td>
</tr>
<tr>
<td>Similar to… (reflecting)</td>
</tr>
<tr>
<td>Ideation</td>
</tr>
<tr>
<td>Limitations and Requirements</td>
</tr>
<tr>
<td>Issues not directly relating to design problem</td>
</tr>
<tr>
<td>Travelling System</td>
</tr>
<tr>
<td>A form moving</td>
</tr>
<tr>
<td>Storage of transport entities</td>
</tr>
<tr>
<td>Users of transport</td>
</tr>
<tr>
<td>Results of movement</td>
</tr>
<tr>
<td>Why move?</td>
</tr>
<tr>
<td>Why do they need something new?</td>
</tr>
</tbody>
</table>

- Workers
- Day Trippers
- Leisure Users
- Public Use
- Personal Use
- Health Consciences
- Council
- Transport Department
- Bus & Bike roots / Maps
- What they have seen?
- What they have used?
- What they think of existing designs?
5.3 RESEARCH HISTORIES

To further validate the interpretation of designers searching strategies, a record of their researching histories were also collected. The researching histories were automatically captured through the Internet history toolbar. This feature allows all queries entered (keywords) and sites visited to be recorded throughout the study. The purpose of the history feature is to record the users researching journey for later reflection and possibly repeat referral to already visited sites. These keywords were then compared against the terms (extracted from the transcriptions) the participants proposed to search during the course of the study. This was to see whether the participants proposed searches were actually researched or whether the direction of searches altered when using IR systems.

5.3.1 Research Histories Capturing Designers Query Keywords

Figure 6 is an example of a research history captured within the study. It illustrates both the sites that were selected from the retrieved results of a search engine and the entered in query keywords. The visited sites were stored under the Homepage Title folder. If a site was quite large and had its own search feature, the keywords used to search the site were also stored inside the Homepage Title folder. This was helpful as the limitations of video restricted viewing of the entered keywords. Each folder was listed in sequential order of when they were viewed. For example: A researcher searched and found a site (site 1) and then returned to the search engine and visited site 2. However, there are limitations to search histories in regards to following a researchers searching path. If a participant returns again to the hypothetical site 1 again, the site will be recorded twice under the ‘Site 1 folder’. This means that the path doubles back on itself and no longer remains sequential. This is why a cross examination of the transcriptions (Section 7.2.3) is necessary to put the research history into perspective. By following
the participants on video, the research histories could be marked accordingly in order to plot the keywords in sequential order of occurrence.

**Figure 6.** Example snapshot of a studies researching history list with one folder expanded.

For the purpose of this study, the research history list acted as a development map to where the participants were searching and when major changes in their searching behaviours occurred. This extracted data as seen in figure 7, was invaluable to the tracking of the designers searching direction.

When a participant began to search for only one particular area, the research history documented the point in which the users of the Information Retrieval Systems altered their search. With the combination of each research history and the video transcriptions, designers approach to retrieving information could be closely analysed.
5.3.2 Research Histories Compared to Research Intention

From the study, keywords were collected from both the transcriptions and the research histories. These keywords were listed against each other in two columns to compare the generated searching keywords to that of the research keywords used to operate the IR systems. This was to see whether the keywords initially generated in brainstorming, discussion, sketching and other searching activities were being used when querying IR systems.

Figure 8 highlights two lists: the left column demonstrating the keywords generated through searching, the right column being the keywords found in the researching histories. The terms are listed in order of generation. The comparison illustrates that the terms were mostly different in concepts. The specific existing devices are listed in blue, the abstract concepts are illustrated
by green and the red text depicts alternative transport devices that currently are not catered for within the public storage units.

<table>
<thead>
<tr>
<th>Keywords Extracted From The Abstract Searching</th>
<th>Keywords Extracted From The Research Histories</th>
</tr>
</thead>
<tbody>
<tr>
<td>bicycles</td>
<td>non-motorised transport</td>
</tr>
<tr>
<td>scooters</td>
<td>human powered vehicles</td>
</tr>
<tr>
<td>roller blades</td>
<td>storage devices</td>
</tr>
<tr>
<td>trick boards</td>
<td>wheeled transport</td>
</tr>
<tr>
<td>joggers</td>
<td>alternative transportation</td>
</tr>
<tr>
<td>wheelchairs</td>
<td>man-powered</td>
</tr>
<tr>
<td>row boats</td>
<td>lock-up mechanism</td>
</tr>
<tr>
<td>uni cycles</td>
<td>secure unit</td>
</tr>
<tr>
<td>kangaroo feet</td>
<td>bicycle racks</td>
</tr>
<tr>
<td>pogo sticks</td>
<td>bicycle storage</td>
</tr>
<tr>
<td>prams</td>
<td>bike parking in the city</td>
</tr>
<tr>
<td>tricycles</td>
<td>bicycle cycling tracks</td>
</tr>
<tr>
<td>canoes</td>
<td>push bike lockup</td>
</tr>
<tr>
<td>storage devices</td>
<td>push bike parking</td>
</tr>
<tr>
<td>public storage units</td>
<td>automated bike lockers</td>
</tr>
<tr>
<td>council projects and facilities</td>
<td>fold up scooter</td>
</tr>
<tr>
<td>international systems</td>
<td>trick scooters</td>
</tr>
<tr>
<td>domestic products</td>
<td>roller blades</td>
</tr>
<tr>
<td>mechanisms and dimensions</td>
<td></td>
</tr>
<tr>
<td>misc. information</td>
<td>international systems</td>
</tr>
<tr>
<td></td>
<td>public storage systems</td>
</tr>
</tbody>
</table>

Figure 8. Keyword extracted from research histories and noted transcriptions.

It was interesting to note that the designers keywords extracted from their abstract searching listed many devices of non-motorised transport devices as well as some abstract concept sentences. However, the list of keywords from the research histories demonstrates that the designers initially attempted to research similar abstract categories but seemed to use specific queries over time. For example, bicycle racks and bicycle storage.
5.4 VISUAL THINKING

Sketches and notes generated within each study were also cross-referenced to the findings from the video transcripts and search histories. This was achieved by amalgamating the two sets of data (sketches and text) according to the time of their generation. This was to investigate whether the visual thinking was reflecting the designers' IR searching practices. The collected sketches were sorted under several categories. These were defined as an Access Sketch, an Analysis Sketch and a Generation Sketch. The headings previously mentioned in section 5.2 were from a cross-reference to the labels used by Baya and Leifer (1994) in which they sorted designers' information handling activities under. As perceived in this study, the designers recorded their searching process through sketches which in turn related to their information handling activities. It is important to note here that the sketches collected were at a basic level due to the early stages of the design process. Therefore, detailed sketches or renderings were not seen at this level of development.

5.4.1 Access Sketch

An Access Sketch is defined as a visual note to one’s self to record an image of an existing entity for later referral. This type of sketch normally is a reference drawing from existing knowledge or information. Figure 9 shows a comparison of an access sketch to the real object. The designer recorded enough detail to document the mechanism of storing a bike on a wall.

Figure 9. An Access Sketch showing its direct reference
5.4.2 Analysis Sketch

An Analysis Sketch allows a designer to work through a problem visually, whether the sketch is referring to an existing entity or a concept. The sketch shown in figure 10 demonstrates a designer thinking out a way to store a bicycle vertically to save valuable space. They were analysing their idea of a storage bag. This sketch was taken from the later stages of the study where the participant was satisfied with the level of research achieved and had begun visually recording some design ideas. It can be seen that the sketch represents a person storing a bicycle in the ‘storage bag’ vertically. This image demonstrates that the participant is designing specifically for a bicycle, however prior the participants research, the design brief requested a design to cater for various transport devices. Further details of this design direction shift are described in Section 6.6 of the findings.

![An Analysis Sketch in the form of an operation system diagram.](image)

Figure 10. An Analysis Sketch in the form of an operation system diagram.

5.4.3 Generate Sketch

A Generation Sketch is a concept that embodies a new idea with possible references to existing knowledge and information. Figure 11 shows a generate sketch which the designer is thinking of a new concept for storing transport devices. The participant thought of the problems they have had with
existing storage devices and attempted to solve these issues in the new design. The sketch is similar to a locker which has an easy to clean entry surface, strength to resist vandalism and a sturdy hinge system for security; all existing mechanisms which is referred to as existing knowledge. However the designer highlights that he has contributed a new idea to existing knowledge by suggesting that these modular components could be resized to suit different types of transport devices like scooters as well as accessories such as running shoes or bags. The sketch represents a combination of existing knowledge and ideas generated by the designer.

![Sketch of a locker-like design with labels: easy to clean, strength, and hinge system.](image)

**Figure 11.** A *Generate Sketch* showing a new concept.

These three categories of sketches summarise the various sketches that were seen within the early stages of the design process. Rogers (2000) points out that “the flexibility of freehand methods means that there are many different types of sketch, even within the conceptual phase of designing”. The sketches once formulated into the three categories, Abstract sketch, Analysis sketch and Generate sketch were then related back to the video transcriptions to see whether the visual thinking of the participants reflected the other searching activities throughout. Examples of video transcriptions are found within the following research findings with the cross referencing of sketches.
5.5 SUMMARY

From the video analysis of the research study, interpreted theories and significant findings resulted. These were documented and cross-referenced against each study’s collected data of generated notes, sketches and search histories. In addition to the accumulated data from the participants searching, video snapshots and transcriptions also acted as evidence to support the research outcome. The findings that were taken from the research analysis are documented in detail within the following chapter (Chapter 6.0).
6.0 FINDINGS
6.1 INTRODUCTION

Through the research analysis the assembled pool of information pointed towards commonalities relating to the searching activity patterns of both designers and librarians alike. It was observed that the early abstract searching strategies of industrial designers were translated into specific keywords for the operation of Information Retrieval Systems. Within the research findings, this transitional searching behaviour is referred to as the “CLASS activity; Converting Language from Abstract to Specific Searching” (Francis, 2005).

This activity will be further outlined in the following sections of the findings. Video clippings and other supporting material will be evident throughout the chapter to validate the CLASS activity.

Common observations will first be presented outlining the four sections reflecting the designers’ information handling stages as seen within the studies. These four highlighted stages will then be discussed in detail with supporting material included. The findings will then be followed by a concluding summary.

6.2 OBSERVATIONS

The collected data across all ten studies showed similar searching activities. It was observed that once the industrial designers began utilising IR systems, they started to modify their searching strategies away from abstract searching and into specific navigation.

In relation to the listed ten abilities (CAUL, 2001) found in an information literate person, four stages were extracted for the purposes of this research (Section 3.4.1).
The four stages being:

1. **The Preparation Stage**;
   - design problem introduction

2. **The Search Stage**;
   - abstract searching

3. **The Research Stage**;
   - information retrieval

4. **The Analysis and Application Stage**;
   - reflecting, managing and applying new knowledge

Through the analysis of the video data, these common stages emerged from the research data. The video recordings demonstrate the transformation of designers searching strategies over the duration of each study. It is important to note that all four stages were not seen in sequential order as previously listed. They also were not seen as exclusive stages from each other. However the data showed evidence that all four stages occurred and could be grouped for analysis.

To understand the CLASS activity developed by Francis (2005), the abstract searching strategies of the designers as seen from the research studies must be discussed in detail. Both the preparation and the searching stages outline the designers’ broad exploration through abstract searching. Following this is the research stage, which demonstrates the translation of abstract to specific searching. Finally, the analysis and application stage gives an insight into what searching behaviours were adopted by the designers post IR systems operation and demonstrates the impact on early designers searching strategies.

These four highlighted stages will now be discussed in greater detail showing supporting material relating to each topic.
6.3 THE PREPARATION STAGE; design problem introduction

The participants began by evaluating the design brief by discussing its contents and verbalising concerns or confusion with their co-designer. Along with verbal communication, the participants were seen to use various methods to extract the objectives from the design project.

These methods were in the form of:

- identifying and highlighting;
- duplicating and discussing;
- managing.

This stage was seen to be the preparation period in which the designers initiated their design approach based on the provided design criteria. This stage highlights the activities associated with only 'extracting' main points from the provided information which are seen to be concerned with accessing and analysing.

6.3.1 Identifying and Highlighting from the Design Brief

The designers searched through the given information and began to select terms and categories from the brief by highlighting or underlying them. The designers familiarised themselves with these words and some were seen reading these terms out loud to emphasise to one another their importance. Two examples are demonstrated here depicting an example of the words that were highlighted from the design brief. Figure 12 depicts participant 6 underlining keywords such as ‘storage system’, ‘CBD’, ‘analysis of potential users’ to gain a clear understanding of what is being asked. Figure 13 again demonstrates a designer highlighting a key sentence (non-motorised transport devices) that describes the devices in which the new design must cater for.
Aims & Objectives:
- To conduct research in order to gain a greater understanding of the design requirements in regards to users storing items such as bicycles, scooters, skateboards and the like.
- To generate initial brainstorming for storage systems catering for non-motorised transport devices that can be implemented throughout appropriate public spaces within the CBD.
- To promote the findings and explorations to the client through a reflective presentation.

Design Requirements:

The client has done little research and would like to look at existing designs to compare what is on the market and other products that may influence the style, function and so on, of the device or system. Also, the client requires notes demonstrating an analysis of potential users. These findings will hopefully guide the market direction and construct the requirement criteria based on user needs.

The research also may address issues such as existing devices/systems, user profile, task analysis, social acceptance, functionality, aesthetics, usability, manufacturing, and so on.

**Figure 12.** An example of a participant underlining keywords from the brief.

**Design Scenario**

A client representing the Local City Council has approached your design consultancy wishing to develop several design concepts for a new storage system for non-motorised transport devices. These concepts along with a research report will be presented to the head director of the City Council who will decide on whether or not to grant funding to the project.

**Figure 13.** An example of a participant highlighting a key sentence from the brief.

These identified groups of words acted as a guide for the designers to follow. At this stage, the designers were in the initial stages of building up a repertoire of design language based on what was given in the design brief. They would then refer back to these terms throughout the design project when describing the design problem. As the brief used both abstract and specific language (section 2.3), the participants’ highlighted terms therefore reflected these opposite categories. However, the specific language found in the brief was given in the form of examples to guide the design process, such as examples of existing products. Although each participant highlighted the specific terms alongside the abstract terms, it was obvious that the abstract terms outnumbered the specifics as seen in table 3. The terminology accessed at
this stage was seen to initially guide the designers searching direction. The terms were marked with an ‘A’ or ‘S’ representing Abstract or Specific terms. Table 3 demonstrates the common highlighted terms from each study. It shows that only four specific terms where highlighted from the brief being: city council, bicycles, scooters, skateboards. Specific categories are terms located at a detailed level. For example: given names; existing designs; explicit requirements. The remaining terms were found at an abstract level, these were defined as: general design tasks; broad concepts; groups of entities described at a vague level. Further discussion of abstract and specific categories is found in section 2.3.3.

Table 3. Example of common keywords drawn directly from design brief.

<table>
<thead>
<tr>
<th>KEYWORDS HIGHLIGHTED FROM BRIEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>storage system</td>
</tr>
<tr>
<td>non-motorised transport</td>
</tr>
<tr>
<td>city council</td>
</tr>
<tr>
<td>bicycles</td>
</tr>
<tr>
<td>scooters</td>
</tr>
<tr>
<td>skateboards</td>
</tr>
<tr>
<td>public spaces</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
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<td></td>
</tr>
</tbody>
</table>

6.3.2 Duplicating and Discussing Words from the Design Brief

Once the designers had identified the categories and terms, they extracted and duplicated them through note-taking, word for word. This was to separate the given terms out from the other information so the designers could focus on these areas. Participants 4 and 5 depicted in figure 14 are an example of designers duplicating words without alteration from the design brief. The transcription is a direct quotation taken from a video clipping at 25 seconds into the study. The third column notes the occurring activity along with a numeric code classing the snippet as an access activity. Through the video analysis, participant 4 was observed reading out the highlighted terms and participant 5 was duplicating them into notes.
Figure 14 Designers duplicating keywords from brief and reading them out loud.

Figure 15 also demonstrates designers either reading or rewriting the design briefs sentences word for word. It depicts participant 16 reading aloud the areas of interest to the other designer even though they had both fully read through the requirements individually. At this point, the designers were confirming with each other the requirements that were most important.

Figure 16 is another example of a designer reading through the design brief word for word to the other participant (a reference librarian). To emphasise a keyword or sentence, the designer raised their voice highlighting its importance.
Figure 16 An example of a designer raising their voice to emphasis a keyword when reading directly from the design brief.

This activity draws attention to the importance of language which is used in design briefs as it forms the basis on which designers construct their plan of attack. Up to this point the designers had been highlighting and duplicating keywords from the design brief mostly at an abstract level. These terms reflected the required design scope which was set inside the design brief. The following stage will now look at how the participants managed this accessed information.

6.3.3 Managing Information from the Design Brief

Throughout the study, the designers organised the given data through the means of hierarchy trees, numbered lists or brainstorming mud-maps. These methods allowed the designers to categorise the given information into levels of importance and manage the data for future referral. This is described as one of the abilities listed by CAUL (2001) which outlines that an information literate person must be able to “classify, store, manipulate and redraft information collected or generated”.

Figure 17 illustrates an example of a designer managing the keywords from the accessed information taken from the design brief in a numbered list format.
At the time in which these terms were duplicated from the design brief, the designer was also commenting to the other participant that this list would become a guide for their proposed searchable topics as seen in figure 18.

<table>
<thead>
<tr>
<th>Time</th>
<th>Transcript (P = Participant)</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:58</td>
<td>P6. So if we were to split up the research tasks. (Points to list) I would get you to research issues on the user and I would more enjoy looking up similar existing products.</td>
<td>P6. Discussing and Delegating</td>
</tr>
</tbody>
</table>

Figure 18. Transcription of designer delegating the list of responsibilities to co-participant.

Figure 19 also shows another group duplicating keywords from the design brief into a list.
Throughout the study, the designers managed this duplicated data into lists of various styles such as point form; numbered keywords; alphabetical lists, categories and diagrams. Figure 20 provides examples from individual studies showing lists of similar notes to each other. It shows that many designers use lists to manage the given data to highlight the requirements and provide clarity.
With this stage, the accessed terms were taken from the design brief to provide the designers the foundation to expand upon. These basic planning methods were seen as preparation for the next stage where the designers began expanding their searching strategies.

### 6.4 THE SEARCHING STAGE;
abstract searching

Once the designers were satisfied with duplicating the terms from the design briefs requirements, they then began to generate (Baya and Leifer, 1994) new information, developing further on the information supplied to them. The
activities that were observed contributed to the expansion of their searching strategies overall, broadening the scope of the design possibilities.

Although, the activities such as sketching, discussing and note-taking were repeatedly observed throughout the study (before, during and after IR systems usage), the designers were seen to modify them as they progress in their searching. The common activities found at this stage were grouped together under several headings outlined below. This is to demonstrate the searching strategies that occurred, prior to designers using Information Retrieval Systems. The designers searching strategies at stage 2 were seen to broaden the scope of the design problem.

Following are examples of the searching activities observed which are described under the headings as:

- redefining the brief;
- expanding on categorised given information;
- generating visual thinking through sketching;
- communicating through storytelling; and
- reflecting on past experiences.

Other searching strategies were observed throughout the studies however, these were the most commonly practiced by designers in the studies.

6.4.1 Redefining the Brief

From duplicating the main abstract terms from the brief, the participants began to interpret selected sentences into their own words (MacMillan, Kirby, Spence and Simon, 2002). They took the abstract terms used in the given information and reworded it into their own sentences to further understand the category. These sentences mostly remained abstract in nature in order to maintain a broad searching ground. The terms were generated from an identified source and not from any provided or published documents. The designers were seen to be ‘reflecting’ and drawing upon their ‘own past
experience and knowledge’ (Schön, 1984; Stoll, 1999) to think of new terms and images that described the design problem. This language (which was not limited to words) was continually expanding as long as the designers were searching broadly. This design language is made up of abstract terms and lacking in specifics so to not restrict the designs possibility.

The transcription examples below describe the abstract categories which the designers generated from their own words in order to redefine the design problem.

‘what people get around on’. (Participant 8)

‘things that people use to travel on’. (Participant 7)

‘personal space’, (Participant 1)

‘alternative transport’, (Participant 10)

‘man-powered’, (Participant 9)

‘lockup mechanism’. (Participant 6)

These snippets were classified as abstract terms using the level of abstraction criteria outlined in the study by Ho (2001). This study is discussed in greater detail in section 2.3.3.

These abstract descriptions demonstrate that the designers are attempting to avoid detailed terms and are describing the design problem through natural categories. Specific terms such as bicycles, skates or scooters all could have been used however the selected abstract language was maintained to sum up all devices.
6.4.2 Expanding on Categorised Given Information

From the preparation stage earlier discussed, lists and basic mud-maps were created using the existing terminology *accessed* from the design brief. This was to aid in management of the accumulating data. Following this, the designers were found *generating* new information developed from the *accessed* information which was described as redefining the design problem.

At this stage, the designers used the organised *accessed* information to combine it with new *generated* terms. They revisited their categories and/or lists’ and build upon them with the new keywords which expanded the intended design criteria.

This categorical process differs from the previous activity of ‘extracting’ or ‘redefining’ the keywords from the design brief as it uses a combination of *abstract* and *specific* keywords to record descriptions of existing designs rapidly. Take for example the list *generated* from participant 6 and 7 in figure 21. Even though the specific designs of transport devices such as ‘bikes’, ‘scooters’ and ‘skateboards’ are mentioned, the terms are not focused on and are merely recorded and then left. It was observed that once the designers had exhausted the exploration of conventional devices under the category of personal transport devices, they then began to move on to less obvious forms of non-motorised transport devices.
Figure 21. A transcription between a professional designer and a librarian.

<table>
<thead>
<tr>
<th>Time</th>
<th>Transcript (P = participant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:30</td>
<td>P6. I am guessing… they are going to make it free easily accessible, safe, secure… to encourage people to do it, So we also need to look at existing devices…</td>
</tr>
<tr>
<td></td>
<td>P7. Smart devices</td>
</tr>
<tr>
<td></td>
<td>P6. Technologies that are out now, scooters skateboards, bicycles, jumping pogo-sticks</td>
</tr>
<tr>
<td></td>
<td>P7. Ha ha ha, what a way to get to work</td>
</tr>
<tr>
<td></td>
<td>P6. I've seen them Yeah, well I've also seen um… some kangaroo feet that allow you to sort of run, but they increase the spring in your step… So your bouncing two or three meters.</td>
</tr>
</tbody>
</table>

Figure 22 demonstrates both designers listing down sub-categories of non-motorised transport that would be seen as conventional devices such as bikes, scooters. Following this less apparent devices were then recorded. The image depicts the two designers describing a walking frame for elderly people. The designers are mimicking the way they would use the device with their hands in the air holding imaginary handles suggesting the form of the design being discussed. They were expanding on the brief using abstract searching. They used activities such as reflecting on past knowledge of products and storytelling (Section 2.3.1). An understanding of a design problem can be gained through the act of reflection and this is a common activity amongst designers throughout the design process (Schön, 1983).
Again, a similar example is given (Figure 23) depicting the two designers discussing the existing list and contributing additional ideas to the list such as BMX bikes, walking shoes and water transport. This is also then documented into their notes shown in figure 24.
Through these transcriptions and notes, one can observe the variations of non-motorised transport mentioned. Some participants went further than the conventional devices used for human transport and listed concept devices such as pogo-sticks, kangaroo feet or even horses and donkeys. Figure 25 is an example of the designers exploring avenues both conventional and alternative. Some designers’ listed alternative terrains the devices may travel over while others mentioned possible animals such as donkeys that could be passed under the category non-motorised transport devices.
Figure 25. A generated list of human powered and animal powered transport devices with the less apparent entities being highlighted.

This exploration may seem unproductive as the final design most likely would not need to cater for such devices or animals. However, through *abstract searching*, the designers recognised these ideas were not limited to current technologies and mechanisms and by maintaining a broad mindset, they could be open to explore beyond automatic responses to expose possible unmet design needs. They continued to search abstractly through ideas,
exploring beyond conventional boundaries, adding to the given information by expanding on the lists generated in the earlier stages.

Another method of expanding the terminology that describes the design problem was the use of mud-maps or bubble diagrams. Figure 26 demonstrates one group centralising the word ‘storage’ from the given information and branching off smaller categories. The words depicted in this mud-map are a combination of terms referenced from the design brief and new generated terms. By documenting and managing the briefs information into a skeleton mud-map a primitive searching structure is created in which the designers can then build upon.

Figure 26. Designers utilising a mud-map to contribute new terms so to expand the design scope.

Up to this stage, the designers were seen to redefine the brief into their own words and were using abstract searching to expand the scope of the design. Sketches were also used to explore and expand the design scope.

6.4.3 Generating Visual Thinking through Sketches

Once the designers had outlined the requirements and listed down areas which they found worthy of investigation, they looked to various searching
methods such as discussions with each other on design issues and reflective storytelling of past experiences.

Another form of searching was using sketches to visually think through ideas and problems. The initial sketches collected from the generated material reflected both abstract and specific searching. However the specific searching was brief and was only to document each idea as it occurred. Most sketches seen within this period contained little detail and recorded only what was necessary to communicate to another person or to capture a thought. The designers not only used sketching to explore through ideas but also to search through their memory of past experiences and learnt knowledge. Before designers used Information Retrieval Systems to carry out research, sketches were commonly seen to be abstract. These sketches are shown in the following examples.

Figure 27 exhibits an illustration of the visual thinking that was captured through early sketching. The sketch acts as a documentation of the devices identified by the participants which need to be considered. Even though the sketch depicts conventional devices such as bicycles and skateboards, another less common device, the ‘wheelchair’ is recorded also. This sketch suggests that the designer is thinking broadly and not limiting the new design to conventional transport devices.
Figure 27. Visually representation of various transport devices.

Figure 28 also demonstrates other designers documenting transport devices through early sketches. From the transcriptions, the designer suggests that the empty circle represents the potential solution.

Figure 28. A sketch depicting the design problem.
Visual thinking through sketching was commonly used to support neighbouring notes. They were used to express a thought or an idea. Within the early stages, the designers were observed using sketching as a communication device along with verbal discussion. This type of exploration is a form of visual design language (Section 2.3.2) which the designer builds upon in order to broaden their searching activities. Figure 29 demonstrates a designer visually thinking through the problem of storing various transport devices.

Figure 29. Working out problems through sketches
Figure 30 depicts a sketch showing the designer generating new ideas through visual thinking. Their concept is to clamp the common entity that is found on most non-motorised transport devices which is the wheels. From the transcriptions the designer was suggesting that the circles roughly sketched in figure 30 represent all forms of non-motorised transport with a common entity of circular wheels. The device would clamp the common entity (the wheels) and thus storing all types of devices. Here, the designer is not limiting their sketching to one device, they are exploring broadly. It is important to note that this one group did not conduct any research through an IR system and therefore their sketching represented here is recorded within the later stages of the study.

![Figure 30. Sketching an idea that could store devices with wheels.](image)

Figure 31 demonstrates another group visually documenting the various devices for storage. The sketch shows a box around the devices in which the designer suggested to be a representation of the possible design.
Figure 31. Sketching a box that represents a design that caters for various devices.

A common observation was that the sketches produced before the designers used IR systems were seen to depict more generative ideas. That is ideas that were generated by the designers in comparison to existing designs that can be accessed (Baya and Leifer, 1994) through researching of external knowledge (Section 2.3.1). Not only did the concepts cater for various transport devices, they explored ideas recorded through the early sketches showed innovative ways of solving the design problem. Figure 32 is yet another example of visual thinking demonstrated by participants 8 and 9. The sketches collectively demonstrate a centre poll that has modular wired pods that extend out when pulled. These retractable pods can be wrapped around or through the device requiring storage and then slotted back into the appropriate locking cavities.
Another designer also had a similar idea to a poll with stems protruding out of the centre to store transport devices on. The idea was sketched in the form of a tree as seen in figure 33. It is interesting to note that the designer returned to this sketch and titled it a bike tree after seeing something similar through their research.
Other groups also demonstrated different ideas through the use of sketches. Several groups thought of reducing the storage space by elevating the transport devices off the ground. Figure 34 demonstrates an idea sketch of a pulley system which may seem broad in concept however is valuable to the designer abstract searching.

Figure 34. An example of a designer using a sketch to explore broad ideas.
Figure 35 is another example of a designer generating an idea to store devices on a ferries wheel storage system. The image depicts only bicycles being stored however through the video transcription, the designer implies that it could hold any device.

"...the unit could lift the bikes into the air like a ferries wheel and you use a chain to rotate the wheel around to get to your bike or what ever you have stored on it." (Participant 3)

These sketches are described as abstract searching where a designer explores broad ideas that are unlimited and possibly unrealistic. They serve a purpose of allowing a designer to explore the extremities or even outside the limitations of the design constraints. By doing so, this explorative approach produces innovative concepts that could possibly be modified later back to a more feasible design. Whether the designers’ used sketching as a form of recording existing devices, communication to another person or visualising
and working through their ideas, it enabled them to explore through information and knowledge without being restricted by words and specifics.

6.4.4 Communicating through Storytelling

Storytelling is an important tool for designers to convey a picture to another person. It puts the device or system being discussed into a context in which people can relate to. Designers were seen exercising this tool to search further and gain a greater understanding into the users needs. They put themselves into the situation to interpret how a real life user would use the current design or system.

Figure 36 demonstrates participant 6 searching through his thoughts by describing to participant 7 a hypothetical scenario which defines the context of the design problem. Although the designer was not referring to a particular experience, he was generating a story-like picture for his co-participant to be involved in his thinking.

This activity is classified as a form of abstract searching. A designer is not restricting themselves by exploring a hypothetical situation or a past experience. Instead he or she is broadening their perception of the users need.

<table>
<thead>
<tr>
<th>Time</th>
<th>Transcript (P = participant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:28</td>
<td>P6. We take person A, they wake up in the morning, they catch the train to a certain point and get out and leave their car at the station, and then they mount onto their jet propelled skateboard or whatever it is…Ahhh non-motorised sorry</td>
</tr>
<tr>
<td></td>
<td>P7. Non-motorised, yes</td>
</tr>
<tr>
<td></td>
<td>P6. Their skateboard, and push their way into the city where they work in... say an office.</td>
</tr>
</tbody>
</table>

Figure 36. Communicating the context of the proposed design through storytelling.
It was noted that the description of the proposed device, when mentioned throughout the activity of storytelling, was vague or conceptual. This again gives evidence that the designers’ early searching strategies are abstract and broad. For example, participant 6 describes the transport device in a jovial manner and refers to it as a:

‘…jet propelled skateboard…’

The participant quickly corrects themselves with:

‘Ahh….non-motorised sorry.’

Again, even though the participant was adding some humour to their story, it demonstrates the designers need to maintain abstract language. By refraining from describing the design problem in a specific term, or in this case correcting oneself on using the term skateboard, the designer allowed more scope to design possibilities.

By using an unknown or non-existent device, along with a character named ‘A’, it is almost leaving a blank space for the co-participant to fill in themselves. Possibly this approach could allow the listener as well as the story-teller to fill in the gaps with various alternate details enabling them to imagine many endings to the story. This method allows for the person to think broadly and occasionally unrealistically however it opens up the avenues which lead away from the norm and to the innovative.

The language used within this activity was again seen to be based on natural categories instead of superordinate categories (Section 4.2) avoiding specific searching.
6.4.5 Reflecting on Past Experiences

Designers also use the activity of reflecting on past experiences or real life scenarios describing particular problems with existing designs and/or systems. The co-discovery setup benefited the designers in this activity as it enabled them to explore and discuss past memories of designs, experiences, users and situations. Figure 37 is an example of a designer reflecting on a past situation which he experienced. It depicts the designer using the situation to describe an issue relating to the design problem which is storage for transport devices in the city.

![Figure 37. Reflecting on a past situation to assist in describing the issues of storage in the city.](image)

Communication was not limited to language or sketching, designers were also observed miming out actions and moments that described how designs were used. Reflecting on other designs or systems may not specifically relate to the design problem essentially however, it may have transfer applications that could benefit the future users.

An example of a designer describing a mechanism through an analogy is seen in figure 38. It demonstrates one designer referring to the action of operating blinds on window and how this pulley mechanism could be transferred to rotating the transport devices around for easy access.
By searching broadly and at an abstract level, designers were seen to initially explore inside and outside the given limitations from the design brief. They generated new information and identified many unmet needs where conventional devices and methods failed.

Their design language within these early stages was non-specific and many methods were used for communication including non-verbal communication such as sketching and miming. Overall, the searching activities that occurred resulted in a broad coverage of the given topic.

This section supported the idea that designers use abstract searching strategies within the early stages of the design process. Through the various design activities, designers were successful in maintaining an abstract level of exploration. The following section will outline the changes in the designers searching strategies as observed when IR systems are operated.
6.5 THE RESEARCH STAGE; information retrieval

Each participant chose to utilise Information Retrieval Systems (IRS) at alternative periods during the study. Several groups initiated their searching within seconds of beginning the study and then attempted to return to the abstract searching stage after IR systems usage. Whereas others spent time extracting and generating information, defining the design problem before attempting to access published information. It is at this stage that the designers were observed altering their searching strategies when operating IR systems. Common activities were recorded and grouped to demonstrate the shift that was seen in their abstract exploration.

These are described as:

- selecting terms from abstract searching;
- natural categories to search IR systems;
- retrieving results on saturated categories; and
- compromising abstract searching for specific keywords.

6.5.1 Selecting Terms from Abstract Searching

As IR systems operate on keywords and query sentences, the designers were required to generate such keywords from their previously developed information from stages 1 and 2. These keywords could have been extracted either from the ‘accessed’ or ‘generated’ information. This activity of converting their previous information into category keywords is required because IR systems are managed by categories (Section 3.3). They require a user to understand the searching practices required to research their contents and to have some knowledge of which category the desired information may be found under. This was further discussed in Section 5.2.
Two types of participant groups (Figure 39) were observed at this stage:

1. The first group were designers that accessed or generated little information from the Preparation or Searching stages. Such participants began operating IR systems soon after reading through the design brief and spent little time searching abstractly. Figure 40 demonstrates the stages they bi-passed.

2. The second group were designers who spent time prior to using IR systems accessing and generating information through abstract searching as discussed in the previous stages.

The returning arrows demonstrated that the designers did not travel through these stages in a linear process.

**Figure 39.** Two groups of designers exploring the 4 stages of information handling.

**Designers with little previously generated keywords**
The participants that produced little notes and sketches prior to using IR systems generated keywords directly from the brief. These designers were forced to generated keywords whilst using IR systems. Figure 40 demonstrates one group using an IR system within 5 minutes of the study.
The sites they visited were mainly for investigation of existing systems and designs.

<table>
<thead>
<tr>
<th>Time</th>
<th>Transcript (P = Participant)</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 5:10  | P16. Ok, we might have a look on the Internet  
P17. Ok  
P17. Have a look on the Brisbane city council website.  
P17. Alright, they might have some existing designs | P16. Driving the IR system  
P17. Reading brief and defining design requirements |

**Figure 40.** Using IR systems early within the design process.

Figure 41 is another example of designers spending little time generating information previous to using IR systems. The keywords again were generated at the time of entering a query.

<table>
<thead>
<tr>
<th>Time</th>
<th>Transcript (P = Participant)</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 5:15  | P12. Lets do a search on some existing designs.  
P13. Yep  
P12. Bike racks  
P13. Hey look at all the types of designs  
P12. ...lets try looking at bike lockers | P12. Discussing IR system operating  
P13. Discussing Watching |

**Figure 41.** Designers immediately begin using specific keywords.

Their search history shown in figure 42 also demonstrates the designers limited for searching scope.
Designers with previously generated information from the Preparation and Searching stages

Groups that successfully reflected back on their previous searching had to select from notes that were in the form of images, notes or categories. Therefore, in order to operate the information databases, the designers were required to convert the abstract data into query keywords. At first, the natural categories (Chapter 4.0) that were previously generated were used to query the Information Retrieval Systems in sentence form.

Figure 43 shows examples of information generated from the abstract searching activities (stages 1 and 2) are then converted into keyword queries. Many participants initiated their searching of IR systems with keyword sentences taken directly from their generated abstract categories.
Natural categories that were previously mentioned include: ‘personal space’, ‘alternative transport’, ‘man-powered’, ‘lockup mechanism’ as mentioned in Section 6.4. In this illustration, the lower image depicts a natural category sentence being used as a query in a search engine: non-motorised transport device. This is further discussed in the following Section 6.5.2.

![Figure 43](image.png)

**Figure 43.** Converting the information generated from abstract searching into keyword queries.

### 6.5.2 Abstract Categories to Search IR Systems

The search engines that were selected within the study ranged from the well known search engine, Google to online academic databases for example Pro Quest or Science Direct. These information retrieval systems accepted the sentences entered in by the participants, which were made up of terms initially found at a natural category level. Some required basic information literacy techniques such as Boolean or truncation to combine the terms. Some participants (reference librarians) generated keywords from the beginning of the study especially for the use of IR systems as shown in figure 44.
They also showed a level of information literacy by using the basic operators such as (+) or (and), (-) or (not) to assist in their searches. So the natural category which was previously given as an example now became:

'transport + devices - motorised'.

These operators were not used for some search engines as they did not accept these advanced searching techniques. However they were required when utilising databases that offered advanced assisted searching.

It was common to see the natural categories that the designers had developed in stages 1 and 2 being used originally to act as a query sentence in the IR systems. This was quite an interesting observation as it revealed the issue of retrieving results that either were restricted in quantity or restricted in content. Figure 45 demonstrates a reference librarian using an abstract category ‘non-motorised transport device’ as a query sentence within the advanced search section of an academic database. The search results (as shown in the transcription) are few in numbers. Soon after, the librarian alters the search query several times using different abstract categories and again the results were limited and not many relevant results were retrieved.
Most of the relevant information found through researching the academic databases was discovered through the references of the visited articles. It was occasionally observed that the terms initially being used to query the IR system were not finding the articles that were required. It was over time that the user was obtaining the correct terminology to then use as a query to find the appropriate material. The correct terminology to find the required information was based on specific terms of information categories.

This research therefore supports the study by Godby and Reighart (2001) who found that the ‘search terminology differs to that of the terminology found in published articles’. Frappaolo (1999) also comments that ‘search engines are increasingly recognizing however the search words being ‘looked for is not to be found solely in a document, database, or Web site but rather in some expert’s head.’ This statement points out that the terminology used within the content of a document or site may be completely unrecognisable to the searching user. This means that the search queries entered in by a person may be unrelated to the desired topic or unrecognisable by the search engines operators.
6.5.3 Retrieving Results on Cluttered or Saturated Categories

At first, this process looked promising as the participants were not compromising their abstract terminology and were utilising their previously generated abstract categories to search the databases. However, this approach quickly dissipated when the designers saw that the abstract sentences were retrieving results saturated with unwanted information.

A closer look at Information Retrieval Systems categorisation system would help in the understanding of this change. Rosch (1978) points out that ‘categories are not mutually exclusive (an object can belong to more than one category to different degrees), i.e. they are fundamentally ambiguous’. This means that if a user adopted the Boolean technique ‘not’ to remove the term motorised from the search, therefore, one would expect the results would come back relating to the query terms minus any information relating to motorised products. Actually no, the term motorised could be only one form of power source. Other descriptions such as engine or fuel powered could still appear in the results.

Information literacy searching methods assist in finding appropriate material to a particular research question. They can support in sorting through categories that are cluttered with unwanted information. However this research demonstrates that such techniques encourage users to search broadly and then slowly narrow the search to refine the area of investigation. Abstract terms are initially encouraged however, due to categories ever expanding with accumulating data, popular terms are required to retrieve specialised topics.

Abstract categories appeared to retrieve results in large numbers or with results saturated with one topic. These topics were focused on one particular area especially when using search engines. Results that are saturated with a specific area may contain other information unrelated to the dominant topic however it is difficult to find.
What was interesting to see was that all of the participants that retrieved these saturated results began to neglect their abstract searching to overcome the dominant topics.

Figure 46 is an example of a reference librarian and a designer searching academic databases using a combination of terms of both abstract and specific. The query terms are entered into the advanced search section offered by the database to maximise the results.

<table>
<thead>
<tr>
<th>Time</th>
<th>Transcript (P = Participant)</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>19:35</td>
<td>P18. We need some terms.</td>
<td>1=generate</td>
</tr>
<tr>
<td></td>
<td>P19. Ok, can you do multiple terms</td>
<td>2=access</td>
</tr>
<tr>
<td></td>
<td>P18. Sure</td>
<td>3=analyse</td>
</tr>
<tr>
<td></td>
<td>P19. Can you search <code>bicycle, storage, lookup</code>?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P18. Do you want to put both bicycle and alternate so we get all the other devices.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P19. Can you do that?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P18. Sure, and we can make the alternate term use a truncation operator so we get both alternative and alternate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P19. Great (presses search)</td>
<td>P18. Discussing IR system operating</td>
</tr>
<tr>
<td></td>
<td>P18. Oh, we only got 46 results. I was hoping for more.</td>
<td>P19. Discussing Watching</td>
</tr>
</tbody>
</table>

**Figure 46.** A reference librarian databases to search for abstract and specific terms.

After the search results were retrieved, the librarian repeatedly stated that he was disappointed with the quantity of results and attempts to broaden the search using terms such as bicycle OR scooter OR alternative transport. Even though the results increase in number, the search was becoming more defined. The participant soon changes to Internet based search engines. From an Internet search engine, he entered in the same query that was
entered in previously however now using less advanced searching techniques. The retrieved results were found to be in the 60,000 and therefore required a more simplified query to reduce the results.

The following example (Figure 47) demonstrates designers using the broad abstract categories they developed in stages 1 and 2 as query sentences however retrieving results that are dominantly related to bicycle information.

<table>
<thead>
<tr>
<th>Time</th>
<th>Transcrip (P = Participant)</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:25</td>
<td>P14. (Enters in the query ‘non-motorised transport’) P15. I found some sites relating to alternative transport... a lot of bicycle info P14. That’s good go to that site</td>
<td>P14. Discussing IR system operating P15. Discussing Watching Notetaking</td>
</tr>
</tbody>
</table>

Figure 47. Designers using abstract terms and retrieving bicycle saturated results.

These designers continued to search the IR system and overtime retained much information. With reflection on the information at the conclusion of the study one participant stated:

“I would have liked to have done more research on other topics”

(Participant 14)
6.5.4 Compromising Abstract Searching for Specific Keywords

The specific superordinate categories, which were previously recorded through searching and originally avoided, were now being focused on and transferred into keywords. They were selected because they were seen to be more descriptive and allowed specific searching to be achieved. The data resulting from visual thinking, miming or storytelling was commonly abandoned altogether as the designers commented that this was a separate activity to the previous searching activities.

Figure 48 is an example of designers using specific keyword queries after attempting to use abstract or broad categories and unsuccessfully retrieving little relevant results. Previously these designers were searching for information using queries similar to the sentence: alternative transport devices. Here in the given example, they are no longer concerned with searching broadly and are now searching for specific information.

<table>
<thead>
<tr>
<th>Time</th>
<th>Transcript (P = Participant)</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:12</td>
<td>P10. Brisbane city council should have some information</td>
<td>1=generate</td>
</tr>
<tr>
<td></td>
<td>P11. We could find park tracks for bikes</td>
<td>2=access</td>
</tr>
<tr>
<td></td>
<td>P10. Can you do a search in the site for bicycle storage.</td>
<td>3=analyse</td>
</tr>
<tr>
<td></td>
<td>P11. What are we after? P10. ...look for bicycle storage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P12. Discussing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IR system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>operating</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P13. Discussing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Watching</td>
</tr>
</tbody>
</table>

**Figure 48.** Specific terms used by designers within each query.

The abstract searching previously documented is abandoned and now searching IR systems using specific terms is the dominant activity.

For the purpose of operating Information Retrieval Systems, the industrial designers had to translate their generated abstract searching strategies into
specific keywords which have been identified as the CLASS activity (Section 6.2). Initially they entered whole concept sentences based on abstract categories such as ‘non-motorised transport devices’ into the query line. However, this particular query produced search results based on the most saturated topic – bicycles. Therefore, whenever the designers attempted to find further information on storage devices and methods, they had to enter in specifics, or superordinate categories to get away from the saturated pool of bicycle information.

The study showed designers modifying their searching strategies to suit the conditions placed on them in order to operate successfully the Information Retrieval Systems. Overtime, the designers became very specific in their searches and concluded with most of the research relating to only one area of the design problem. This can be seen within figure 49 where 6 different video snapshots were taken from varying studies all showing a searching focus towards bicycle related topics.
These examples are taken from the conducted studies at varied times however, it was noted that this searching direction continued well into each study. These types of specific searches became the dominant focus for each participant.

Feedback from the participants demonstrated that they were satisfied with their searching activities and research even though the study showed they
were retrieving narrow focused information. This means, the designers were unaware that their searching for various topics was not resulting in a broad scope of information. It instead was returning results dominated with bicycle related data.

Their sketches at this stage also differed to that of stages 1 and 2. Figure 50 is an example of the types of sketches and notes generated when the designers had been using IR systems for 25 minutes. The illustration depicts the designers’ documenting the researched existing designs through access sketches (Section 5.4.1). The sketches demonstrate designers researching information which deals with specific bicycle storage devices including wall mounted hooks, vertical polls, wheel braces, parallel racks and ceiling supports. These sketches differed to those found in the previous stages as they were documentation sketches of existing designs with no input of generated information from the designers.

It is interesting to note that the sketches depicted in figure 50 are all devices concerned with the storage of bicycles. It was highlighted from such notes that the designers were focusing on specifics at an early stage.

So how does this impact on the overall scheme of early design? If IR systems retrieve results based on popular subjects does this affect the designers abstract searching strategies? After the bicycle saturated notes and sketches are documented as seen in figure 50, do designers return back to stages 1 and 2 and search broadly? These questions will now be answered in the final common stage of the studies which demonstrates the impact on designers when operating Information Retrieval Systems.
Figure 50. Research notes demonstrating specific searching
6.6 THE ANALYSIS AND APPLICATION STAGE; reflecting, managing and applying new knowledge

Up to this point, the designers had retrieved a considerable amount of information as seen in stage 3. Within the final period of the study (stage 4), the participants again returned to sketches for the purpose of recording ideas and visually working through problems. However, the sketches found at this period of the study were comparatively different to the previous sketches.

This section firstly outlines a summary of the sketching activities that were observed over the previous 3 stages. It will show a comparison of these early sketches to the sketches found generated after the use of IR systems (stage 4). This is to highlight the searching direction before, during and after Information Retrieval Systems usage. Secondly, common patterns discovered within analysed study graphs will be demonstrated and discussed.
6.6.1 Summary of Sketching History Found Throughout the Grouped Stages

In summary of the stages 1 and 2, the sketches demonstrated by the designers were of reflective thinking. Visual thinking was used to communicate to one another about possible designs and story sketches were also witnessed to depict past experiences or future scenarios. The sketches were lightly detailed and showed the bare minimum to communicate an idea or function.

Following this, sketches taken from stage 3 were seen to be visual records of what the designers were retrieving from the Internet or databases. These drawings were a visual note to themselves recording interesting information and knowledge from their searching experience.

It is at stage 4 in which the sketches were different to what was expected. Although, the designers again began producing sketches similar to the ones found within stages 1 and 2, the sketches were found to be altered in direction. The drawings generated within the early stages were explorative, investigating many topics and ideas. However, the sketches generated after the use of IR systems were either focused on one topic of the design problem or remained as recording sketches.

Figure 51 shows a sketch taken from the later stages of a study. It depicts a row of cross-like profiles that are cavities into a pavement which bicycles can be stored away inside. Although the sketch would be classified as a generate sketch (Section 5.4.3) as it uses both accessed and generated information, it does not fulfil the requirements of the design criteria which was to cater for multiple types of transport devices. It demonstrates the designer’s approach becoming increasingly focused on one area of the design problem. This is an example of designers become specific in their search for design solutions.
Figure 51. Design sketch taken from the later stages of a study.

Another example of sketches observed following the use of IR systems is shown in figure 52. This illustration is a sketch of a concept which elevates bicycles up walls. Again, the sketch demonstrates only one type of transport device within its contents.

Figure 52. Design sketch taken from the later stages of a study.

One group of designers decided to present a preliminary concept at the end of the study (Figure 53). They also spent a considerable amount of time researching existing designs for non-motorised transport devices however their abstract searching habits rapidly became focused on specifics. Figure 53
is a snapshot of their concept in which suspended bags with supporting frames fully open to allow a person to store their bicycle vertically inside. This was securely locked away inside a rigid house away from vandals. The house also provided the local council to rent the exterior faces for advertisements. The design was described as a pay as you go system in which a code was given out when a space was purchased for a given length of time.

Overall, the designers suggested that they were satisfied with the outcome of the study within the provided time given. However, the designers seemed baffled when later asked if they considered other forms of transport other than bicycles. The designers then fabricated the idea that all forms of alternative transport could be stored inside and that the bags could be divided into smaller sections for this feature. It was clear that the designers had neglected to consider these requirements of the design brief within the concept design. Previously however, the same designers were quite diligent in documenting all forms of possible transport devices needed to be stored. Most designers showed an increase in specific searching in comparison to the activities that occurred prior to IR systems.
Figure 53. Concept sketch for bicycle storage.
6.6.2 Shift in design direction demonstrated by graphs

The final analysis was to see whether the converging abstract to specific keywords affected individual designers searching strategies post-IRS usage. The recorded observations and the collected notes and sketches across the 10 studies showed similar patterns of designers becoming more concerned about the storage for bicycles and focusing less on alternative modes of transport. Also, groups of designers that used information literacy skills demonstrated by a reference librarian also had to compromise their abstract design language and convert to specific categories and keywords to operate IR systems.

Keywords were extracted from the collected data across each study (Section 5.2.3) and categorised under three headings: Abstract concepts, General Concepts and Specific Concepts. The three headings were a modification of Ho’s (2001) levels of abstraction. Once the keywords were grouped under these headings with corresponding time stamps, they were then graphed (more detailed view shown in Appendix C) to see if this visual representation of the keywords illustrated any change in their searching strategies. Figure 54 and 55 demonstrate two examples of such graphs. Within the study, participants were paired into groups of two (Section 4.3) and therefore two graphs were used to describe the searching activities of each study.

Within each graph, the information handling activities defined by Baya and Leifer (1994) are overlayed on the plotted keywords. The activity ‘access’ represents the periods in which the participants used IR systems for research purposes. This activity is indicated by the orange strips.

Firstly, the designers set out exploring keywords which are mainly found in the abstract and general concept levels as indicated by ‘A’ on the graph. However, once IR systems are initiated, the designer’s keywords immediately alter towards specific categories (represented by ‘B’). This suggests that the searching strategies also are affected. Overall, they show that when an IR system was operated, over time it was common to see that the designers
early abstract searching resorted mainly to specific searching (represented by ‘C’). Within the later stages of the study, the designers referred to the design problem within specific terms rather than abstract concepts. For example, the participant associated with the graph shown in figure 55 was recorded at ‘D’ saying that “I don’t think we need to design a storage unit for other devices, I can’t see people locking up their skateboard, they just hold onto that”. This statement represents a specific searching approach to the design problem. The designer was no longer thinking of ‘what could be’ but instead was focusing on ‘what happens now’.

Figure 54. Example of participant 1’s keywords graphed against searching activity.

Figure 55. Example of participant 2’s keywords graphed against searching activity.
The graphs from the one study were then compared together to see if the change in searching strategies was a common occurrence. Figure 56 shows a partial section of the study demonstrating that both participants searching became specific when the use of IR systems (marked by ‘X’) was initiated (Francis, 2004).

![Figure 56. The focus of early searching strategies transfers from Abstract concepts to Specific concepts immediately after the use of the Internet demonstrated at both points marked ‘X’ (Francis, 2004).](image)

The two participants highlighted in blue and purple show a significant shift in searching strategies from abstract to specific whenever they begin to use IR systems marked at 3 minutes and 12 minutes of a study. It was interesting to note that both participants after repeatedly using an IR system began to use more specific terms to describe the problem as well as began focusing on details of the design such as mechanisms, dimensions and existing designs.

### 6.7 SUMMARY

From the initial introduction of the design problem to the exploration of design concepts, the industrial designers navigated through an information space utilising various searching strategies to ‘Generate’, ‘Access’ and ‘Analyse’ information. The observed searching strategies involved the activities of
reading, highlighting, note-taking, discussing, listening, reminiscing, criteria setting, sketching, initial brainstorming/mud-mapping, ideation, concept/product comparison, product analysis, describing through miming and story-telling. These searching strategies are evidence that designers use many methods to generate ideas and solve problems. They used reflective approaches by using past experiences and knowledge to aid in the design process. These searching strategies showed designers evolving and expanding their early design language to an abstract state.

However, it was repeatedly demonstrated that the operation of Information Retrieval Systems impacted on the designers’ expansion of their abstract searching. The process of converging the designers verbal and visual design language into query keywords and searching practices causes a premature focus on specific searching.

From these common findings, two similar diagrams were created to summarise the four stages of the designers’ information handling activities. It is noted here that the diagrams do not represent a linear design process, however they portray the stages taken from ANZIL’s (2004) list (Section 3.4). The first diagram illustrated in figure 57 demonstrates the searching strategies of designers in a general context. The second diagram shown in figure 58 describes the actual observations from the research study. Figure 57 depicts designers using abstract searching to expand the design process and to define the design problem. Once this has been achieved, the searching strategies converge into specifics refining the solutions to the design problem. The four stages are positioned in reference to the occurring searching strategies.
However, the diagram illustrated in figure 58 summaries the observations from this research which demonstrate that the searching strategies are altered to that of figure 57. It outlines that when the research stage is conducted before designers have defined the design problem (marked as ‘C’) a premature conversion to specific searching occurs (marked as ‘P’).
Both diagrams are simplified to clearly show the shift in the designers searching. Abstract searching is represented by ‘A’ and Specific, ‘S’. It is important to note here that both ‘A’ and ‘S’ were infrequently found together before and after the convergence. However, both diagrams simply represent the major searching activities occurring at each non-linear stage. They visually portray the designers’ point of convergence from abstract to specific becoming increasingly premature.

This final summary of the findings gives support to the CLASS activity (Francis, 2004). This activity suggests that Information Retrieval Systems cause designers to converge their abstract searching strategies into specific keyword queries because of the hierarchical classification structure of its management system.

This research acknowledges that an awareness of information literacy (Section 3.4.1) assists in retrieving relevant results to a research problem. However, in the case of designers, it is the process of using keywords for the query of Information Retrieval System that causes their abstract searching strategies to alter.

The significants of these findings will now be discussed in the following Chapter 7.0.
CHAPTER 7

7.0 SIGNIFICANCE OF FINDINGS
7.1 SIGNIFICANCE OF FINDINGS

The research findings as outlined in Chapter 6 reports on designers’ early searching strategies in four stages within the study. These four stages were concerned with:

- Firstly, designers being introduced to a design brief and preparing a research plan;
- Secondly, their abstract searching within an information and knowledge space;
- Thirdly, conforming this abstract searching into keywords to query IR systems; and
- Finally, comparing the post-IR system searching strategies with the previous stages to see if any changes occurred.

In summary of the findings, it was evident that Information Retrieval Systems operational searching practices differed greatly to that of designers abstract searching strategies. The most significant finding was the discovery of the designers prematurely converging their searching strategies toward specifics. This caused the designers to neglect or compromise some parts of their early searching and specific searching was adopted as described by the CLASS activity. This was supported both by the language used demonstrated in the video transcriptions as well as the generated information such as sketches which showed significant transformation during the use of these systems.

Designers’ searching was closely tied to their design language. This language was made up of verbal communication and physical visual sketches. The terminology that structured the language was drawn from various sources including the provided design brief. The findings demonstrated that the wording within the design brief was highly important as it acted as a resource for the designers to reflect and extract keywords from. The abstract and
specific categories used within a given design brief was seen to initially drive the designers early searching direction.

Early abstract searching was essential for the designers to heighten their awareness of the interlinking external issues that a design problem may face. Limiting exploration is seen to minimise a designers understanding of the problem and are more susceptible to being influenced by the demands of IR systems specific queries. It was observed that designers that neglect abstract searching prior to IR system operation are more likely to prematurely turn to specific searching. Even when they returned to explorative searching, the limitations seemed more restrictive. This is because they were generating keywords as they researched and therefore were more susceptible to the influences placed on them by the IR systems specific classification structure. Most other groups of participants, within the given time frame of the study, accessed and generated a good level of data in which notes and sketches were recorded. In consideration of this accumulated information, the designers were demonstrating abstract searching with discussions recorded on various topics and broad issues relating to the design problem. Their language captured on video also was evidence that they were maintaining an open approach to the design scope. The strategies of the designers were to gain an extensive yet thin understanding of the many issue relating to the content of the problem. The moment the designers began transforming their abstract searching information into query sentences, specific terms of transport devices, mechanisms, manufacturing processes were becoming mentioned. During the period in which the designers were searching the systems, the terms being used also were being converged from abstract to specific. This was also reflected in their conversations with each other. Topics being discussed became focused on real situations, actual mechanisms and existing designs. It was evident that the designers did reflect occasionally on the generated information however during the period of IR systems usage, this reflective activity became less common and the designers seemed driven by the results from the specific queries.
The information accessed and analysed from the use of IR systems also demonstrated that the designers carried out little research on varied topics as previously demonstrated within their early abstract searching. The search histories revealed the designers' keyword queries which were dominated by one topic terms. Few designers retrieved information on topics other than that related to bicycle storage. This suggests that IR systems are excellent at retrieving information based on popular topics and in order to move away from such saturated categories, specifics keywords and searching practices are required to be adopted to the query.

The librarians paired off with the practicing designers demonstrated a greater understanding of advanced information retrieval skills which was expected. These groups of participants used more technical operators which assisted in minimising unwanted data and sorting out desired information. However, even with the information literacy skills, the librarians had to use specifics within their searches to eliminate unrelated specific categories. In other words, the librarians assisted in finding information for the designers however, the designers searching again turned towards specifics and the information returned also reflected this transition.

Finally, in comparison to these groups, the designers that spent a considerable amount of time developing sketches, discussing issues, suggesting conceptual unbound ideas and exploring outside the given limitations formulated a good understanding of the design requirements. These designers appeared to have a greater foundation of generated abstract information to draw upon and their early design language was more stable when researching. As the designers postponed their use of IR systems until the later stages of the study, their searching was not limited by the information categories of IR systems. The significance of these findings is to inform researchers on the impact that Information Retrieval Systems have on individual designers early design activities. This shift in early design direction caused by a premature focus on specific queries is evidence that the Designer / Information Retrieval System relationship is interconnected.
8.0 CONCLUSION AND RECOMMENDATIONS
8.1 CONCLUSION AND RECOMMENDATIONS

Information Retrieval Systems are constructed on a hierarchical system of categories to manage their content. This means that users of Information Retrieval System have to move from the "natural (abstract) categories" (Rosch, 1978) that encase many topics into “superordinate sub-groups” known in this research as specific categories. This is to enable a person to pilot through the maze of information stored in their mass-content. Although, information literacy skills enables smoother navigation through the content of IR systems, these advanced search approaches also require combinations of specific queries to refine the search and retrieve relevant results. In relation to designers searching strategies, exploring through categories and focusing on specific keywords results in a compromise to their abstract searching strategies.

The use of Information Retrieval Systems within the early stages of the design process was seen to cause industrial designers’ initial goals to be reduced to only part of the design problem. Recorded designers’ early language and searching strategies demonstrated a design direction shift in comparison with the initial design definition.

Another issue raised from the research analysis was that not all design language is transferable between searching activities. For example, the searching activities that of designers involve both the generation of verbal and visual information. Both are attributes to design language. When a designer shifts to a searching activity that requires only text such as that of researching an IR system, then the sketching component is left aside. Currently, a communication void exists between designer and IR system. This means that the searching strategies of a designer when interacting with an IR system are not being used to their full potential.
This research is inline with the recommendations made by Winograd and Flores (1987) who proposes the development of future systems which would ‘allow us to interact as though we are in a conversation with another person who shares our background’. Such systems would query the user to enable a clarification on the desired searching direction without communicating in specifics. More advanced IR systems could possibly communicate with a designer in both verbal and visual language with closer linkage to design terminology. It could offer various forms of searching outside the realms of categories. This would assist the designer to search in an information space without the limitations of specific keywords.

Recommendations include the further investigation into the designer / Information Retrieval System interaction to justify a move towards developing systems founded on abstract categories and terminology specific to the design professions. Such systems could possibly search by concept statements in comparison to keyword queries. Other forms of product databases could management its information encompassing visual searches that are constructed on the internal view (Buchanan, 2001) of a product’s properties. The case studies of products developed on this perspective would maintain a focus on the abstract levels of the product rather than specific entities of the products makeup.

This research concludes that there is an expanding need for further research to be conducted on the relationship between designers searching strategies and IR systems searching practices and the future of bridging the communication gap between the two.

ANZIL. (2004) *List of Abilities Representing an Information Literate Person*. Australian and New Zealand Institute of Information Literacy, University of South Australia Library, Holbrooks Road, Underdale, South Australia.


School of Design and Built Environment
Faculty of Built Environment and Engineering

INFORMATION SHEET FOR PARTICIPANTS

Project Title:
Research and Design of an Interactive Information Retrieval System for Industrial Design Usage

Researcher:
Caroline Francis (Research Investigator)
Sam Bucolo (Principle Supervisor)
Vesna Popovic (Associate Supervisor)

Project description:
To investigate and evaluate classification systems and how they impact on individual designers search strategies within the problem definition stage of the industrial design process.

What you are being asked to do:
After a briefing session, you will be asked to complete Part 1: Design Exercise. Your identity is not required.

Following this you will be asked to complete Part 2: A Reflection Summary.
Part 1: DESIGN STUDY

Design Scenario

A client representing the Local City Council has approached your design consultancy wishing to develop several design concepts for a new storage system for non-motorised transport devices. These concepts along with a research report will be presented to the head director of the Brisbane City Council who will decide on whether or not to grant funding to the project.

The client has outlined a basic brief discussing the aims and requirements for the project. A maximum of 2 hours has been allocated for research and preliminary ideation in order to demonstrate to the client the convincing benefits of integrating an industrial design consultant throughout the design process. Therefore the client requires a collection of research notes and sketches generated which will be briefly presented to the client through a reflective interview.

Design Brief

Aims & Objectives:

- To conduct research in order to gain a greater understanding of the design requirements in regards to users storing devices. Examples of these devices include: bicycles, scooters and skateboards.
- To generate initial brainstorming for a storage device that caters for non-motorised transport devices. The design needs to be implemented throughout appropriate public spaces within the CBD.
- To promote the findings and explorations to the client through a reflective presentation.
Design Requirements

The client has done little research and would like to look at existing designs to compare what is on the market and other products that may influence the style, function etc of the device or system. Also, the client would like to see a user analysis of who would use this type of product for the purposes of identifying future consumers which will direct the market direction.

The research also may address issues such as existing devices/systems, user profile, task analysis, social acceptance, functionality, aesthetics, usability, manufacturing, and so on.

The design should be for high volume manufacturing and at low costing for production. The overall design should cater for various users and can easily be implemented into a local CBD environment.

Study Requirements

In summary, you are asked to talk aloud throughout the duration of the design project explaining your actions.

Also, you are required to gather notes which may include sketches, keywords, point forms, ideas, observation findings, and present this at the end of the study through Part 2 A Reflective Summary.
APPENDIX B

SAMPLE OF TRANSCRIPTIONS
SAMPLE OF STUDY 4 + 5

Slide 1

**Classification**

**Dialogue**

P4. Non-motorized transport devices
P5. OK...bicycles, scooters, skateboards
P4. That's for...quality & manufacture.

**Activity**

Highlights keywords
‘Non-motorised transport devices’

Students classify the design problem into manageable headings.

Slide 2

**Brainstorming**

**Dialogue**

P4. So we've got...bikes, scooters, skateboards, things that people use to travel on.
Appropriate public spaces within the CBD.
So we have already got...you know...bike racks.

**Activity**

Mud maps:
- Storage
- Bikes (major)
- Skateboards (minor)
- Modular
- Scooters (minor)
- Rollerblades (minor)

Students brainstorm together and document this into a mud map of ideas and keywords inspired from the design brief.
Students make comments about the design problem based on past experience.

Discussion about whether devices other than bicycles are worthy of consideration.

After briefly exploring the design brief, the students adopt the use of the Internet to source related information.
Searching on the Internet offers many results on existing products, however the designers focus primarily on bikes & related equipment.

Here, the designers are researching the overall dimensions of bicycles although other modes of transport need to be considered.
Student generate new keywords as they progress through the use of IRS's. However, such keywords are conforming to specific searching.

**Dialog Activity**

P4. What am I going to search? 'Bicycle storage'
P5. Yeah... While you are searching, do the same thing in Google.

**Design Inspiration**

P4. When people come into the CBD over the bridge, the Goodwill bridge, the Victoria bridge, and the Story bridge and their going to store these things in a public space.

So like... see this thing, you know what they have got down there, the indoor bicycle storage

P5. I wonder that's really space efficient

P5. That's what I am trying to say, for some reason...
P4. Like you need a six footer bike for people to walk in a store their bike

Like it would be easier to push your bike in a long thin... you know... like something that comes out of a wall.

Here, the designers ideation is influenced by the existing designs found through the IRS. Bicycle storage is their main concern.
Slide 9

**SCENARIOS**

DIALOGUE

**P5.** Well, that's like to... today, the perfect scenario. I was going to ride, catch the train and ride and take the bike in, but then I actually thought about where I would put my bike in the city.

A designer demonstrates his understanding of the user requirements as he depicts a scenario concerning the storage of his bike.

**ACTIVITY**

Relating to the user through past experience or made up scenarios

Slide 10

**IDEATION**

DIALOGUE

**P4.** Maybe we should find a...

**P5.** What do you think of a bicycle tree?

**P4.** A bicycle tree?

**P5.** Yeah, you could put them on polls and hoist them up so they are on...

**P4.** Like the s-f i divers like you've got the robot that goes in and... have you seen... where you store your car in a massive, in-bui l...

**P5.** A car store, yeh yeh.

Ideation begins with a bicycle tree concept and through discussion, further possibilities emerge.

**P4.** Like it goes in and gets lifted up 25 levels and then parked and then brought back down again

**P5.** Like you can do that with boats, like they've got a grid system

**P4.** Well, what have we got, we've got carparks in the city, king's carparking and things like that

**P5.** Ah yeah, we could put it in conjunction with a carpark.

**P4.** Yeah, well that's just big open space, let's get a map of the CBD
Slide 11

**SUPPLIER ENQUIRY**

**DIALOGUE**

**P5.** We should look up a bike store while we are there.

**P4.** Yeah, there are plenty of cycle places in Brisbane.

**P5.** Let’s say ‘Brisbane Cycles’

Through the yellow pages, the designers decided to search for cycle stores in order to find existing products.

**ACTIVITY**

Keyword generation

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Slide 12

**DESIGN INFLUENCE**

**DIALOGUE**

**P4.** Hey, look at that, bicycle storage.

**P5.** Yeah, that’s the kind of thing I was talking about, if you can imagine, like a… shutters on your window or something, and you pull them up and down.

**P4.** Yeah right, but then wouldn’t you need like…so if you’ve got pipes and there’s the ground level, you need it to go...down into the ground

**P4.** Unless you could fix it to the side of a building, such as king storage, have your pushies like that...

**P4.** No your still going to have that problem, you need it to go...if you’re going to get the top bike and you’re at this level…you’ve got so many bikes that need to come down there.

The designers are influenced by the existing products and of each other.
Designers re-evaluate the design brief and realise they need to further research other non-motorised transport devices.
The designers find several possible solutions including storage methods for bikes and other transport devices.

EXISTING SOLUTIONS

DIALOGUE

P4. See that's all they've done, see this, you've got this rope, clips onto here and here.

P5. On a common rail, so you can have different attachments onto one common...

P4. Yeah, So that's a pretty good solution, doesn't solve the aesthetic issue though.

P5. Well bikes can look pretty cool, if you can just make them... put them into a key configuration that looks attractive.
SAMPLE OF STUDY 6 + 7

Slide 1

**USER FOCUS**

**DIALOGUE ACTIVITY**

| Students classify the design problem into manageable headings. |

**USER FOCUS**

**DIALOGUE ACTIVITY**

**ACTIVITY**

| Highlights keywords: 'Non-motorised transport devices' |

Slide 2

**PROBLEM DEFINITION**

**DIALOGUE ACTIVITY**

| Highlights keywords: 'Non-motorised transport devices' |

**PROBLEM DEFINITION**

**DIALOGUE ACTIVITY**

**ACTIVITY**

P6. So they want to obviously... guide the market direction, so I suppose if were... if the council is supplying... areas where non-motorized transport can be stored then perhaps they are going to make it free... I am guessing... they are going to make it free easily accessible, safe, secure... to encourage people to do it

P7. Yes

**PROBLEM DEFINITION**

**DIALOGUE ACTIVITY**

| Highlights keywords: 'Non-motorised transport devices' |

**PROBLEM DEFINITION**

**DIALOGUE ACTIVITY**

**ACTIVITY**

P6. So I guess we'll see a whole range of new products come out on the market specific, specifically for the local Brisbane area... I'm just guessing that.
**DIALOGUE ACTIVITY**

P6. So we also need to look at existing devices.
P7. Smart devices
P6. Technologies that are out now, scooters, skateboards, bicycles, jumping pogos sticks
P7. Ha ha ha, what a way to get to work

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**USER ACTIVITY**

P6. We take person A they wake up in the morning, they catch the train to a certain point and get out and leave their car at the station, and then they mount onto their jet propelled skateboard or whatever it is... Ahhh non-motorised sorry
P7. Non-motorised, yes
P6. Their skateboard, and push their way into the city where they work in say an office.
Slide 5

EXPANDING POSSIBILITIES

DIALOGUE ACTIVITY

P6. I guess the first thing I thought...one of my first things is that, that it's something that's fixed in a whole stack of different areas but um... Perhaps I am wrong... perhaps this is a portable device. Perhaps there is just areas where you have got a docking stations which might be just a hole in the ground with a little clamp coming out of it... and ahhh your pack just docks in wherever you want it.

Slide 6

INITIAL SKETCH

DIALOGUE ACTIVITY

P6. So... user profile. We have already got that, we have to have consideration of that.
Task analysis.
Social acceptance.
Ok.
APPENDIX C

SAMPLE OF A RESEARCH GRAPH