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Traces on the Walls and Traces in the Air:
Inscriptions and Gestures in Educational Design Team Meetings

by

Dewa Wardak

A thesis submitted in fulfilment of the
requirements for the degree of
Doctor of Philosophy
The University of Sydney
Faculty of Education and Social Work

November 2014
AUTHOR’S DECLARATION

This is to certify that:

I. this thesis comprises only my original work towards the Doctor of Philosophy Degree
II. due acknowledgement has been made in the text to all other material used
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25 November 2014
ABSTRACT

Designers from various domains have relied extensively on the use of drawing and sketching to communicate their design ideas. Domains such as architecture and engineering design have well-established and refined visual languages. In these areas significant research is dedicated to the study of drawing and sketching.

One design area that is lagging behind others is educational design. Very little is known in this field about how participants in teams use drawing and sketching to support their communication in design meetings. This study draws on an applied ethnomethodological perspective to investigate how participants in educational design meetings interact with each other, and with objects in their environment, while creating and attending to drawings. Two case studies involving four separate groups of designers were analysed. The first case involved the design of an educational blog and the second the design of an educational game. The meetings were conducted in the Design Studio, a purpose-built room for conducting research on educational design at the University of Sydney. The studio features two writable walls, which were widely used by the majority of participants in the study.

The participants in this study created various types of inscriptions. Inscriptions are defined here as all types of drawings, sketches, and visual marks created in support of design activity. Inscriptions entail a shift from mental representations to social activity. A face-to-face design session often involves multimodal resources thus requiring the analysis of other modes such as gestures. In this study gestures were often used as an additional communicative channel. They functioned as complementary representational means through which the participants made sense of the inscriptions. Understanding the nuances involved in the way designers interact with inscriptions is a necessary step for building better tools, which may support more effective
communication between experienced designers, and help novices as they learn to negotiate the design process. This thesis contributes to our understanding of multi-modal communication in educational design team meetings and has implications for the functioning of next-generation design tools and design environments, as well as for the training of educational designers.
Acknowledgments

I would not have made it this far without the guidance of my supervisors and the support from my family and friends.

There are no proper words to express my deepest gratitude and respect for my supervisor, Professor Peter Goodyear. He is one of the co-directors at CoCo (Centre for Research on Computer Supported Learning and Cognition) at The University of Sydney. He is humble and approachable; he leads by example. He is immensely intelligent and chooses his words carefully. You would know when he is in his office, because his door is always open, always there when you need him.

My heartfelt and sincere thanks and appreciation go to my associate supervisors, Dr Kate Thompson and Dr Lucila Carvalho. Kate and Lucila are bright yet humble. They are caring, and honest. They were always there when I needed them, for both emotional and academic support. I remember emailing Lucila to ask a question and she would reply back within a minute. Kate has replied to my emails at 12am in the morning, despite having a new baby at home. I have been exceptionally lucky to have had such great people mentoring me through my PhD candidature.

I would like to thank members of The Laureate Team; a group of great people who I became close friends with over the years. I would also like to thank members of the CoCo team who provided an academically rich and distinctive environment to study and explore new ideas. In particular, I would like to thank Dr Lina Markauskaite from CoCo who supervised my Master dissertation and encouraged me to embark on a journey through PhD. I have been very privileged to have known and collaborated with you all.

I would like to thank my loving family. To my husband, Mohammad Omar Wardak, without your encouragement I would not have enrolled in my bachelor degree over eight years ago. You encouraged me to take it ‘one step at a time’. You are always there offering your endless and unconditional love and support in hard times and I love sharing my successes with you before anyone else. You are my best friend, confidant, honest advisor, and my supporter. To my two beautiful children, you are the joy of my life. To my amazingly smart son, Asem, who started a university degree at the age of 16 this year, you are my inspiration. To my lovely and intelligent daughter, Sara, a born leader, I hope I live long enough to see how far you will go.
Selected Publications


These two chapters are from the first book published as part of the five-year Australian Research Council’s Laureate Fellowship research project led by Professor Peter Goodyear. My contribution to the first chapter included the analysis of ISQua Knowledge network. For the second chapter, I had the privilege of sharing my experience with web design/programing using an online platform.


This chapter offers a review of empirical studies of how educational/instructional designers carry out their work. My contribution included the review of the factors that influence the design process.


This paper is based on observation of five high school students as they engaged in a learning by design task in the Design Studio - designing an educational resource about a local waterway. My contribution included the analysis of their drawing and sketching practices.

This paper is based on research I carried out for my Masters dissertation, co-authored with my supervisor.


**Under Review**


The research reported in these three papers is taking a synthesis approach- a method that involves bringing together experts in different areas to address a research question that cannot be entirely answered by a single perspective. My contribution to these papers includes the analysis of the drawing and sketching practices of the designers/participants in this study.
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“Designing and making is like having a quiet sort of game, and that game is played through drawing” architect Renzo Piano (Robbins, 1994, p. 127)
Introduction

The word *design* derives from the Latin word ‘designare’, meaning ‘to mark’ or ‘draw’ (Hokanson, 2008). Very little is known about how participants in an Educational Design (ED) team meeting use drawings to communicate ideas. This thesis aims towards a better understanding of how educational designers utilise visual representations, in particular drawing and sketching, during the conceptual phase of design team meetings. Bilda, Gero and Purcell (2006) consider that the conceptual phase of design happens at an early stage of the process, when designers are coming up with ideas and proposed schemes. The drawings created during this phase are tentative and exploratory, functioning as aids in the decision making process. Once most of the design decisions are made, the drawings tend to become more formal, specific, and structured. Formal drawings are typically used to communicate design decisions to other stakeholders such as clients, developers, and end-users.

The use of visual representations is yet to become a major topic of research in ED. This thesis is informed by a definition of ED that is broader than the common understanding of designing materials for instruction (Goodyear & Yang, 2008). Educational design in this study is defined as “the set of practices involved in constructing representations of how to support learning in particular cases” (Goodyear, 2005, p. 82). Furthermore, in this study design is considered a social activity in which ideas are communicated and negotiated until an agreement is reached (Bucciarelli, 1988). The terms educational design and instructional design are often used interchangeably. In this thesis the two terms are considered to be almost on the same level, with educational design representing a slightly broader perspective (Goodyear, 2005).
ED lags behind other design fields in exploiting the value of drawing and sketching during the early conceptual phase of design. Design areas such as architecture, engineering, product design, web design, interaction design and more have extensively relied on the use of visual representations in their design process. The benefit of the act of drawing to the design process is well recognised in these design areas. Architectural and engineering design, for example, have well-established and refined visual languages. Engineering designers have relied so much on drawing that they would remark “I can’t think without my drawing board” (Henderson, 1999, p.1). For these designers, thinking and drawing are closely interconnected. There is a large body of research dedicated to the study of sketching and drawing in design. A search for the term ‘drawing’ in the most prominent journal in this area ‘Design Studies’ reveals more than 700 articles on this topic¹. Among these articles there is virtually no empirical research conducted on the role of visual representations during educational design.

The term representation is ambiguous in that it can refer to both material and mental representations. When representations are made visible, they can be discussed and talked about, and in so doing, these external representations support and facilitate interaction between team members. In this study, the term *inscription* is used to refer to all types of drawings, sketches, and visual marks created and used in support of the design activity during educational design team meetings. Inscriptions refer to visual marks, sketches, or images made through the act of writing, drawing, and engraving onto a surface (Oleksik, Milic-Frayling, & Jones, 2012). Inscriptions also include representations in the form of numbers, tables, diagrams, and graphs (Roth & Tobin,

---

¹ As of June 25 2014 search conducted using Elsevier at http://www.journals.elsevier.com/design-studies/
Focusing on inscriptions entails a shift from representing as a mental activity to representing as a social activity (Roth & McGinn, 1998). Inscriptions are external representations rather than mental representations. They are usually created in order to enable two or more people to interact with them simultaneously, facilitating group communication.

A face-to-face design activity is often multimodal. Complex explanations, such as those conveyed through interaction in design team meetings, will most likely require more than one mode of communication (e.g. talk, gestures, posture, gaze, and drawing). While each mode has relative advantages and disadvantages, they all complement and supplement each other by working in concert (Tversky, Heiser, Lee, & Daniel, 2009). In multimodal interaction, the inscriptions serve as the perceptual ground against which other forms of communication such as gestures and talk make sense. The effectiveness of inscriptions can be increased when people use them together with gestures and words in face-to-face interaction. However, unlike talk and gesture, the act of drawing leaves a visible, more persistent and tangible record of design activity. Furthermore, ideas represented in inscriptions do not have to be expressed in language; people can simply refer to ideas by pointing at corresponding inscriptions, when they are needed during the design process. It makes sense then to study the use of inscriptions together with gestures and verbal representations of ideas. Each communicative mode has a role to play in the meaning-making process. For example, gestures make salient the entities - like various visual elements in the inscription - while the talk provides a clue as to what is made salient (Roth & Lawless, 2002). Designers need to see the gesture, with the inscription as the ground, and hear the words, in order to fully understand the communication.
The term gesture is at times imprecise and is said to have “fuzzy boundaries” (Kendon & Muller, 2001, p. 1). Gestures are thought to have predated both language and depiction. Gestures, like inscriptions, are a visual mode of communication, however they do more than just depict; they can also enact (Tversky et al., 2009). Gestures are often co-produced with words and are rarely used on their own in complex explanations (Tversky et al., 2009). While the gestures analysed in this study are all hand movements, not all hand movements are gestures and not all gestures are hand movements. The hand movement gestures analysed in this study are co-expressive with speech and are not redundant. These are called gesticulations (McNeill, 2002). The types of gestures identified in this study are deictic, iconic and metaphoric. Deictic gestures are pointing movements; iconic gestures perceptually resemble the entity they depict; and metaphoric gestures are similar to iconic but reference abstract concepts that are not easily communicated in words (McNeill, 1992).

Throughout history the study of gesture has had an appeal for artists, historians, linguists, and philosophers. Relevant research on the role of gesture in design comes from various disciplines including artificial intelligence, computer supported collaborative work, as well as psychology and semiotics (Visser & Maher, 2011).

More recently, a growing interest in this area has emerged in human-computer interaction (HCI) using gestures (Kendon & Muller, 2001). For example, some research has focused on dealing with the difficulty of designing devices to recognise certain gestures while also taking into consideration the ‘human side’, in that some gestures might be difficult to learn and remember (Card, 2014). Some studies have also focused on how gesture-based interaction with technological devices changes the way we think (Maher, Clausner, Gonzalez, & Grace, 2014). Research on the role of gestures in
learning and instruction is also of importance for educational design (Roth, 2000; Roth & Welzel, 2001; Roth & Lawless, 2002).

Many of the gestures in design team meetings are enacted in relation to design artefacts (Bekker, Olson, & Olson, 1995). However, the majority of studies in design still seem to overlook the importance of gestures in face-to-face interaction, even if, as pointed out by Visser and Maher (2011) “The use of gestures in the construction of representations of design objects is fundamental” (Visser & Maher, 2011, p. 216).

In this study, gestures were often used as an additional communicative channel. They functioned as complementary representational means through which the participants made sense of the inscriptions. Previous studies of sketching and gestures in design report a similar complementary role (Tholander, Karlgren, Ramberg, & Sokjer, 2008). In this thesis, gestures added dynamic information to the inscriptions, such as movement and trajectory. Gestures were also used as shorthand to refer to shared ideas that no longer needed to be described in words. Gestures were almost always used together with words to clarify ideas or to provide emphasis, such as stating ‘tick a box’ while enacting a click action in the air.

**Aims and Approach**

The main goal of this thesis is to develop a better understanding of the drawing and sketching practices of participants in educational design team meetings. This research has four aims:

1. To identify the types of inscriptions created by the participants in the selected educational design team meetings.
2. To reveal how and in what ways these inscriptions are developed.

3. To determine for what purposes these inscriptions are used.

4. To establish the part played by gestures in a multimodal system of face-to-face communication in educational design.

In order to achieve these aims, I observed and analysed the interactions and inscriptions produced by four groups of educational designers meeting in the Educational Design Studio. The Educational Design Studio is a purpose-built environment at The University of Sydney for conducting research on educational design. The Studio is an evolving, prototype space for augmenting designers’ collaborative work. It is a hybrid digital-material space within which groups of designers use various digital tools as well as two writable walls to sketch their design ideas. Observation of how people work collaboratively in this space can help inform future iteration of the space, the tools, the kind of design tasks, and the groupings of people best suited to use the space.

This study draws on an Applied Ethnomethodological perspective (Heap, 1990). Ethnomethodology is an analytical perspective that has been employed previously in order to understand how people make sense of visual representations (Goodwin, 2000, 2003). This approach has also been used as an exploratory starting point to study the practices of sketching and gesturing in conceptual design with the aim of suggesting more focused future research (Tang & Leifer, 1988; Tholander et al., 2008). Ethnomethodology in this study is used together with Multimodal Interaction Analysis (MIA) (Norris, 2004) to investigate and analyse diverse phenomena such as talk, gesture, and drawing actions.
Significance of this Research

According to Snyder (2012b, 2013), we would be able to build better tools and engage in more effective communication if we could improve our understanding of how people use drawings to support their face-to-face conversations. In ED, visual representations are usually created and used during the conceptual phase of design team meetings on a purely intuitive basis. By better understanding the factors that may affect the way educational designers use these representations in the educational design process, new approaches may be developed to facilitate better design outcomes. Without this understanding, new approaches and tools would most likely introduce limitations. Previous studies of design work in other design areas show that designers adapt their interaction according to the limitation that is placed on them (Bekker et al., 1995). However this adaptation comes at a cost. For example, when tools prevented designers from seeing each other they would produce lower quality design solutions and experience more communication frustration (Olson, Olson, & Meader, 1995).

An ethnomethodological perspective together with multimodal interaction analysis provides a coherent framework to investigate the inscription-related *practices* of educational designers. It is a new way of looking into the practice of educational design that may provide us with better ways of supporting educational designers and teacher designers: “A new vision of a domain provides new possibilities for its study, and as a consequence opens new views of needs for assistance and the potential support modalities” (Visser, 2006, p. 143).
Structure of Thesis

This thesis is organised in six parts. Part 1 presents related literature and it is divided into three chapters. Chapter One is concerned with visual representations in design, including in educational design. This chapter also has a discussion of the gap the present research is addressing. Chapter Two introduces literature on inscriptions in science. Chapter Three presents an overview of the literature on gestures.

Part 2 reports the methods used in this research. This part has three chapters. Chapter Four presents the theoretical framing, the methodological and the analytical approaches. Chapter Five describes the research design, and it includes a detailed introduction to the research environment and the participants. This chapter also describes the data collection and processing procedures. Chapter Six describes the process of analysis including the transcription conventions, presentation of data, selection and definition of modalities, and consideration of research rigour.

Part 3 of this thesis is about inscriptions. This is the largest part which presents the results pertaining to the first three aims of this study: 1) identifying types of inscriptions created by the participants, 2) how and in what ways these inscriptions are developed, and 3) for what purposes these inscriptions are used. This part is presented in four chapters. Chapter Seven describes the inscriptions created by the participants in case Study-A. Chapter Eight presents the inscriptions created by the participants in case Study-B. In both these chapters a thin description is provided for how each individual inscription was created. In Chapter Nine I present the semiotic analysis describing the visual cues in the inscriptions. Chapter Ten is a summary of the results in Part 3 of this thesis. This chapter describes what I see as significant in the results of this part.
Part 4 is about gestures. This is the second largest part of the thesis. It presents the results relating to the fourth and last aim of this study, which is to establish the vital part played by gestures in a multimodal system of face-to-face communication in educational design. This part is presented in two chapters. Chapter Eleven discusses the main results of how gestures were used in this study in relation to the inscriptions. Chapter Twelve presents a summary and synthesis of the results in Part 4.

Part 5 is about how gestures and inscriptions come together to make meaning and aid communication in educational design team meetings. This is a slightly shorter part than the two previous. This part is presented in two chapters. Chapter Thirteen describes the three ways through which the inscriptions became ‘transparent in use’ during the selected design meetings in this study. The chapter ends with a summary and synthesis of these results. Chapter Fourteen describes how gestures can ‘orchestrate’ the multimodal development of ideas in educational design team meetings. This is explained through micro-analysis of one particular event from the data corpus. This chapter also ends with a summary and synthesis of these results.

Part 6 of this thesis is the conclusion. It consists of a single chapter - Chapter Fifteen - which presents a summary of the main findings of this research, discussion of the implications of these findings, limitations of the study and recommendations for future research. The chapter closes with a structured summary of the contributions made by the thesis to knowledge in the field.
Part 1- Review of Related Literature

This part of the thesis is presented in three chapters. In Chapter One I explore the literature on drawing and sketching practices in design; including educational design (ED), architecture and engineering design. In Chapter Two I discuss another area that has inspired this study, inscriptions. I explain what inscriptions are, how they are used in science, the types of visual elements in inscriptions and how they are used to communicate abstract ideas. In Chapter Three I review the literature on gestures. I explain what gestures are, how they are used in relation to visual representations, how they are used in design, and how they can become cognitive artefacts.
Chapter One: Visual Representations in Design

Throughout history, designers were primarily the makers and crafters who actually made the objects. However, they mostly crafted objects by copying or adapting existing designs (Lawson, 2004). Once design was separated from making, the design ideas needed to be communicated to the makers and drawing was a popular option for such instructions (Lawson, 2005). This change made it possible for the designer to experiment, not with the object itself, but with the representation of the object. The impact of using drawings of actual objects in design is more obvious when designers need to plan for large, complex and expensive objects such as buildings, bridges or aeroplanes.

This chapter begins with an investigation of drawing practices during the early stages of educational design, followed by a brief analysis of the research gap. Subsequently, a review of drawing and sketching practices of designers in architecture and engineering design is provided. The chapter ends with an explanation of the unique function of drawing and sketching that can help designers in their thinking process.

Drawing in Educational Design

ED can be seen as more closely aligned with craft than with design (Hokanson, 2008). In craft, advances are made through corrections and improvements applied to existing objects. The separation of design from craft enabled designers in many domains to experiment with, and evaluate ideas before they were applied to the object. In ED, Gráinne Conole (2012) has published an insightful book that deals with the
issue of the need for a shift from traditional craft-based design for learning to a more systematic and explicit approach to design for learning.

In ED, studies that examine the practice of drawing and visually representing design ideas during the initial conceptual design process are rare. One of the few studies that investigated the general use of drawing during ED team meetings was a PhD thesis by Todd Stubbs (2006). Stubbs found that design drawings do play an important role in ED and provide many of the same advantages found in other design fields. However, educational designers use drawings implicitly and are not aware of the role that drawings play in their design activities. Furthermore, Stubbs mentioned that one of his study participants said that she does not keep early design drawings because they are very messy. This means there is no systematic way of producing and/or improving design drawings. Stubbs (2006) found that educational designers use very limited forms of drawings compared to other fields of design, such as architecture or engineering, during the initial stages of design. His study discovered that drawing in educational design tends to move through a progression from simple to complex drawings. These drawings, he stated, are part of the design narrative and without them understanding the evolving design becomes difficult. The study by Stubbs found that design drawings facilitate shared vision in design team meetings. Although not the focus of his study, Stubbs also noted that these design drawings are mostly referenced in the meetings using gestures.

There is another area in ED in which the use of visual representations is the focus of research and it is Visual Instructional Design Languages (VIDL). VIDL attempt to visualise the ED process and make it more explicit (Gibbons, Botturi, Boot, & Nelson, 2008). VIDL are intended to improve communication between experts, reduce
complexity, facilitate better alignment of face-to-face and distant activities, lead to a more profound understanding of e-learning scenarios, make possible the re-use and sharing of existing designs, and help in training new designers (Figl & Derntl, 2006).

VIDL are mainly computer-based. Conole (2010) recommends the use of seven types of representations in ED; one being text-based and six in visual forms; but all those in visual form are created using computer tools. VIDL play an important role in supporting teachers’ design processes (Agostinho, 2011; Agostinho, Bennett, Lockyer, Jones, & Harper, 2013), however they are different to free-form design sketches that are studied in this thesis. In terms of the visual forms, VIDL seem more structured and more oriented to presentation. They seem less suited to experimental and free-flowing work, which is the common form of drawings during the conceptual phase of design.

Those involved in education and educational design have long recognised the importance of utilising visual representations in communicating design ideas. In an earlier publication Hortin (1983) recommends that “Instructional designers can share the processes of experiencing the image with clients, instructors, and learners to help them design better curriculum products” (Hortin, 1983, p. 21). By visualising educational design ideas Hortin states that “The content, values, and experiences can be shared and communicated in a collaborative fashion” (Hortin, 1983, p. 21).

**Gap vs. Void**

After reviewing the literature on drawing practices in the early stages of educational design, I found a void rather than a research gap. Even Todd Stubbs, after his 2006 thesis, had turned his focus towards studying computer based visual
instructional design languages rather than freehand drawings and sketches during the conceptual phase (Stubbs & Gibbons, 2008). This prompted me to look into the drawing practices of designers from other domains. I found that there is a vast area of research concerning the role of drawings in design. Some of the topics researched are: the role of visual cognition and mental imagery in problem solving (Sullivan, 2010), the use of computers for sketching in the conceptual design phase (Jonson, 2005), the benefits of sketching versus using ready-made sketches (Schütze, Sachse, & Römer, 2003), and the difference between experts and novices in their use of visual representations in design (Bilda et al., 2006; Liu, Liu, & Chuang, 2009; Tversky, 2002).

Some have also looked at the issue of using sketches in domains that do not produce visual products (Eckert, Blackwell, Stacey, & Earl, 2004). Another issue that many researchers have touched upon is drawing skills. Powell (1985) states “Without this [drawing] skill, too many designers are forced to design only what they can draw, rather than draw what they can design” (p. 6). Goldschmidt (2003) acknowledges that for some communication and reasoning, ordinary drawing skills may not be sufficient. However, she believes that the designer does not need to draw perfectly, rather, be able to use drawing to reason with on the fly. An important issue that Purcell and Gero (1998) have referred to is not just being able to draw or sketch, but to draw in a way that facilitates emergence and reinterpretation.

Although I could have followed the footsteps of one of these lines of research and tested some forms of hypotheses, I decided that the field of educational design would benefit from an exploratory study that may form the base for future research into this area. At the beginning of my search, I found that there are many similarities between the types of activities pursued by designers in different design domains (Goel & Pirolli,
This prompted me to consider the possibility that other design areas might provide a starting point for my research where I could learn about how designers utilised drawings in their design process. Through a general examination of the design literature, I understood that many design fields utilise drawings for different purposes; however, drawing and sketching practices are in particular more prominent in architecture and engineering. Drawing is considered imperative for the early stages of architectural design and architects are expected to know how to draw (Unwin, 2007). Design in engineering is said to start with hand drawn sketches (Ferguson, 1992). Consequently, I decided to investigate the drawing practices in these two design domains to see how they could provide inspiration to my exploratory study of drawings in educational design. Some of what I read in the literature related to these two design areas is as follows.

**Design Drawings in Architecture**

Architecture has a rich and well-developed tradition of utilising visual representations during the conceptual design stage, and this has proven beneficial for the success of creative inspirations in architectural designs. Architecture is located at the intersection between arts and aesthetics, and traditional civil engineering sciences (Styhre & Gluch, 2009). Architecture is also said to be similar to ED (Hokanson, 2008), in that both have complex technical issues, are socially based and are practiced within firms and in teams. Both have to deal with, and satisfy, clients and different stakeholders, both involve the *design of* tangible objects and *design for* less tangible
experiences, and finally, both architecture and ED have to address theoretical and philosophical issues in their application.

In the process of their design work, architects make use of a number of visual representations including drawings, photographs, sketches, plans, 3D models, and CAD (computer aided design) images. The most dominant activity for architects, however, is drawing, mostly in the form of free-hand sketching, with text annotations for effective collaboration and shared understanding (Garner, 2008; Styhre & Gluch, 2009). Evidence from empirical studies of the practice of sketching in architecture suggests that architects have an intense interaction with their sketches in the preliminary conceptual stages of design (Menezes & Lawson, 2006). Architects engage deeply with their sketches, and with more experience, can read more information from their sketches (Suwa & Tversky, 1997).

When students in architecture learn how to draw, they also learn how to progress their design by using sketching (Liu et al., 2009). They do this by developing their ideas from one plan or proposal to another one while keeping track of their design progress. Architects come up with new design concepts while sketching, because sketches capture the moments of new ideas and store them (Liu et al., 2009). Architects record ideas into initially vague visual representations that become clearer as the designers’ thoughts progress. An example of this process can be seen in the following illustrations reproduced by Lawson (2004, pp. 46-48), where the architect Ken Yeang formulates the plan for a Hard Rock Café in Malaysia. The architect’s thought process starts in a fuzzy unclear form illustrated in Figure 1. In Figure 2, the main features of the design are more defined. The sketch in Figure 2 also seems to have layers where the designer has drawn over other less-defined features. This exhibits the changes in the
architect’s thought processes. Figure 3 illustrates a more fixed version of the design where most of the features are now well defined and resolved. These initial drawings are not discarded in architecture in favour of more refined drawings in the later stages.

Figure 1. Ken Yeang's early fuzzy sketch for a Hard Rock café in Malaysia

Figure 2. A further, more defined, sketch by Ken Yeang for the Hard Rock café
The function of drawing in architecture is broadly defined as a medium for communication, a medium for design, and a medium for analysis (Petherbridge, 2008; Unwin, 2007). Fraser and Henmi (1994) looked at the general characteristics of drawings in architecture, or the purposes they were created and used for. They identified five types of drawing that they called ‘referential drawings’, ‘diagrams’, ‘design drawings’, ‘presentation drawings’ and ‘visionary drawings’. These were produced for different purposes, such as using the visual imagery as reference to pre-existing phenomena, using diagrams for analysis, and using drawing for presentations to outsiders. Architects are very much aware of the benefits of drawing for their design process. For example Goldschmidt (1991) quotes an architect who was one of her study participants stating “I can’t get very far with just thinking about it without drawing something” (p. 129).
As the practice of sketching in architecture has reached maturity, there has been a call to progress to the next stage and utilise computer technologies. The emphasis now is on how computer tools can support the idea-generation conceptual phase of the design process, which has been dominated by the use of pen and paper throughout history (Do, 2002; Do, Gross, & Zimring, 1999; Salman, Laing, & Conniff, 2014; Szalapaj, 2013). Lawson (2005) states that:

The designers of today can no longer be trained to follow a set of procedures since the rate of change of the world in which they must work would soon leave them behind. We can no longer afford to immerse the student of architecture or product design in a few traditional crafts. Rather they must learn to appreciate and exploit new technology as it develops. (Lawson, 2005, p. 6)

**Design Drawings in Engineering**

Compared to the more artistic expression in architecture, engineering traditionally has focused on satisfying a real or perceived need by modifying processes or procedures, or introducing new products, technologies and knowledge (Sheppard, Colby, Macatangay, & Sullivan, 2006). This, however, does not mean that artistic expression is unimportant in engineering design. The literature on the role of design sketching in this area is relevant to broad domains of industrial design, product design, mechanical engineering, electrical engineering and more. In engineering, sketching is a key feature and a fundamental process throughout all the stages of design (Cross, 2000; Henderson, 1999; McGown, Green, & Rodgers, 1998). In one of the pioneering textbooks titled ‘A Manual of Engineering Drawing for Students and Draftsmen’,
French (1911) writes: “The designer must be able to sketch his ideas with a sure hand and clear judgment. In all mechanical thinking in invention, all preliminary designing, all explanation and instructions to draftsmen free hand sketching is the mode of expression” (p. 217).

Henderson (1999) states that sketching is essential in engineering for communicating ideas, and designers often talk to one another and sketch simultaneously. In engineering, early conceptual sketching has a positive impact not only on the quality of the designed solution, but also on the experience of the design process (Schütze et al., 2003). A higher volume of sketches produced in the early conceptual stages of design, rather than the later stages, is shown to end up in better design outcomes (Yang, 2009). Furthermore, sketching can help designers develop spatial skills, such as the ability to mentally rotate 3-D objects (Sorby, 2009).

The free-hand sketches in engineering can take on three different forms. Ferguson (1992) divides them into ‘thinking sketch’, ‘prescriptive sketch’, and ‘talking sketch’. Thinking sketches are preliminary idea-generation sketches that guide non-verbal thinking. Prescriptive sketches are made by engineers to communicate the design to a drafter who makes a finished drawing of the design. This is done after the design has been approved and preliminary issues resolved. The talking sketch is constantly exchanged between designers and other stakeholders, including builders and makers. This sketch seems to be more prevalent in the early stages of engineering and product design. A thinking-sketch and a prescriptive-sketch can both become a talking-sketch when used to elicit opinions from other designers or to clarify complex and confusing ideas (Ferguson, 1992). Van der Lugt (2001, 2005) adds another type of sketch to this list, which he calls the ‘storing sketch’. A storing sketch is used when
design groups in a meeting refer to previous ideas and utilise them in the idea
generation process. For whatever purpose the sketches are used in engineering design,
they are easier to understand if they include additional annotations to provide context
(McGown et al., 1998).

The future of engineering design seems to be moving towards the development of
computer tools with more natural and intuitive interfaces. In addition, the aim is to
integrate traditional engineering software, such as CAD tools, with the more
collaborative knowledge-based applications that make it easier to support knowledge
capture and reuse (Chandrasegaran et al., 2013).

One of the main benefits of drawing and sketching in both architecture and
engineering is that designers use them as aids in their thinking process. This is further
explained in the following section.

**Sketches for Design Thinking**

“**Drawings, paintings, and other similar devices serve not simply to translate finished thoughts into visible models, but are also an aid in the process of working out solutions**” (Arnheim, 1969, p. 129).

Creating a sketch became a common practice in the arts and design during the
Renaissance when it was given the name ‘pensieri’ meaning ‘thoughts’ (Goldschmidt,
1991). There is a general agreement that drawing and sketching is the archetypal
activity for designers in various design fields (Buxton, 2007; Gedenryd, 1998; Goel,
1995; Jones, 1992; Lawson, 2004, 2005). For designers, sketching is the act of
exploration (Hokanson, 2008), discovery (Berger, 2007), and an aid to their thought
process (Buxton, 2007). Designers draw in order to spot problems, see new features and relations among elements, discover or promote new ideas and refine current ones (Suwa & Tversky, 2002).

The importance of sketching in design is not the sketch as a final product of design, but as the process that explores, questions, suggests, proposes, and provokes thoughts and ideas (Buxton, 2007). In other words, “sketching is thinking” (Goldschmidt, 1991, p. 130). The initial ideas in design can be vague and impossible to conceptualise and express clearly with words alone. This is called the ‘preverbal’ phase where sketches can help designers express their ideas clearly without applying verbal descriptions to them, which can ‘narrow emerging concepts too quickly and impede their full development’ (Hansen, 2000). Sketches in these situations help the designers externalise their incomplete ideas into initially vague drawings that become clearer as the designers’ thoughts progress.

The early conceptual sketch has been called many names including ‘study sketch’ by Goldschmidt (2003), ‘design drawing’ by Fraser and Henmi (1994), ‘proposition drawing’ and also ‘thinking drawing’ by Lawson (2004), ‘heuristic sketch’ by Eppler and Burkhard (2006), ‘ideational drawing’ by Rosenberg (2008), and, ‘idea sketch’ by Hansen (2000). One thing all these sketches have in common is that they help the designer to quickly visualise and represent the main idea in an accessible format with little effort. The benefits of sketching to the design process are numerous. Sketches visualise the designers’ thought process. Sketches are quick and easy to make with only the degree of detail required for the intended purpose. They are inexpensive and can be produced when needed. Sketches can help designers explore their initial vague ideas and avoid premature decision making (Hansen, 2000). Sketches provoke thoughts, help
designers to notice inconsistencies, question decisions, propose new ideas, and more (Buxton, 2007).

Ultimately, it is important to see how designers themselves value sketching in their design activity. Robbins (1994) reports Renzo Piano, an Italian architect, stating in relation to his own practice:

Unless you draw something, you do not understand it. It is a mistake that now I understand the problem and now I draw it. Rather, right at the time you draw you realize what the problem is and then you can rethink it. (p. 127)

Henderson (1999) quotes an engineer who stated “I can’t think without my drawing board”. In another example, designer Kurt Hanks (Hanks & Belliston, 2006) explains how learning to draw improved his thinking process, stating:

Yes, I had learned to draw, but more importantly, I learned to think. My whole method of thinking underwent a complete metamorphosis. I began to see the world more clearly. As my hand sketched the lines, my mind revealed a whole new method of thinking that I had not known before ... I could nail down my ideas on a sheet of paper ... An idea is a very delicate and fleeting thing and if it is not quickly crystallized into reality, it just slips away never to be found again. (Hanks & Belliston, 2006, p. 2)

Finally, sketches can greatly improve communication in collaborative team situations. For example, Eppler and Burkhard (2006) state that ‘heuristic sketches’ can be used to assist group reflection and communication processes. This is because they bring the main features of the object of design to the conversation by making them explicit and thus debatable. Furthermore, information can be added to sketches where it
fits best to convey meanings in face-to-face meetings, rather than forcing words into linear text-based formats (Hansen, 2000). In general, there is no clear line between the process of creating sketches for thinking and sketches for communicating ideas in groups (Eckert et al., 2004). In some instances, a sketching session can help individual designers understand their object of design while at the same time communicating their ideas to others in a group or team setting.

This review illustrates that drawing and sketching is a prominent activity in many design fields, in particular in architecture and engineering design. Drawing has been used as exploration, discovery and as an aid to thinking in design. Drawing also improves communication in teams. Educational designers also draw, however, the little research that we have suggests that they draw implicitly and do not fully comprehend the benefits of drawing for their design process. As mentioned, there are many types of drawing in design. There can be ‘referential drawings’, ‘design drawings’, ‘presentation drawings’ or ‘thinking sketches’, ‘prescriptive sketches’, and ‘talking sketches’. There is another area in which drawing and visual marks play a similarly important role: inscriptions in science.
Chapter Two: Inscriptions

Inscriptions represent the world in its absence (Latour, 1987). Abstract ideas, enormous buildings and structures, microscopic organisms, out-of-reach stars and galaxies, islands and continents, all can be represented on a piece of paper, on a whiteboard, or a computer screen. The term inscription is widely used in science and technology studies. It was originally borrowed from archaeology to provide a distinction between material representations and mental representations, which are not directly accessible to others (Latour, 1987; Roth & McGinn, 1998). In this chapter I discuss what inscriptions are, their contributions to science, their function and their impact on task performance. I will also describe how visual cues are used in inscriptions and how space and elements can be used to communicate abstract ideas.

Inscriptions in Science

Science and design are similar in many ways. Farrell and Hooker (2012, 2013) argue that design and science are not different when it comes to the core problem-solving processes involved in both. They state that scientists and designers both solve problems by searching through large sets of possibilities. They indicate that there is no difference between the underlying processes, methods, and the kinds of products produced by both design and science and that inventing is an integral part of both domains. They state that scientists too produce novel and abstract artefacts such as
concepts and theories and new physical artefacts such as new instruments and technical procedures.

It is widely accepted that recent human evolution is strongly correlated with the use of representations (Roth & Welzel, 2001). Scientists in the field and in laboratories transform their objects into inscriptions in order to make sense of them. Inscriptions also enable the scientists to represent objects that are absent and are far away. Scientists transform objects into inscriptions in order to accumulate them, label them with captions, and combine them in a way that words and images come together to form a visual culture (Latour, 1988). Latour (1988) explains how inscriptions in the laboratory form an important part of the conversation between the scientists. He states:

> When these resources [inscriptions] were lacking, the selfsame scientists stuttered, hesitated, and talked nonsense, and displayed every kind of political or cultural bias. Although their minds, their scientific methods, their paradigms, their world-views and their cultures were still present, their conversation could not keep them in their proper place. However, inscriptions or the practice of inscribing could. (Latour, 1988, p. 4)

Inscriptions are an intrinsic and integral part of scientific practice, “their development and the development of science are tightly interwoven” (Pozzer-Ardenghi & Roth, 2010, p. 228). Inscriptions can be developed and standardised to a level that will make them resemble a language with its own rules and vocabulary.

An Example from Chemistry

The innovation of the periodic table of chemical elements by the Russian scientist Dmitri Mendeleyev in 1869 is considered to be a turning point for chemistry (Ruecker
Chapter Two

& Liepert, 2006). The organisation of the elements in a table format established an immediate orderliness and clarity and has since provided inspirations to other related areas in science (Pritchard, 2010). The strength of the periodic table lies in its flexible visual organisation of elements, which enables vertical and horizontal cross-referencing. This visual form enabled scientists to detect errors and incompleteness. For example, after the organisation of the table, Mendeleyev was able to make several discoveries including noticing that several elements had been miscalculated. Prior to this innovation, “the lack of an underlying conceptual structure meant that chemistry’s development had to rely on experimentation alone” (Ruecker & Liepert, 2006, p. 239). Without the guiding theories, scientists were faced with a lack of structure and a disorganised body of facts. According to Latour, “Chemistry becomes powerful only when a visual vocabulary is invented that replaces the manipulations by calculation of formulas” (Latour, 1988, p. 14). On a practical level, the periodic table made the transmission of chemical knowledge to the next generation a much simpler task. The simple form of the periodic table relied on several visual strategies, such as the abbreviation of names and terms, the addition of keys and legends, the introduction of colours and graphic coding, and the tabular arrangement of the information (Ruecker & Liepert, 2006).

Prior to the periodic table, other scientists also tried to organise the elements in some form of visual format by taking their ideas from other domains with a better-developed visual language. For example, Englishman John Newlands drew on musical conventions for his strategy to visually organise the elements in 1864 but failed to accommodate all the known elements (Ruecker & Liepert, 2006). Around the same time, Alexandre-Emile Béguyer de Chancourtois, a geologist, created a visual
representation of the elements called the ‘telluric screw’ in a cylinder form (Ruecker & Liepert, 2006). However, the cylinder form would always conceal a section of the representation from direct viewing, which made the telluric screw impractical. The inspiration for creating the periodic table for Mendeleyev was the game of solitaire (Ruecker & Liepert, 2006). One of the main benefits of this format was that the table could be viewed in its entirety at a single glance and nothing was hidden from view.

**Functions of Inscriptions**

Tversky (2001) mentions six main functions of inscriptions (that she calls graphic displays). The first function is to attract attention. One of the ways they attract attention is by using aesthetic qualities that can be shocking, or funny, or calming etc. The second function is to record information, for example one of the earliest uses of tally marks was to keep a record of property ownership. The third function of inscriptions is to facilitate memory. Inscriptions can provide visual cues that can help organise memory and make recall easier. A fourth function of inscriptions is to facilitate communication. Inscriptions externalise private mental conceptualisations turning them into public shared resources that can be discussed, debated, and examined in groups. A fifth function of inscriptions is to provide models of actual and theoretical worlds and things in them. The essence of these models is that they only present features that are relevant to the task at hand while omitting other features that might exist but are not relevant. These models can even add features that do not exist in the modeled world but can communicate specific ideas. And finally, the sixth function of inscriptions is that they convey meaning which facilitates discovery and inference. Some cleverly devised
inscriptions can bias users towards specific kinds of inferences. For example presenting an idea or a concept on a straight line might bias users towards linear thinking whereas presenting the concept as a circular diagram might encourage a non-linear view (Tversky, 2001).

Mary Hegarty (2011) mentions four functions of inscriptions, which she refers to as visual-spatial displays. The first two functions are similar to those mentioned by Tversky above. First, inscriptions provide external storage, or a record, of information. This function, according to Hegarty (2011), frees up working memory resources for other aspects of thinking. The second function is organisation of information. Visual displays have the ability to group relevant information and use empty space to indicate their relation. For example, items located closer to each other in an inscription may indicate a close relation in the world. The third function she mentions is that inscriptions allow the offloading of cognitive processes onto perceptual processes. For example, complex data displayed in a graph can facilitate easy pattern recognition instead of requiring complicated computations. The fourth function is offloading cognition on action. An example of this is when a user manipulates external representations, such as working with interactive displays, where the user can use the tool to do computations instead of conducting them all inside his/her head.

These functions of inscriptions are very similar to those of drawings in other design domains. For example, both design drawings and inscriptions facilitate memory by providing a visual record, they both capture and store information and ideas. Design drawings and inscriptions can facilitate communication in teams. They can help their users make discoveries and spot problems. And lastly, both design drawings and
inscriptions can be used to display only that which is important for the task at hand, omitting other features and irrelevant information.

**The Impact of Inscriptions on Task Performance**

As mentioned, inscriptions and design drawings share a number of functionalities. Unlike design drawings however, inscriptions can illustrate the same phenomenon using very different visual representations. For example, to show the location of a country on earth, a person can draw a map of the country, or she can note down the longitude and latitude coordinates. Both representations can communicate the location; however each will be more suited to different tasks and purposes. A lost sailor might benefit more from longitude and latitude coordinates than from a drawing of the sea.

Hegarty (2011) refers to numerous studies that provide evidence on how different visual representations of the same phenomenon can influence task performance. There is no ultimate inscription which can perfectly represent a phenomenon and can communicate to any audience of any level and all domains. Some inscriptions are more suited to illustrate certain objects or phenomena while others might not be as suitable. The key is to match the right inscription with the task at hand. There are some general issues however that influence the viewers’ ability to interpret visual elements in an inscription. Visual elements need to be used in ways that communicate to the viewer directly instead of requiring the user to conduct additional mental operations, such as for example mentally rotating shapes or interpreting ambiguous symbols.
From the review of the literature, there are a number of good practices associated with the effective design of visual representations. Some examples that are relevant to this study include:

- **Chunking information:** if a visual display chunks information the viewer can map the inscription and find the relevant information more efficiently (Freedman & Shah, 2002).

- **Salience:** an effective inscription needs to illustrate what is important to the task at hand. Task-irrelevant information and features may distract the viewer (Hegarty, 2011). There are often misconceptions about this issue. It is generally believed that more information will make a visual representation better. However, the opposite can be true if the user fails to notice the most salient information and is distracted by details or visual clutter.

- **Layout and position of visual elements:** the user might not have many alternatives when representing the layout of objects that are inherently visual (Purchase, 2014). For example, when communicating the layout of a web page or a building there are certain rules that need to be followed and in some cases ignoring those rules might make the inscription unrecognisable. However, the user might need to pay more attention to the layout of inscriptions when displaying abstract ideas. For example the placement of a central node in a network diagram or the placement of the highest box in an organisational chart will communicate certain notions and may influence the viewers’ perceptions.

- **Embellishment:** this includes visual cues like colour, shading, highlighting, emboldening, underlining, or some other ways of making elements stand out (Purchase, 2014). Embellishments play an important role in communicating the
right idea. For example, the colour red is often perceived as denoting danger. In most visual forms it is used in order to attract the viewer’s attention to certain elements. When colour is misused it can cause misinterpretation.

- Compatibility: the form of visual element used in an inscription needs to be compatible with its meaning (Hegarty, 2011). For example circles indicate cyclic processes, lines indicate connections, and arrows indicate causality or directional relationships.

There are numerous studies arguing for the need to learn graphical literacy so that users in any domain can use visual representations effectively. A brief review of this line of research is provided by Purchase (2014). Hegarty (2011) argues that users of visual-spatial displays need to possess the knowledge necessary to extract and interpret the information in the representation. These representations, she believes, are based on implicit conventions which become evident only when we find people that do not know them.

Although graphical literacy is a valuable skill, another reason for misinterpretation of inscriptions is the viewer’s knowledge of the relevant domain (Freedman & Shah, 2002). When users of visual representations know the main issues, concepts, and jargon of a domain, coupled with an understanding of the meaning behind visual elements, they can engage with the representation on a deeper level. For example, novice users of graphs with no domain knowledge typically provide surface-level descriptions of the data, such as concentrating on each line in the graph, whereas skilled users of graphs and those with relevant domain knowledge engage with the graph on a deeper level, making inferences about the data (Freedman & Shah, 2002).
The decision to interact with an inscription, and the level of interaction, is also based on the characteristics of the medium on which the inscription is drawn (Hegarty, 2011). For example, inscriptions drawn on whiteboards are easier to erase and redraw so participants are less hesitant to make changes to these inscriptions. Inscriptions drawn in ink on paper do not have this level of flexibility.

**Visual Cues in Inscriptions**

The key to conveying meaning through visual and graphic representation is the use of space and elements. Elements may include symbols and icons. Symbols are signs that do not resemble what they depict, and icons are signs that perceptibly resemble what they designate (Connolly, 2000). The use of space in depictions that portray inherently visual objects, such as a building for example, has a long history, whereas the use of space and spatial elements in depicting abstract ideas or concepts is more recent (Tversky, 2001). Ideas such as temporal, quantitative, causal, and social relations are difficult to visualise because they are not inherently visual. To represent an object one can depict a miniature version of it, or an enlarged version that makes it easier to see the intricate details. An example of miniaturisation is representing the shape of galaxies on paper. In order to represent abstract ideas, however, some depictions rely on systematically arranging elements in space that is analogous to a relationship or an arrangement in the world while others rely on analogy. Some icons rely on analogy to represent a concept, an action, or an idea. The image of a folder on a computer screen is one such example.
The Use of Space and Elements for Communicating Abstract Concepts

The interplay of space and the elements within it on a two-dimensional plane can be used metaphorically to represent abstract concepts and ideas. Lines, circles, squares, blobs, arrows, crosses etc, are graphic forms that can convey abstract meaning. These are called ‘meaningful graphic forms’ (Tversky, Zacks, Lee, & Heiser, 2000). These graphic forms can take on particular meanings in specific contexts because they have a useful level of ambiguity (Tversky et al., 2000). For example a line can stand for a path, a barrier, or a connection.

There are a limited number of graphic forms; however they take on specific meanings in different domains. This is precisely their strength. For example when sketching a map, a line can stand for a route and a square shape can denote a landmark. When creating a graph, a line can be used to show a trend while rectangular shapes can be used to show comparison. The graphics are interpreted based on the context in which they are used. A user would not interpret a line on a map as a trend or a square shape as a comparison. Similarly, users of graphs would have specific expectations for what should be represented in a graph.

There are certain uses of space and elements in inscriptions that are more relevant to this study. These include the use of elements to indicate grouping, order, meaningful concepts, and centrality of ideas. For example, proximity in space is often used to indicate grouping (Tversky, 2001). Things that are near in space are inferred or implied to be in a closer relationship than those further away. This strategy can be used for conveying abstract meaning by simply placing elements that are conceptually related in a close proximity to each other. An example of this strategy is using lists to separate...
ideas that are related by arranging them into a column separated by empty space from
the surrounding elements. Each item in a list starts at the same point in each row,
indicating some kind of equivalence. Another strategy for indicating grouping is the use
of signs such as parentheses, circles, boxes, and frames (Tversky, 2001). These signs
are based on the idea of enclosure and resemble physical structures in the world, such
as fences or bowls. Parentheses and brackets, for example, face each other to include
the related words or terms and to separate them from the rest of the text. Circles and
boxes enclose items that are related. Other strategies for indicating grouping include the
use of colour, size, shape, and font to signify similarity (Tversky, 2001).

Space and the elements in it can also be used to indicate order. “Writing is
ordered” states Tversky (2001). Examples might be: writing the names of students in
order of their age or in order of their test mark. Empty space in writing can be used to
indicate order, as in indenting subordinate list items. Visual elements such as lines are
also used to indicate order. Lines can show a variety of relations such as kind of, part
of, reports to, derived from, and more (Tversky, 2001). Some examples of inscriptions
using lines to indicate order are linguistic trees, organisational charts, and network
diagrams. Lines link one concept to another through space, bringing related concepts
closer together. Arrows are special kinds of lines that indicate directionality and
asymmetric relationships.

Another visual cue to indicate meaning in visual representations is using
directionality or orientation of elements (Hegarty, 2011; Tversky, 2001). Inscriptions
can be organised vertically, horizontally, diagonally, or in any combination. Concepts
such as indicating increase or decrease are usually depicted in vertical displays.
Concepts such as time are often illustrated as horizontal. Cultural and linguistic
differences often influence directionality. For example, ordering of events on a
horizontal axis is different for people who write from right to left from those writing
from left to right.

Layout and the positioning of elements in inscriptions can also be used as visual
cues (Hegarty, 2011; Tversky, 2001). For example placing an item in the centre of a
diagram may indicate its importance, as with the central node in a network diagram, or
placing a category on the top may indicate power, as in organisational diagrams. There
has been a wealth of research conducted in the area of understanding how layout and
the different positioning of elements in visual depictions influence understanding and
improve interpretation (Purchase, 2014).

In summary, there are a variety of visual cues in inscriptions that are intended to
communicate and ease interpretation. Some of these include using space to group
related items together; using signs such as parentheses, circles, boxes, and frames to
enclose and group related items; using space in writing to indicate order; using lines
and arrows to indicate relationships; using directionality and orientation to denote
specific meanings; and using layout to influence perception and interpretation. Users
can also draw on other visual cues to attract attention to salient parts of an inscription.
For example, elements can be drawn in different colours; in larger or smaller size than
the surrounding elements; in a different font; underlined; highlighted; capitalised; or
made bold. I am using this short review to identify the visual elements in the drawings
created by the participants in this thesis. This will help me categorise the inscriptions in
order to analyse and understand them better.


**Diagrams**

Diagrams are the most widely used type of inscriptions. In this study several types of diagrams were created by the participants. This short review will explain how diagrams are perceived in this study and inform the analysis reported in Part 3.

Purchase (2014) provides a review of twelve years of diagram research represented in the *International Conference on Theory and Application of Diagrams*. She defines a diagram as:

> a composite set of marks (*visual elements*) on a two-dimensional plane that, when taken together, represent a concept or object in the mind of the viewer. Examples of visual elements include lines, geometric shapes, “blobs, crosses and arrows” – any visual mark that cannot be decomposed. (Purchase, 2014, pp. 59, emphasis in original)

She also defines a word or a phrase that is not intended to be separated into its individual words as a visual element. The Oxford Dictionary defines a diagram as a schematic representation “showing the appearance, structure, or workings of something” (“Diagram”, 2014). Diagram notation comprises the rules which define meanings for visual elements. The notations often need to be learned for users to correctly interpret diagrams (Purchase, 2014). Interpretation of concrete diagrams is simpler due to the direct perceptual relation of the diagram elements with the objects they depict (Purchase, 2014). Nevertheless, concrete diagrams still need to include sufficient correct visual elements in order to be interpreted accurately by the viewers. Correct interpretation also depends on the context in which the diagram is presented. “Abstract diagrams on the other hand, always need a clear set of rules that need to be known by the viewer for correct interpretation” (Purchase, 2014, p. 59). Examples of
notations for abstract diagrams include network relations, overlapping geometric shapes as in Venn diagrams, and charts that represent data such as bar, line, or pie charts.

Nakatsu (2009) classifies general diagram types into six categories. These include 1) system topology such as conceptual models and network diagrams; 2) sequence and flow, for example basic flowcharts and activity diagrams; 3) hierarchy and classification, for instance organisation charts and classification hierarchy; 4) association diagrams including semantic networks and entity-relationship; 5) cause and effect diagrams such as fishbone diagrams and directed graphs; and 6) logic reasoning, examples of this type include Euler graphs and Venn diagrams.

A diagram can be sketched with a pencil on paper, drawn with a marker on whiteboard, drawn using a stylus or finger on a tablet computer, generated automatically using a computer program as output from a dataset, or drawn with a keyboard and mouse. The strength of a diagram is in its ability to abstract information and present only that which is deemed to be relevant to the task. “Diagrams are often used in collaboration, as a means of communicating information between people” (Purchase, 2014, p. 64).

This review illustrates that inscriptions are just as important to scientists as drawings are to designers. Inscriptions too represent things that are absent. Similar to designers, scientists draw in order to understand and find solutions to problems. Just like design drawings, inscriptions can be used to facilitate communication in teams. They are an important part of the conversation between scientists in laboratories. One of the important distinctions between design drawings and inscriptions, however, is that inscriptions include a wider range of visual formats in which text is considered just as important as the drawings of iconic elements. This is one of the reasons for labeling the
drawings (etc) created in this study as inscriptions rather than design drawings. In Part 3 of this thesis I will be referring to the ideas discussed in this review of the literature to explain my findings about the inscriptions created in this study.
Chapter Three: Gestures

The use of inscriptions is part of a multimodal system in which gestures also play an important role. Gesturing towards visual representations has been frequently observed in studies of science and mathematics (Roth, 2005; Roth & Tobin, 1997) and also in design (Visser & Maher, 2011). Accordingly, the analysis of gestures became an important part of this study.

Gesture as a Topic of Research

Gesture as a topic of research has been studied within the framework of many disciplines including linguistics, anthropology, cognitive psychology, sociology, communication studies, semiotics, informatics and more recently, human-computer interaction (Visser & Maher, 2011). In 2001 a new journal titled ‘Gesture’ was established by the International Society for Gesture Studies. It is the only scholarly association devoted to studies of gesture (Visser & Maher, 2011). The journal is aimed at drawing together gesture-related research from different domains. In its first editorial, the journal stated that “It is becoming clear that the analysis of gestural expression can tell us much about the way in which human cognition is anchored in how humans experience and deal with the physical environment in which they all live” (Kendon & Muller, 2001, p. 1).

Face-to-face communication is commonly multimodal, and gesture plays an important role. “Indeed, if gesture is ignored our understanding of human expression
will only ever be partial, at best” (Kendon & Muller, 2001, p. 6). In this research, gestures are studied as part of the larger social and material context within which they are enacted.

**What are Gestures?**

Gestures are normally defined as movements of the hands and arms during which the hands represent something other than themselves (McNeill, 1992). Not all movements of the hands are gestures and not all gestures are hand movements. Gestures can also be enacted by other parts of the body, such as indicating or pointing with one’s head (McNeill, 1992). Gestures form a visible interactional phenomenon and can be as important in communicating ideas as language use and inscriptions are. Gestures are “embodied in the sense that they involve actions of the body and perception of the body, and they are situated in the sense that they make use of the surrounding world to ground the communication” (Tversky, 2007). Speakers create gestures on the fly because they are not constrained by standards of linguistic forms as spoken language is (McNeill, 1992). Gestures convey fewer details than inscriptions, however such details can be unnecessary or distracting (Tversky, 2007). Unlike inscriptions, gestures are fleeting and leave no permanent trace.

Gestures synchronise with speech at points where both embody shared underlying meanings (McNeill, 2005). Although gestures and spoken language can often have identical meaning they can express this same meaning in very different ways. Gestures often produce images that cannot be expressed in words alone. Gestures
are dynamic and can convey meaning not present or expressed in other media, such as attributing motion or trajectories to static drawings, as will be described in this study.

Norris (2011) defines three hierarchical positions of gesture in relation to spoken words. The first type of relation is where gesture is sub-ordinate to spoken words. In this situation gesture builds up one system together with spoken words, but if the gesture is omitted it does not render the spoken words meaningless. For example, if a person is holding a painting and is looking at it while stating that she likes ‘this’ painting, it does not render the spoken words meaningless if she does not point to the painting as well. The second type of relationship is when gesture and spoken words are on equal level in the hierarchy. In this situation gesture is an important mode and may affect communication if omitted from the interaction. An example might be gesturing the movement or trajectory with hands. Norris describes this relationship through an event when a child was explaining to her how his toy machine worked. The child was stating “this little battery powers up this battery and this battery”. Norris states that in this type of situation we need to see the gestures, as well as the machine, in order to understand the utterance. The third type of relationship is when gesture is, what Norris specifies as, of hierarchically super-ordinate level to spoken words. In this situation the gesture alone can communicate the meaning without the need for spoken words. This last type of gesture was not encountered in this study.

The most widely known and referenced gesture classification system is that introduced by McNeill (1992). He classifies major gesture types into deictic, iconic, metaphoric, and beat gestures. He also defines gesture as passing through five phases - preparation, pre-stroke hold, the stroke itself, post-stroke hold, and retraction. Except for the stroke itself, the other phases are optional. The stroke of the gesture is the most
visible part of the gesture and it is mostly this part that is analysed and reported in this thesis.

In this thesis gestures are not analysed as self-contained individual sign systems but as part of the larger system of semiotic resources juxtaposed to mutually elaborate each other. As such, the focus of this study is to investigate the development and use of gestures as they are performed in relation to the inscriptions. According to this perspective, inscriptions are analysed not as self-contained standalone visual phenomena, but as an integrated set of actions and interactions encompassing the people and their use of tools and technologies using language, gestures and the inscriptions in the process.

**Types of Gestures**

**Deictic Gestures**

McNeill (1992) classifies pointing movements as deictic gestures. These gestures are often used with demonstrative pronouns such as *here, there, or this, that* and their plural forms. Demonstrative pronouns are incomplete without an associated demonstration (Kaplan, 1989). According to Kaplan (1989), the demonstration is typically a visual presentation of an object discriminated by a pointing gesture. In situations where linguistic rules determine the demonstrative pronouns’ referent a physical pointing or demonstration might not always be required. However, in some circumstances linguistic clues might not be sufficient to determine their referent. For example, when saying “I am here” one does not need to point to oneself or to the location, except for emphasis. However, when the intended location is different from
where the speaker is right now, saying “I will be here next week” will need further clarification, such as pointing to a city on the map. Furthermore, the use of demonstrative pronouns with or without an associated demonstration is dependent on the context. The contents of a demonstration can be determined when it is set in the context; such as pointing to some people and saying “these people”. Saying the same words and pointing to different people will change the contents.

The context is also important when demonstrative pronouns are used to refer to objects represented in an image, on a computer screen, or on paper. Pointing to an object in an image is different from pointing to other objects in the real world such as people, chairs, desks etc. This is because what is represented in the image might not actually exist, have never existed, and may never exist in the real world (Zeevat, 1999). Furthermore, an object, an action, or a phenomenon that exists in the real world can be represented with something entirely different in an image. An example would be representing choreography on paper. Context usually determines how the contents of an image are interpreted. For example pointing to a painting of Picasso and saying ‘this is Picasso’ does not mean the image illustrates Picasso himself. The speaker in such situations assumes that his/her audience and listeners know that Picasso is a painter and therefore will have the necessary context to interpret his/her utterance as intended.

Deictic gestures as such situate the knowledge in the world where it is used (Tversky et al., 2009). They draw attention to selective critical aspects of the message. According to Goodwin (2003), pointing gestures create a shared focus for the organisation of cognition and action. A range of semiotic resources coalesce to make the act of pointing meaningful; Goodwin describes it in the following way:
1) a body visibly performing an act of pointing; 2) talk which both elaborates and is elaborated by the act of pointing; 3) the properties of the space that is the target of the point; 4) the orientation of relevant participants toward both each other and the space that is the locus of the point; and 5) the larger activity within which the act of pointing is embedded. (Goodwin, 2003, p. 2)

As such, analysing pointing gestures requires taking a multimodal perspective to situate the gesture within a larger framework of action. Deictic gestures have been shown to allow scientists to orient each other to what is salient to one but not the other, or to coordinate talk about highly abstract concepts and visual displays simultaneously (Roth, 2001).

**Iconic and Metaphoric Gestures**

An iconic gesture has the closest relationship to the semantic contents of the speech. This means, “an iconic gesture displays, in its form and manner of execution, aspects of the same scene that speech also presents” (McNeill, 1992, p. 78). An iconic gesture and its accompanying speech present overlapping but different aspects of the same object or topic of discussion. This type of gesture is used when speech alone does not convey the same meaning or details. These gestures bear a perceptual relation with the concrete entities or events depicted (Roth & Lawless, 2002).

According to McNeill (1992), these gestures are like mind-reading, in that they can give us the closest look into what a person is thinking. This is because an iconic gesture has the ability to highlight the most important and relevant features of the context from the speaker’s point of view. An iconic gesture is formed by the speaker’s construction of meaning at the precise moment of speaking and almost always depicts a
concrete event or object. The stroke of the gesture often coincides with the part of the utterance that represents the same meaning. “Jointly, speech and gesture give a more complete insight into the speaker’s thinking” (McNeill, 1992, p. 13). When iconic gestures are occurring against the material setting, as with inscriptions in this study, they make salient particular aspects of the material world and therefore have deictic as well as iconic functions (Roth, 2003b).

Metaphoric gestures are similar to iconic gestures but the pictorial contents in these gestures present an abstract idea or concept rather than a concrete object or event as in the iconic gestures (McNeill, 1992). “In such gestures, abstract content is given form in the imagery of objects, space, movement, and so forth” (Roth & Lawless, 2002, p. 289). In other words, iconic and metaphoric gestures are similar on the surface and the difference is in their referent. Metaphoric gestures are useful for making salient features of an abstract concept that is not easily communicated in words, such as laws of physics of gravity for example.

**Using Gestures in Relation to Visual Representations**

In this study, gestures are regarded as a communication channel (Eris, Martelaro, & Badke-Schaub, 2014). As a communication channel, gestures are indispensable for conveying actions and processes; the types of information absent from most forms of visual representations such as diagrams, sketches and photographs (Tversky, Jamalian, Giardino, Kang, & Kessell, 2013).

In science classrooms, gesturing in the presence of visual and material objects can help students construct complex explanations while lowering the cognitive load
(Roth, 2001). This is because it allows students to distribute their communication and cognition across the material setting. The example from Norris (2011) earlier of a child explaining how his toy machine worked represents this type of distributed system where communication and cognition was distributed across the setting. As part of a distributed cognitive system, gestures have been found to add dynamic information, such as the trajectory of motion, to a static visual representation (Hutchins, 2006). Gestures are dynamic and so they are typically suited to communicating dynamic information (Kang, Tversky, & Black, 2012).

Roth and Lawless (2002) state that speakers generally use gestures in the presence of visual and material objects to support their thinking and understanding in transitional states. This may apply to learning situations in which students do not yet have linguistic competencies to express their understanding in progress, and they turn to gesture to express their grasp of the concepts discussed. In such situations, gestures are a medium on which language can piggy-back until speakers have developed better vocabulary for talking about new concepts (Roth & Welzel, 2001). Accordingly, it is important that the visual and material objects, against which gestures make salient features to be discussed, should be present in order to be indexed. “These materials should not just be present in the room, but available directly to the person currently attempting to construct an explanation” (Roth & Welzel, 2001, p. 20). Proximity to visual representation seems to aid the construction of more complex and better quality concepts and explanations.

The advantages of using gestures in the presence of material and visual artefacts is that each mode will assume part of the representation so that the speaker will have
time to develop new competencies and the associated verbal descriptions. Roth and Lawless (2002) state that:

Gestures are enacted against a perceptual ground, from which, as part of the function of gestures, certain features become salient. Consequently, because they are salient, they do not need to be talked about. This, then, frees up resources in the production of speech which, in some theories, taxes the short-term memory required for word search and assembly of sentences. (Roth & Lawless, 2002, p. 299)

**Gestures in Design**

The study of gesture has only recently become a topic of research in design. The main motivation for this has been the development of environments that can support remote collaborative design activities. In 2011 a special issue of the journal ‘*Artificial Intelligence for Engineering Design, Analysis and Manufacturing*’ (Visser & Maher, 2011) was dedicated to the role of gesture in designing. However, the issue only included three papers (Donovan, Heinemann, Matthews, & Buur, 2011; Herold & Stahovich, 2011; van den Hoven & Mazalek, 2011) and this is a testament to the scarcity of gesture studies in design. Of these papers, the study most relevant to this thesis was by Donovan and colleagues (2011), who conducted an ethnomethodological study of pointing or deictic gestures. They concluded that pointing gestures are more than just attracting attention to a referent and can also solve or prevent problems of intersubjectivity, such as misunderstandings and disagreements.
Other research relating to the use of gestures in design includes an earlier study by Bekker, Olson, and Olson (1995), which investigated the role of gestures in face-to-face design activities in order to provide guidance for the development of remote collaborative design tools. The authors concluded that: gestures in design are often brief and can be missed if outside the fields of view; gestures are synchronised with words; they often occur in sequences; they are often interleaved with drawing activities; gestures may have complex trajectories; gestures can refer to imaginary objects; and, gestures can refer to gestures enacted in the past. More recently, Visser has been one of the proponents of this area and has produced a number of papers that looked into the function and form of gestures in design (Visser, 2009, 2010). In the paper published in 2009, Visser distinguished between different families of gesture. She categorised these gestures as representational, organisational, focalising, discourse and interaction modulating, and disambiguating gestures. She identified representational and organisational gestures as corresponding to design activities more than the other gestures. In the 2010 paper, Visser examined the relationship between the form and function of gestures. She concluded that this relationship is complex and that a gesture with a particular function could take various forms and similarly a particular gesture movement could fulfil different functions.

**Gestures and Design Sketching**

Studies that investigate the interrelation of design sketches and gestures are rare in design. Most studies initially focus on investigating the drawing practices of designers but soon notice the vital function of gestures in this process, one example of this is Stubbs (2006). He stated that educational designers sometimes use gestures as
substitutes for drawings. He referred to these gestures as “gestured drawings”.

Similarly, an early study by Bly (1988) initially investigated the use of drawing surfaces but soon included the analysis of gestures as a form of actions specifically related to the use of the drawings. Only those gestures enacted towards an existing drawing were included in the analysis. The study found that the process of drawing is as important to design as the drawings themselves and a significant portion of the actions analysed were gestural actions. A major limitation of this study was that a single two-person design team, one of whom was the researcher, was studied in three different settings. Another study in the same year by Tang and Leifer (1988) investigated the drawing and gestural activities of small groups of designers working face-to-face on the design of an interface for a smart appliance. This was an ethnomethodological study that explored the process of drawing using pen and paper and concluded that if the drawings were analysed as artefacts then the findings would overlook the important role of gestures. A limitation of this study was that the researchers mainly analysed the drawing and gestural activities in isolation and only referred to the accompanying talk in order to understand some events and actions.

More recently Tholander, Karlsgren, Ramberg and Sokjer (2008) conducted an ethnomethodological study of sketching as an embodied practice in interaction design. The authors investigated the process of drawing by two designers using a whiteboard and noticed that the sketching activity of the designers was highly complex and needed an analysis of other communicative modes such as gestures, gaze, and body position in relation to the drawings. The authors concluded that “The sketches were in many ways specified and conceptualized through gestures and bodily action. Taken out of the context of the designers’ talk and action, the sketches provided only a limited account
of the system being designed” (Tholander et al., 2008, p. 552). The designers used gestures to simulate interaction with the system. They used deictic gestures to specify a section of the drawing and also symbolic gestures such as ‘clicking’ in the air to show how the user would interact with the system. Furthermore, the designers added dynamic information to the static drawings through gestures such as the actions that the users would perform with the system.

**Gestures as Cognitive Artefacts**

McNeill (1992) talks about how some iconic and metaphoric gestures serve to tie together thematically related, but temporally separated, parts of the discourse. He calls these repeated gestures *cohesives*. Cohesive gestures emphasise continuities in that the reoccurrence of the gesture shows continuation of a theme. The cohesion of the gesture depends on “repeating the same gesture form, movement, or locus in the gesture space: the repetition is what signals the continuity” (McNeill, 1992, p. 16). The repeated cohesive gesture becomes a ‘local semiotic resource’ for talking about certain concepts developed during face-to-face interaction (Koschmann & LeBaron, 2002). The repetition forms a mechanism for establishing links across turns at talk. According to Roth (2001), gestures are like glue that binds together layers of perceptually accessible entities and abstract concepts. Becvar, Hollan, and Hutchins (2008) state that certain repeated gestures serve as cognitive artefacts. These repeated gestures are essential resources for shaping theoretical understandings when used in face-to-face collaborative activities. They can serve as cognitive artefacts when they are used to support thinking, communication and collaboration in the process of concept
development in groups. These gestures operate as instantiations of essential spatio-
dynamic features that are not efficiently conveyed by language and graphical
representations (Becvar et al., 2008). Becvar and colleagues (2008) observed how
biochemists created, shared and reused certain gestures during laboratory meetings,
scientific conferences, and interviews with the researchers. A single gesture was
developed as a meaningful and conceptually useful representation by the scientists. The
gesture packaged theoretical inferences into a single semiotic form which was then
used by the scientists to evoke a rich shared conceptual history. The authors also report
on the stability of the gesture as a meaningful and conceptually useful representation
when it was re-used around six months after it was first conceived. The formulation of
this shared system of representation was seen as a powerful process by the researchers
who observed how it allowed the scientists to reinvoke shared knowledge and
experiences in support of their theoretical inferences. Gestures thus can be built upon,
and referred back to, as shared cognitive artefacts. In another example, Nomura and
Hutchins (2007) demonstrate how trainee pilots reused gestures enacted by flight
instructors to show that they had understood the instructions. The authors concluded
that the reuse of the gesture as a semiotic resource was an indicator of successful
accomplishment of common ground understanding.

This review was aimed at introducing the role of gesture in the creation and use
of visual representations. Gestures are used in relation to inscriptions to facilitate
communication in teams, support thinking and reduce cognitive load. An interesting
finding of this review was that the study of gestures in most studies of design process
was unintended. The researchers often started to study some form of drawing and
sketching practices of the designers but soon noticed the vital role played by gestures in
the design process. Although gestures themselves are fleeting, some repeated gestures can become cognitive artefacts in teams where the enactment of the gesture can invoke rich conceptual history which can then support communication at a higher conceptual level.

**Drawing and Gesture from the Perspective of Design Anthropology**

I find it interesting to think about drawing from various perspectives. One that I find relevant in relation to this thesis is how design anthropologists describe drawing. Tim Ingold, a design anthropologist, sees no clear points of demarcation between drawing and hand writing (Ingold, 2011). He gives an example of medieval writers who did not subscribe to the modern ontological distinction between words and pictures. To these writers words and pictures were equal. Both could tell a story and none was less valued than the other. The distinction between hand writing and drawing diminishes further when we realise that most letters in the alphabet evolved from drawings. For example, the letter ‘A’ was originally a drawing of an ox-head (Ingold, 2011). It was a representation of an object and it evolved to represent itself, a sound. Ingold (2011) considers drawing to be the trace of a gesture: the mark that gesture leaves behind. This is an interesting view on both drawing and gesture. According to this, we can say that there is a close relationship between gestures and drawing that is more than gestures making salient aspects of drawings. Drawing grows as a tree with its branches spreading organically. It has no beginning and end point and is always a work in progress.
The review of the literature in this part of the thesis illustrates that drawing and sketching are important for both designers and scientists. They are an aid to the thinking process; in order to explore and evaluate ideas, discover new things, understand problems and find solutions, and facilitate communication between team members. The review also exposed gestures as an important element in the design discourse. As a result of this review, the drawings and sketches produced by the participants in this study are described as inscriptions and these inscriptions are analysed as part of the larger system of semiotic resources, including gestures and other non-verbal communication. The methods for how these inscriptions and gestures are analysed are explained next.
Part 2 – Method

This part of the thesis is presented in three chapters. Chapter Four is a discussion of the theoretical framing of this study as well as the methodological and analytical approaches undertaken. Chapter Five is the research design. This is where the participants, the research environment, data collection and data processing procedures are introduced. Chapter Six explains the procedures I followed for analysing the data in this study.
Chapter Four: Theoretical and Methodological Approach

In this chapter I first define how I see the design activity in the context of this study. I then introduce Applied Ethnomethodology as the methodological approach I draw on. At this point I will briefly illustrate, through a review of some literature, how ethnomethodology can be, and has been, used to study similar research phenomena; visual representations and face-to-face design work. Following this, I will explain how I draw on Multimodal Interaction Analysis to study complex face-to-face design activity.

Theoretical Framing

What Kind of Activity is Design?

In this study, I have adopted Goodyear’s (2005) definition of educational design. Educational design is “the set of practices involved in constructing representations of how to support learning in particular cases” (Goodyear, 2005, p. 82). These representations are goal oriented. They are built in order to make things visible so they can be seen, talked about and manipulated (Visser, 2006). It is to some extent a similar position to that of Schön and Wiggins (1992) who believe that design is a reflective conversation with materials, which is conducted in the medium of drawing, and is consequentially crucially dependent on seeing. Furthermore, in this study I take the perspective that design is a social activity in which ideas are communicated and negotiated until an agreement is reached (Bucciarelli, 1988). It follows a process in
which the problem-space and solution-space co-evolve together (Dorst, 2003): both the formulation of the problem and the ideas for a solution are refined together in an iterative process.

*The Distributed Cognition Perspective*

In collaborative design, interaction may take different forms such as linguistic, graphical, or gestural. These are not the simple expression or transmission of ideas previously developed in an internal medium (Visser, 2006), but instead, collaborative design involves adjustment and integration of collective ideas. Groups of designers working towards a common goal apply their unique individual perspectives using tools and resources, and they need to have some common ground in order to reach a shared design decision. Various terms are used for describing this phenomena, including shared cognition, collective cognition, team knowledge, team mental models, and more (Cannon-Bowers & Salas, 2001).

The perspective I take in this thesis is ‘distributed cognition’, which is not a kind of cognition but a perspective on cognition. “It assumes that cognitive processes are always distributed in some way” (Hutchins, 2006, p. 376). According to this perspective, a group of people working together is seen as a distributed cognitive system in which cognition is distributed across brains, bodies, and a culturally constituted world. This distribution is always mediated by human interaction and human interaction is deeply multimodal. “In such systems the correct unit of analysis is not one brain or even one semiotic modality, such as speech or gesture taken in isolation, but the entire system” (Hutchins, 2006, p. 390). The emergent properties of such a system cannot be partitioned into certain percentages belonging to brain, body,
or the world. Multiple representations such as talk, gesture, and drawings are together more stable than any single representation alone. Furthermore, the distribution of cognition across different modalities facilitates better communication by reducing the cognitive load associated with the production of speech (Roth, 2003b).

Internal processes of the designer can sometimes be inferred from the observable pattern of behaviour. As Hutchins (2006) states, “in some activity settings, acting in the world is thinking” (p. 391, emphasis in original). According to this view, studying the artefacts that designers create spontaneously in order to support their design activity can be a window into their cognitive and collaborative processes (Carroll, Borge, & Shih, 2013). A study of visual design artefacts is thus worth considering as a starting point when developing digital tools to support the activities of educational designers.

**Methodological Approach**

In this study, I take a specific methodological stance, defined by Heap (1990) as Applied Ethnomethodology (AEM) and informed by the work of Harold Garfinkel (1967). Heap describes applied ethnomethodology as “the study of the local rationality of members' practices of reasoning and activity organization” (Heap, 1990, p. 46). AEM aims to identify practices that may impact decision making, particularly focusing on the continuation and/or modification of some specific practices. The main point of doing AEM is to uncover functions facilitated by practices that are unnoticed, unrecognised, or unappreciated by the members of a community. In other words, “Applied ethnomethodology is ethnomethodology which can make a difference to members” (Heap, 1990, p. 47).
The results from AEM studies are often reported to an audience who are perhaps only distantly acquainted with ethnomethodology (EM). Such studies explicate unnoticed or unappreciated practices to an audience of ‘lay ethnomethodologists’ (Heap, 1990). AEM is intended for ultimate applicability. It is expected to render certain actions visible. The hope is to explicate these unrecognised practices as important, worth knowing, writing, and reading about in order to bring into reflection reasons for doing certain activities. AEM proposes that certain practices, such as those studied in this thesis, are important because they can make a difference to how participants live and work.

AEM assumes a phenomenological perspective by asking what certain actions in a situation mean to actors, rather than what those actions mean to the analyst, which is an objectivist perspective. For example, Heap (1990) writes about a situation where a student is reading in a classroom and the other students and the teacher are listening. An objectivist perspective would look for what errors the student makes as s/he reads, whereas the phenomenological perspective might look for what constitutes an error by analysing the reactions of both the teacher and other students to errors. These reactions indicate what counts as an error from the point of view of those present and listening. “Under this perspective, error is not a context-free event, a thing in itself, but an event made public as an error by someone's reaction to it, in some context” (Heap, 1990, p. 59, emphasis in original).

Ethnomethodology provides the analytical orientation to case studies; it connects all the details of activities conducted by the participants studied in a case study (Aggestam, 2010). Another method that is has been widely used in the study of design activities is protocol analysis (Jiang & Yen, 2009). However, one of the criticisms of
this method is that it uses verbal introspective think-aloud and retrospective reflections and interviews as its main type of data. The problem is that these types of data are focused on an individual designer working alone rather than group situations (Jiang & Yen, 2009). They do not take into account the fact that the majority of design work happens in teams. I have opted for an ethnomethodological approach because in this perspective words gain meaning in the context, which also includes non-verbal phenomena such as gestures, posture, facial expressions, etc.

Ethnomethodology and the Study of Visual Representations

According to Goodwin (2000), ethnomethodology (EM) can be applied to the analysis of visual representations in a distinctive way where “neither vision, nor the images or other phenomena that participants look at, are treated as coherent, self-contained domains that can be subjected to analysis in their own terms” (Goodwin, 2000, p. 1). Instead, Goodwin argues, visual phenomena can only be investigated by taking into account the diverse set of semiotic resources including talk, gesture and body movement, which participants use to communicate and build their social world. Although talk is not in any sense visual, Goodwin states, the visible phenomena that the participants are attending to cannot be properly analysed without it. Thus, the focus of the analysis in this study is not on the visual representations in isolation, but on the part played by the visual representations in the development of the design concept by the participants. According to Goodwin, EM emphasises the importance of “focusing not on representations or other visual phenomena as self-contained entities in their own right, but instead on how they are constructed, attended to, and used by participants as components of the endogenous activities that make up the lifeworld of a setting”
(Goodwin, 2000, p. 8). The focus of investigation in this study therefore is not just the visual practices, such as drawing, gesturing towards and using the inscriptions, but also on the details of talk and language use in the context of developing a design concept.

**Ethnomethodologically Inspired Studies of Design Work**

The majority of non-verbal design work happens in teams. This has prompted a recent move towards trying to understand design as it happens. Button (2012) expects ethnomethodology (EM) to provide this new direction for studying design by building in “the human perspective” and looking deeper into the social practices of design work (Button, 2012, p. 681). In his view, EM is a ubiquitous methodology that can be used for the analysis of the practices that people display and make visible as they go about accomplishing their actions and interactions.

In 2012 a special issue of the journal *Design Studies* titled ‘Studying Design in Practice’ was dedicated to reporting research on how ethnomethodology and Conversation Analysis (CA) could complement each other to illuminate the ‘social’ aspects of design work (Luck, 2012a). The focus of the studies in this collection (Ikeya, Luck, & Randall, 2012; Luck, 2012b; Martin, 2012; Murphy, Ivarsson, & Lymer, 2012; Oak, 2012) was on investigating what is evident in what the participants in a design meeting say and do. These studies reported how designers perform some of the mundane activities of design during situated interactions. For example, how design students in conversation with occupational therapy students discussed and designed a piece of furniture that could be used by both able-bodied and disabled persons (Oak, 2012). How graphic designers organised their work and how they relied on resources to make decisions and evaluate the emerging design of packaging for foodstuff (Martin,
2012). The researchers in these ethnomethodological studies looked for things like the ways that actions are seen and acknowledged by participants in a design meeting (Luck, 2012b); how designers relied on visual resources such as a whiteboard (Ikeya et al., 2012); and how reasoning practices in design draw on a range of different semiotic resources such as talk, gesture, and drawings (Murphy et al., 2012).

This short review illustrates that ethnomethodology can deepen our understanding of the nuances of collaborative face-to-face design activity. By focusing on the work of design as social interaction, this thesis aims to understand educational designers’ drawing and sketching activities with a view to identifying implications for design and development of supporting tools.

**Analytical Approach**

Applied Ethnomethodology can be used together with Multimodal Interaction Analysis (MIA) to investigate and analyse diverse phenomena such as talk, gesture, and drawing actions. This combination provides a coherent analytical framework to investigate the inscription-related practices of educational designers in this study. Multimodal Interaction Analysis (MIA) takes the action rather than utterance as the unit of analysis (Norris, 2004). MIA is derived from mediated discourse analysis which has a focus on understanding “how the broad discourses of our social life are engaged (or not) in the moment-by-moment social actions of social actors in real time activity” (Scollon, 2001, p. 140).

According to Norris (2004), all interactions are multimodal. Movements, noises and material objects when perceived by an individual convey interactional meaning.
Modes of communication may be structured or they may appear random. Communicative modes may possess audible and visible materiality. The visible materiality can be fleeting or enduring. Actions can be entailed in material objects, such as in drawings. These are what Norris calls frozen actions. Norris (2002) believes that it is important to look at “interaction from the point of view of actions that carry communicative meaning, rather than viewing communication as primarily verbal” (p. 118). People utilise different communicative modes when interacting. They might be using spoken language but also move their heads, bodies, hands and arms or material objects to communicate. There might also be an array of communicative modes that may come into play from time to time in different contexts and circumstances. These for example may include facial expressions, colour or even a type of dress (Norris, 2004).

In MIA participants might be aware of something to various degrees. For example, a person might be aware of something without explicitly paying attention to it. Norris (2004) explains how levels of attention can be distinguished by placing them on a foreground to background continuum. According to this view, when a person is directly interacting with an entity she is placing this entity in the foreground of the attention level. If, on the other hand, a person is not interacting directly with an entity but the entity is part of the larger context then that entity is placed on the background of the attention level. The foreground-background of attention level will be further explained in relation to the inscriptions in Part 3.
Multimodal Interaction Analysis and the Study of Visual Representations

MIA is particularly useful for studying visual phenomena, since, in visual communication, a person often employs certain modes of communicative practices (Snyder, 2012b). Creating and attending to visual marks, images, sketches and drawings embody a particular type of communicative practice that requires a multimodal analytic framework. Research using MIA to study visual phenomena is relatively new. Snyder (2012a, 2012b, 2013, 2014) has investigated how multimodal interaction analysis techniques enable the researcher to explore the role of drawing in face-to-face conversation. She considers the process of drawing as a form of social interaction in face-to-face conversations and states that “mark making is akin to an utterance” (Snyder, 2012a, p. 10). She advises that the creation of visual marks is to be studied in the context of the broader communicative practices. This is precisely the direction this thesis has followed.
Chapter Five: Research Design

In this chapter first, I will introduce the research environment where the design meetings took place. These design sessions provided all the data gathered for the analysis in this thesis. The data collection and data processing procedures will also be explained. Following this, I will present the two case studies, introducing the participants in these meetings, and the design tasks they were working on.

Context of Research

I am a member of a research group working on a project titled “Learning, Technology and Design: Architectures for Productive Networked Learning”. This five-year project is led by The Australian Research Council’s Laureate Fellow Professor Peter Goodyear at The University of Sydney. One of the aims of the project is to understand how groups of designers create new learning opportunities, with a particular focus on how they use tools, methods and environments. As part of the project, a new space for educational design was created.

The Design Studio as the Research Environment

The Educational Design Research Studio (Design Studio for short) was created to help researchers’ investigation of how small groups of people work on existing and new educational design problems. The studio contains various special features to augment designers’ collaborative design work (see Appendix One), including movable furniture such as chairs, desk and a sofa. Designers also have access to a number of
drawing and sketching tools such as drawing pens, pencils, markers, large sheets of paper and more. The central meeting table can be expanded to provide more working space. Furthermore, the table can be covered in drawing paper to provide a collaborative quick-sketching or communication space close at hand. Other special features, particularly important for this study, are two writable walls entirely covered with whiteboard paint. Hence, the designers can draw or write on any part of the two walls without restrictions.

The Design Studio is also equipped with an Interactive Whiteboard and two projectors facing two of the studio walls. The two projectors use the whiteboard walls as projection surfaces. In addition, the designers have access to three Apple iPads in the studio, which can be projected on the whiteboard walls. Designers working in the room have free access to wireless Internet.

For research purposes, the Design Studio is equipped with audio and video recording facilities that can capture designers’ verbal utterances as well as non-verbal design discourse such as gestures, facial expressions, and drawing activities. In addition, high resolution images are taken of selected writable surfaces at a predetermined time interval (e.g. between one and ten seconds). Screen capture records Internet and digital device usage. A map of the Design Studio is provided in Appendix One. I will be referring to features of the Design Studio depicted on this map throughout the thesis.

**Data Collection**

Data was collected in the Design Studio using three high-definition video cameras mounted on the ceiling, capturing video recordings of the studio from three
different viewpoints. There were also four still-image cameras that captured time-lapse photos of the whiteboard walls, providing detailed pictures of any drawings created by participants. In addition, data collection included screen capture of the digital devices, including the interactive whiteboard and the two computer screens projected on the walls. Each participant was provided with a personal voice-recording device that captured their conversation with their other team members. Further data included digital and physical artefacts created by the participants during the design sessions. The digital artefacts included computer files and documents, as well as digital images of inscriptions created on the writeable walls, while the physical artefacts included paper-based notes and drawings created on large sheets of paper. In addition, data analysed included verbatim transcripts of each design session. The verbatim transcripts were created by an external professional transcription service.

**Data Processing**

All data recorded in the Design Studio was streamed into a purpose-built tool named ‘D3 Data Viewing Software’. This tool facilitates the simultaneous viewing of synchronised recordings from all the cameras, including the time-lapse images of the walls. The tool enables the researcher to select any camera view without interrupting the flow of the video or the sound. The researcher can also select to listen to individual participants separately or all participants at once. This tool made it easier to analyse subtle communicative channels such as the fleeting gestures in this study. A screenshot of the D3 tool is provided in Appendix Two.
Study Design

Since the creation of the Design Studio, we have conducted several experiments in design for learning (Thompson, Ashe, Carvalho, et al., 2013; Thompson, Ashe, Yeoman, & Parisio, 2013). During these experiments we have asked groups of participants to complete design tasks and activities, while providing them with specific tools and support systems. Different members of the project team then analyse the data using different perspectives and methods. The aim of this practice is to develop a richer understanding of multiple factors in the design sessions. A second strand of studies conducted in the Design Studio is less experimental. This involves the study of groups of people who are involved in real-world design projects (Thompson, Ashe, Wardak, Yeoman, & Parisio, 2013). Groups of students who were working on design projects for school work as well as professional designers have been invited to use the Design Studio to work on their own design projects using the tools and equipment available in the studio. We do not assign design tasks to these groups but we record their design meetings in the studio. The data from these meetings is also then analysed by several members of the project using different methodological and analytical perspectives.

In this thesis, I have selected two sets of data recorded in the Design Studio. I investigate the practice of drawing and sketching in ED through two exploratory case studies. An exploratory case study is often applied to investigate specific phenomena where detailed preliminary research is needed (Yin, 2013). A summary of the two case studies is presented in Table 1.
Table 1- *Overview of the Case Studies*

<table>
<thead>
<tr>
<th>Case ID</th>
<th>Study-A</th>
<th>Study-B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Groups</strong></td>
<td>Group 1</td>
<td>Started as one team and then separates into three groups.</td>
</tr>
<tr>
<td></td>
<td>Group 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group 3</td>
<td>Towards the end the groups came back together as a team.</td>
</tr>
<tr>
<td><strong>Number of meetings</strong></td>
<td>3 (one meeting for each group)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Duration of meeting</strong></td>
<td>90 minutes for each group</td>
<td>167 minutes</td>
</tr>
<tr>
<td><strong>Date meeting recorded</strong></td>
<td>Group 3: 30/01/2013</td>
<td>26/07/2013</td>
</tr>
<tr>
<td></td>
<td>Groups 1 &amp; 2: 31/01/2013</td>
<td></td>
</tr>
<tr>
<td><strong>Number of participants</strong></td>
<td>9 (3 participants in each group)</td>
<td>13 participants</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>The Design Studio</td>
<td>The Design Studio</td>
</tr>
<tr>
<td><strong>Task</strong></td>
<td>Assigned by the researchers</td>
<td>Real-world project</td>
</tr>
<tr>
<td><strong>Experimental aspects</strong></td>
<td>The task</td>
<td>The environment</td>
</tr>
<tr>
<td></td>
<td>The environment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grouping</td>
<td></td>
</tr>
</tbody>
</table>

*Study-A Groups*

Study-A groups were part of an experiment in which we asked three groups of Education postgraduate students to discuss the design of an educational resource about a socio-environmental issue. The aim was to apply a synthesis approach, focusing on the understanding of the role of scaffolding in a design task.

*Study-A Task*

Study-A was more experimental, where we selected the participants, provided them with a design task, and gave them different scaffolds. We gave the same task to
three groups of participants, each with a different scaffold. The general task was to
design an educational blog about the Murray Darling Basin, which is an important
water system in Australia. Each group of participants was given 90 minutes to produce
a design concept and a preliminary sketch for the blog. Each group was provided with a
set of tailored materials intended as scaffolds for different conditions. The rationale for
providing different scaffolds was to apply a synthesis approach and explore the
interplay of social interaction, tool use and the design process, which was the focus of
another study we conducted in the Design Studio (Thompson, Ashe, Wardak, Yeoman
& Parisio, 2013).

We asked the participants in Group 1 to assume a specific role in the group. The
roles they were required to assume included a designer, a member of the target
audience, and subject matter expert. We gave Group 2 information on the stages of the
design process. These included prompts such as ways of understanding the design
problem, developing a plan and the design concept, and general strategies to deal with
their specific design issues. We provided Study-A Group 3 with suggestions about how
to use the tools available to them in the Design Studio. A copy of the scaffolding
materials provided to these groups is included in Appendix Three.

The task given to the participants was not imaginary in the sense that The Murray
Darling Basin is a real place in Australia with real environmental issues. This attaches a
different value to the task. We noticed that during the meetings some of the participants
discussed stories about friends living and farming in the area and how they were coping
with the environmental issues.
Study-A Participants

Study-A included nine participants in three separate group meetings. Group 1 and Group 3 consisted of two female participants and one male participant while Group 2 consisted of two male participants and one female participant. All of the participants were doctoral students in various stages of their candidature conducting research in an area related to the Learning Sciences. The study design required that the participants have some forms of background experience in education, technology use and design, hence the selection of doctoral students. They came from diverse backgrounds such as eLearning management and design, health sciences, software engineering, computer science, business, and politics. An overview of the participants and their backgrounds is provided in Table 2.

Table 2- Study-A Participants

<table>
<thead>
<tr>
<th>Group</th>
<th>Pseudonym</th>
<th>Gender</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Judy</td>
<td>Female</td>
<td>Health sciences</td>
</tr>
<tr>
<td></td>
<td>Grant</td>
<td>Male</td>
<td>Engineering/computer science</td>
</tr>
<tr>
<td></td>
<td>Natasha</td>
<td>Female</td>
<td>Business</td>
</tr>
<tr>
<td>Group 2</td>
<td>Meg</td>
<td>Female</td>
<td>Health sciences</td>
</tr>
<tr>
<td></td>
<td>Angus</td>
<td>Male</td>
<td>Educational design</td>
</tr>
<tr>
<td></td>
<td>Dom</td>
<td>Male</td>
<td>eLearning design</td>
</tr>
<tr>
<td>Group 3</td>
<td>Taryn</td>
<td>Female</td>
<td>Politics, Philosophy, Economics and Law</td>
</tr>
<tr>
<td></td>
<td>Darren</td>
<td>Male</td>
<td>eLearning management</td>
</tr>
<tr>
<td></td>
<td>Julia</td>
<td>Female</td>
<td>Software engineering</td>
</tr>
</tbody>
</table>

Study-B Team

For the second case study, I selected a recording of a design meeting in which thirteen participants worked on the design of an educational game. This design session
was part of a real-world project to create a game to teach school-age children about environmental issues such as the sustainable use of resources.

The game in Study-B is a touch-based environment intended for phone and tablet experience targeting children between the ages of seven to eleven years. The player in the game needs to take care of a family of polar bears living in a glacier environment. The players interact with the bears and keep them healthy by cleaning and feeding them. The bears also need their environment to be maintained clean and healthy. This means that if the ice melts the bears are not happy. In order to maintain the environment at the healthy level the players have an opportunity to play mini-games, which are accessed from inside the main game. These games allow the players to engage in real-life activities that would keep the environment healthy. These activities include things like switching off light bulbs, planting trees and more. The players are able to add these real-world activities to their game profile and earn eco points. The game also has a social component to it. The players are able to connect with other players and see their progress in the game.

**Study-B Task**

Study-B team meeting recording was 167 minutes long. Unlike the groups in Study-A, this was not the first meeting of the team, and some of the decisions for the Study-B game had already been made in previous meetings. However, the team was still in the early conceptual design phase where they were gathering and evaluating ideas for the design of the game. This meeting observed in the Design Studio was just one of the many meetings that various members of the team attended during the process of designing and developing the game. The team meeting was organised and run by
Malcolm, Jarrod and Kassidy. They had a plan to separate the team members into three groups, each looking at one aspect of the game design, in order to gather as many ideas as possible. This meeting was similar to a brainstorming session because several members of the team were just contributors of ideas and were not regularly part of the project’s team meetings. This was an opportunity to bring all the contributors together and accumulate a list of ideas for further development of the game.

When the team separated into three groups Malcolm assumed the leadership in Group 1, Jarrod in Group 2, and Kassidy in Group 3. Group 1 was investigating the types of data that could be collected from the game players, how the data could be collected, and how it could be communicated to the server. Group 2 was gathering ideas related to the interface design. They were looking into how the game player would enter and move around the game in terms of accessing the many features and executing actions. The participants in Group 3 were gathering ideas for a marketing plan for the game.

Study-B Participants

The participants in Study-B were part of an existing design team working on the design of an educational game. We asked the team to conduct one of their meetings in the Design Studio and acquired their permission to use the recording of their design meeting for our research. Copies of the participant information sheet and consent forms are available in Appendix Five.

Study-B team included thirteen participants. The team separated into three groups during the meeting. Group 1 consisted of four male participants. Group 2 included four male and one female participant and Group 3 comprised of two male and two female
participants. The participants in Study-B team held particular positions in the project which included lead project developer, project manager, creative director, software designer, interface designer, composition and music designer, graphic designer, writer, community builder and marketing strategy specialist. An overview of the Study-B team participants and their roles in the project is provided in Table 3.

Table 3- Study-B Participants

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Pseudonym</th>
<th>Gender</th>
<th>Backgrounds/Roles in the team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idris</td>
<td>Male</td>
<td>Lead Developer – Back end</td>
<td></td>
</tr>
<tr>
<td>Malcolm</td>
<td>Male</td>
<td>Project Manager</td>
<td></td>
</tr>
<tr>
<td>Calvin</td>
<td>Male</td>
<td>University researcher - Algorithms for behaviours</td>
<td></td>
</tr>
<tr>
<td>Jareth</td>
<td>Male</td>
<td>University researcher - Algorithms for behaviours</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
<th>Pseudonym</th>
<th>Gender</th>
<th>Backgrounds/Roles in the team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jarrod</td>
<td>Male</td>
<td>Creative Director/Designer</td>
<td></td>
</tr>
<tr>
<td>Gino</td>
<td>Male</td>
<td>3D Designer</td>
<td></td>
</tr>
<tr>
<td>Bart</td>
<td>Male</td>
<td>Lead Developer – User interface</td>
<td></td>
</tr>
<tr>
<td>Galileo</td>
<td>Male</td>
<td>Composition and music design</td>
<td></td>
</tr>
<tr>
<td>Shima</td>
<td>Female</td>
<td>Graphics</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 3</th>
<th>Pseudonym</th>
<th>Gender</th>
<th>Backgrounds/Roles in the team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neville</td>
<td>Male</td>
<td>Community Builder</td>
<td></td>
</tr>
<tr>
<td>Kassidy</td>
<td>Female</td>
<td>Producer</td>
<td></td>
</tr>
<tr>
<td>Ghita</td>
<td>Female</td>
<td>Writer</td>
<td></td>
</tr>
<tr>
<td>Tory</td>
<td>Male</td>
<td>Marketing Strategy</td>
<td></td>
</tr>
</tbody>
</table>

Cash, Hicks, and Culley (2013) have reported that most studies of design are either controlled experiments in the laboratory or observation of real-world practice. The authors suggest that results from laboratory studies often give genuine insight into design practice. The two case studies selected for this thesis represent a similar variation of these two types of studies. By selecting these two case studies I was able to analyse the drawing practices of designers both in naturalistic design where the task is
authentic (and part of the designers’ daily activities) and experimental design where the task is suggested and is not part of the designers’ daily activities.

Neither Study-A nor Study-B follows an experimental design. Nevertheless, the design of Study-A is more experimentally controlled, as participants are given three different types of scaffold and a specific task, which they need to finish in a set time. Study-B, on the other hand, is closer to a naturalistic study, where only the environment is part of the experimental aspect. Participants in Study-B use the Design Studio as one of the spaces where they interact about the design of the game. Therefore, while Study-A offers opportunities for analysing designers’ interactions in an entire conceptual phase, (starting from scratch and finishing with a proposed idea), Study-B consists of a snapshot of a conceptual process. Participants in Study-B have already exchanged views in previous meetings, outside the Design Studio, and they are expected to continue with design discussions, after their session in the Design Studio. This session was only one of several meetings for the designers involved in Study-B.
Chapter Six: Analysis of the Data

In this chapter I will describe how I approached the analysis of the data selected for this thesis. I will explain in detail the three stages of the review process I used for the analysis and how the different modalities were selected and analysed. I will also illustrate how I transcribed non-verbal interaction in selected events. Towards the end of this chapter, I will explain how I ensured that this approach met the appropriate standards of rigour for qualitative research.

The Process of Analysis

The process of analysis in this study was inspired by several approaches to ethnomethodological research and the study of multimodal interactions. Although no analysis process was followed exclusively, inspiration and general guidance were sought from related fields such as Conversation Analysis (CA) (Sacks, Schegloff, & Jefferson, 1974), Critical Discourse Analysis (Fairclough, 1995), Interaction Analysis (IA) (Jordan & Henderson, 1995), and Multimodal Interaction Analysis (MIA) (Norris, 2004). The analysis followed the iterative process for reviewing the video recordings recommended by Hindmarsh, Luff, and Heath (2010), which consists of a three stage approach involving preliminary review, substantive review, and analytic review. This process was mostly refined during the analysis of the data from a pilot study. For the pilot study I recorded two meetings in the Design Studio in which the participants were discussing the re-design of a unit of study for a Masters program. There were two
participants in the first meeting and three in the second meeting. I did not assign the task for these meetings; it was part of the participants’ real-world professional activity. The participants mostly used large sheets of paper for their drawings.

**Preliminary Review**

During the preliminary review, basic aspects of the activities of the designers were catalogued and content logs were created in the accompanying transcripts, which were uploaded to the research analysis software NVivo. These consisted of descriptive markers that helped organise and provide a visible structure to the transcripts. For example, I identified and used short sentences to describe types of events and when they occurred, such as a new inscription was begun, an inscription was finished, or the information contained in the inscriptions began to be transferred into a Word document, and other similar activities. Content logs provided a quick overview of the large data sets and helped in the identification of areas of interest later on. The preliminary review techniques were tested and revised during the pilot study and then implemented during the analysis of the data for Study-A and Study-B groups.

**Substantive Review**

The substantive review stage included two analytical steps. First, areas of interest or “hot spots” (Jordan & Henderson, 1995) were identified from observing interesting activities. For each individual hot spot a new node was created in NVivo. The aim was to keep the emergence of the hot spots free from predetermined analytic categories. Second, further details were added to the transcripts of the hot spots. These included the transcription conventions inspired by CA and MIA. For example, noticeable pauses,
overlaps, and stress on certain words were added to the transcripts. Furthermore, non-verbal interaction such as gestures, gaze, posture, object handling, and the drawing activity was noted down for each line of utterance in the transcription. Emphasis was on non-verbal interaction, rather than speech intonations. During the substantive review of the data from the pilot study I began to notice the non-verbal interaction and how it played an important role in relation to the drawings. This process was then further refined in the analysis of the data for Study-A and Study-B.

During this substantive review the number of hot spots increased until some initial categories emerged.

Analytic Review

The initial categories identified in the substantive review were analysed more closely during the analytic review. Hot spots were merged into broad categories and sub categories. Categories were developed for inscriptions and gestures. The categories for inscriptions included: types of inscriptions - function of inscriptions - forms of contents in inscriptions - development processes for inscriptions – and use of external resources. The categories for gestures included: types of gestures - forms of gestures- and function of gestures. The categories for inscriptions were similar to the categories that emerged from the pilot study. The categories for gestures mostly emerged from the main data since I only began to notice non-verbal interaction during the pilot study.

Main Data Sources for Analysis

In this thesis I have analysed two main sources of data: 1) the designers’ interaction during the meetings, and 2) analysis of the drawings created. During the
design meetings I observed how the participants created the drawings, how they used them, and how they interacted with other participants as well as the resources in the Design Studio. I also analysed the drawings, looking for visual clues and how visual elements were used to create meanings. The main results from the observation of designers’ interaction are presented as *thin descriptions*, and the results from the analysis of the drawings created are presented as *semiotic analysis* in Part 3 of this thesis.

**Transcription Conventions and Presentation of Data**

The transcription of MIA depends on the analytical categories defined by the researcher (Norris, 2004). Based on these categories, a researcher can define the communicative modes to be included in the transcription of specific events. Not all communicative modes will be relevant to all of the categories selected for transcription. For example, some interactions might be primarily verbal while others might rely more on gestures or objects in the environment. “Salience derives from the interaction as well as the theoretical assumption” states Norris (2002, p. 113). Hence any transcript will exhibit some modes as more salient than others because “the form of a multi-modal transcript needs to be linked to the need of the analysis, which may differ from interaction to interaction and from one focus of analysis to the next” (Norris, 2002, p. 106).

In this study only certain communicative modes were transcribed, as they were deemed important for describing specific events in the preselected analytical category. The interaction with the inscriptions could not be fully transcribed into the verbal conversation of the participants because there were numerous events during which a
participant would write or draw without providing any verbal contribution. Furthermore, there were some events during which none of the participants spoke when an inscription or part of an inscription was drawn.

Table 4 summarizes the transcription conventions used in this study. These were inspired by various ways of transcribing, such as some of the typical Conversation Analysis conventions (Richards & Seedhouse, 2007; Sacks et al., 1974), Interaction Analysis (Jordan & Henderson, 1995), inscription related practices (Roth & McGinn, 1998), and transcribing gestures as cognitive artefacts (Becvar et al., 2008).

Table 4 - Transcription Conventions Used in this Study

<table>
<thead>
<tr>
<th>Sign</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>[</td>
<td>Indicates the point of speech overlap onset. Some researchers have selected to also indicate the offset or end of the overlap; however the majority of transcriptions ignore the offset since overlaps are very brief. In this study overlap offsets were not transcribed.</td>
<td>Grant: [Maybe I didn’t understand</td>
</tr>
<tr>
<td>=</td>
<td>Indicates a latched utterance. A latched utterance is one that immediately follows the preceding utterance, without a gap.</td>
<td>Natasha: [So actually maybe we should draw it because I think it’s sort of...</td>
</tr>
<tr>
<td>()</td>
<td>Indicates a very short pause of less than 0.2 seconds.</td>
<td>Taryn: the people out there () the ordinary people</td>
</tr>
<tr>
<td>(1.5)</td>
<td>Longer pauses with numbers in parentheses indicating length of pause in seconds and tenths of a second.</td>
<td>Jarrod: I just thought that was a way to reinforce that or to make (1.5) make it a bit more fun</td>
</tr>
<tr>
<td>...</td>
<td>Indicates utterance trailing off or fading.</td>
<td>Calvin: Calculations don’t have to be...</td>
</tr>
<tr>
<td>Word</td>
<td>Underlining indicates speaker emphasis.</td>
<td>Taryn: We have to come up with a thing</td>
</tr>
<tr>
<td>:</td>
<td>Indicates elongation of the preceding sound. The more</td>
<td>Darren: ideation is:: ideation</td>
</tr>
</tbody>
</table>
colons the longer the sound.

*text* Indicates the participant reading text from a source such as printed pages.

Judy: *In your design concept you should consider the goal purpose and method*

**Non-Verbal Interaction**

{ Indicates the point of gesture onset.

Dom: the thing is to have multiple {pages like this}

} Indicates the point of gesture termination.

Darren: ^That’s interpretation there^ yeah?

^text^ These symbols are used to enclose parts of the utterance when the participant looks at something while speaking. Not all instances of looking (gaze) could be transcribed. Only those instances to which other participants reacted were transcribed. For example, if the person speaking turned his/her head to look at the interactive whiteboard and other participants also looked at the whiteboard then this gaze was transcribed.

@_ Indicates that the participant begins drawing.

Julia: Like this can go like a @_like a circle kind of process_@

_@_ Indicates that the participant end drawing.

**Codes Used for Types of Gestures**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-Gesture</td>
<td>Stands for deictic gestures.</td>
</tr>
<tr>
<td>M-Gesture</td>
<td>Stands for metaphoric gestures.</td>
</tr>
<tr>
<td>Ic-Gesture</td>
<td>Stands for iconic gestures.</td>
</tr>
</tbody>
</table>

**Selection of Modalities for Events**

The multimodal system of analysis in this study has the sketching and drawing practices of the participants at its centre. Although all interactions are multimodal, there are main modalities that will be present in most of the events, such as visual, audio, and spatial elements (Ehrenstrasser & Spreicer, 2012). The main modalities analysed for each event in this study included talk and drawing. Gesture, posture, gaze and use of
space and other resources were transcribed and analysed only when they were relevant to the analytic category or description of event. See Table 5 for a brief description of the communicative modes analysed in this study.

Table 5- Definition of Modalities

<table>
<thead>
<tr>
<th>Mode</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talk</td>
<td>This includes statements uttered by the participants in the interaction.</td>
</tr>
<tr>
<td>Drawing</td>
<td>This mode describes how the participants sketched or made marks on the whiteboard or on sheets of paper.</td>
</tr>
<tr>
<td>Gesture</td>
<td>This describes how the participants moved their hands to point to and/or interact with the drawings/or in relation to the drawings.</td>
</tr>
<tr>
<td>Posture</td>
<td>This mode illustrates how people positioned their bodies in relation to each other, the drawings, and the resources in the environment, in ways that had a communicative meaning.</td>
</tr>
<tr>
<td>Gaze</td>
<td>This is referred to observable gaze. Fleeting gazes might not be transcribable due to their brevity.</td>
</tr>
<tr>
<td>Use of space</td>
<td>This includes moving about and use of relatively fixed features of the Design Studio such as the main table, the coffee table, or the couch.</td>
</tr>
<tr>
<td>Resources</td>
<td>This includes the use of resources in the environment such as the interactive whiteboard, laptops or iPads projected on the walls, printed pages, and more.</td>
</tr>
</tbody>
</table>

**Research Rigour**

The standards of research rigour I adhered to in this thesis are related to validity and reliability. Although traditionally these terms have been associated more with quantitative research, they can still be used in interpretive qualitative work by employing different means and strategies. To ensure reliability I have provided a record of the decision trail, and to ensure validity I have exercised self-reflection and peer debriefing (Long & Johnson, 2000). In addition, I have relied on data-sources and data-analysis triangulation to increase the validity of this research.
**Decision Trail**

Although the goal of qualitative research is not to generalise the findings (Sharts-Hopko, 2002), if enough information about the methods and decisions is provided, then readers can judge the reliability of the research and decide how unique the research situation is and what they can take from it (Krefting, 1991). Accordingly, the decision trail is provided in several sections of this thesis. A *decision making trail* is recommended by Clarke (1999) in order to support the principles of academic rigour in qualitative research; by making explicit the reasons for methods, ideas and processes used in research. The decision trail explains the approaches to the analysis that I have taken as well as any changes to the direction of the research. In Chapter One I explained the decisions I took after I discovered the research gap. The introductory section of Chapter Two also contains explanation of the decision to investigate inscriptions in science. In Chapter Four I explained the decision to take certain methodological and analytical approaches and in Chapter Six I provided a detailed explanation of the analysis process.

In addition to the decision trail, I have provided direct quotes from the participants in order to support the claims and ideas presented in this thesis. This strategy is often used in the analysis of text-based methods such as Conversation Analysis where the validity of the analysis is not dependent on what the researcher claims is happening, rather it is dependent on how the researcher is able to show through the data the way in which claims are made and the results are reached (Matthews & Heinemann, 2012).
**Self Reflection**

Self-reflection was carried out in the form of taking reflective notes during the analysis period. This approach was inspired by *memoing* in Grounded Theory in educational research (Thornberg, 2011). While analysing the data using NVivo, I frequently wrote memos and associated them with the relevant utterances and images of drawings created by the participants. I also constantly used the ideas I was reading about in the literature to inform and sensitise my thoughts about the potential findings and patterns in the data. This method does not force the data into pre-existing theories and ideas, but is used as a heuristic flexible tool that helps form creative associations between the current research and prior research (Thornberg, 2011). One of the advantages of memoing is that ideas can be noted down early so they are not lost through the lengthy analysis period. The memos that were recorded early in this study were modified and updated throughout the process to represent the evolving nature of the analysis. Some memos were clustered together to represent the relationship between ideas.

Another tool I used for self-reflection was drawing diagrams. This method was also inspired by *diagramming* in grounded theory (Schreiber & Stern, 2001). I created diagrams of ideas I noted down in memos to see their relationships. These diagrams were mostly hand drawn on pieces of paper and consisted of descriptive words connected by lines and arrows. For example, to see the relationship between some gestures and inscriptions I drew a timeline for the design session noting down when the inscription (and specific parts of it) was drawn and at what point the specific gesture was enacted. Through memoing and diagramming I constructed and reconstructed my understanding of the data which then guided the next steps in the analysis process.
**Peer Debriefing**

Peer debriefing was another strategy I used in order to assess the quality of the preliminary findings and also to prevent premature closure of the analysis (Long & Johnson, 2000). I presented new and preliminary findings to interested peers during informal team presentations in my faculty department. I also presented the findings in two Doctoral Colloquia sessions to small groups of academics during which I received invaluable feedback and suggestions. In addition, I presented my preliminary findings in two guest lectures at a Master degree program at the University of Sydney. I also presented a Methodology Workshop where I discussed my methodological and analytical approaches to a group of academics and doctoral candidates. These opportunities for sharing my evolving research ideas, methods and findings with peers, helped in avoiding premature fixation of thoughts during the analysis process, thus increasing the validity of this research.

**Triangulation**

Triangulation is a method of combining two or more data sources, methodological and analytical approaches, theoretical perspectives, or investigators (Thurmond, 2001). It is used as a strategy to increase research validity and provide a degree of assurance in data interpretation. In this thesis, I have relied on two types of triangulation: data-sources and data-analysis triangulation.

Variance in events, situations, or persons is data-sources triangulation (Thurmond, 2001). In this thesis I used data from two different design events and situations: 1) experimental context - where a design task was given to the participants,
and 2) naturalistic context - where the designers were working on their own real-world project. The two design contexts involved two different groups of people: 1) doctoral students, and 2) professionals with various backgrounds in design, marketing, music production, professional writers and more. This combination is intended to provide a better and more comprehensive view of design situations than relying on a single source of data.

Data-analysis triangulation involves the combination of two or more methods of analysing data (Thurmond, 2001). In this thesis I relied on two different methods of analysis: 1) observation of the designers’ interaction which is presented as thin descriptions in Part 3 of this thesis, and 2) analysis of the drawings created which is presented as semiotic analysis, also in Part 3 of this thesis. Rather than analysing design drawings as self-contained separate entities, together these two methods provide a better understanding of the sketching and drawing practices of educational designers.

**Research Ethics**

The Human Research Ethics Committee granted approval (HREC Approval 2012/2794, Learning, technology and design: architectures for productive networked learning - Using complementary methods of analysis) to conduct this research. Copies of the consent form and participant information sheet are provided in Appendix Five. Care was taken to ensure the participants were informed about the research details and their rights to confidentiality and anonymity (Neuman, 2006) before the design sessions were recorded.

1. **Anonymity**: personally identifiable information about the participants in this study are not disclosed to anyone not involved in the project. In this case, the project
team included members of the ARC Laureate research project led by Professor Peter Goodyear.

2. Confidentiality: all participants in the study are assigned pseudonyms. The pseudonyms are used in all publications, including this thesis. The recordings of the design meetings are stored in a secure location at the Faculty of Education and Social Work at the University of Sydney. Copies of the meeting recordings are provided to those researchers involved in the project for analysis.

3. Informed consent: all participants were provided with a participant information sheet that explained the details of the study. Participation was voluntary and the participants were able to withdraw from the study at any time. Participants were required to sign a consent form and were provided with clarifications when needed.

This concludes Part 2. In Part 3 I present the results related to the first three aims of this study. Two methods of analysis are used to describe these results: thin description of the inscription creation process, and semiotic analysis of the inscriptions.
Part 3 – Inscriptions Created in this Study

Part 3 of the thesis is presented in four chapters, and contains my description of the main findings of the thesis relating to the first three aims of the study: 1) to identify the types of inscriptions created by the participants in the design team meetings, 2) to reveal how and in what ways these inscriptions are developed, and 3) to determine for what purposes these inscriptions are used.

The results for Study-A are presented in Chapter Seven, and the results for Study-B in Chapter Eight. For each of the two cases, I will first describe how the inscriptions were separated for the purpose of analysis. I will then provide a thin description for how each individual inscription was created. Following the thin descriptions for each case study, I will present a summary of the results for that specific chapter. In Chapter Nine, I will describe the types of inscriptions created in this study and provide a semiotic analysis for each individual inscription. In Chapter Ten, I will provide some interpretation in the form of a summary and synthesis of the results for both Study-A and Study-B.

In this thesis, I opted for an inductive approach rather than an approach that incorporated hypothesis testing. Hypothesis testing involves testing theories; which limits what a researcher can look for (Gerring, 2006). Since there are no prior theories to test in this specific area, and the aim is to explore the wider, general practices of educational design using visual representations, the inductive approach was more appropriate. Tholander and colleagues state that “design representations do not carry meaning in themselves but are made meaningful through design activity” (Tholander et al., 2008, section 5, emphasis in original). In order to understand how educational
designers make use of inscriptions as representations of design ideas, I analysed the inscriptions in the context of their production. The first set of results in this thesis is thus presented as *thin* descriptions of the drawing practices of the designers.

The term *thin* description was first contrasted to *thick* description by Geertz (1973). Geertz insisted on interpretation and described thick description as going beneath the surface to get at the deep meanings. The method of *thin* description has often been the subject of controversy. Claims of *thin* description taking phenomena as self-evident and ignoring meaning are often voiced against it (Porter, 2012). Brekhus, Galliher and Gubrium (2005) state “Simply put, some qualitative studies are thin on certain fronts because, for good preinvestigative, analytic, and empirical reasons, they need to be” (p.877). The question need not contrast the two approaches, but determine the suitability of each to certain purposes. Descriptions should be thin or thick based on the analytical needs.

The *thin* description, presented in Chapter Seven and Chapter Eight, is intended to make visible that which has been unexplored to date. The *thin* description does not assume knowledge of the internal processes, conceptions, and intentions of the designers for the drawings. It simply describes the interaction of the participants with the inscriptions and aims to provide a step-by-step account of the creation of the inscriptions during the design meetings.
Chapter Seven: Study-A

This chapter presents the first set of results for Study-A groups. The chapter begins with an explanation of how the inscriptions created by the participants were separated for analysis. This is followed by the thin description for each group. The thin description is followed by a summary of what I see as significant in these results.

Separating the Inscriptions

In Study-A, the majority of inscriptions were created on the whiteboard walls in all three groups. The participants in Group 1 and Group 2 also produced some inscriptions on paper. Each inscription drawn on a piece of paper was counted as one inscription. On the whiteboard walls, participants created several types of inscriptions, often close to each other. Even with proximity, there was a clear distinction between the different types of inscriptions. Some inscriptions were erased before other inscriptions replaced them. All groups drew their inscriptions starting from the left side of the whiteboard wall and continuing to the far right side of the wall. For the participants in Group 1 there was not enough space left on the whiteboard walls and as a result they created their two final inscriptions on two large pieces of paper. Some inscriptions could also be differentiated by colour. A number of inscriptions were created by one participant only, while others were created by all participants in the group collaboratively. These distinctions will be further elucidated in the thin descriptions later in this chapter. The inscriptions are labelled using the following convention: SA (stands for Study-A) - G1 (Group 1) - A (the first inscription created by this group).
The Ultimate Inscriptions

Ultimate inscriptions are those created as the final presentation of ideas (Lunsford, Melear, Roth, Perkins, & Hickok, 2007). The ultimate or the final inscriptions in Study-A groups were categorised based on their purpose. The participants were asked to create a design concept sketch as a requirement of the task given to them. Consequently, each group tried to produce at least one inscription by the end of the session that they used to demonstrate their ideas to the researchers. Some groups used the inscriptions that were initially created for other purposes, such as for making sense of the situation, to present their ideas and design concept to the researchers. Therefore, the inscriptions that were used by the participants as their last ideas or design concept, and presented to the researchers, were categorised as ultimate inscriptions. Accordingly, these inscriptions were also more complete inscriptions; in that they represented the groups’ ideas for the Blog in a most succinct and summarised way. Group 3 presented one ultimate inscription while Group 1 and Group 2 each presented two ultimate inscriptions to the researchers at the end of their sessions.

Thinking Marks in Study-A

Thinking marks are simple annotations which may include text, lines, arrows, circles or drawing boxes around text. They can be used as visual aids for grouping, selecting, ordering, labelling, or showing relations between pieces of information. Thinking marks are often used as a learning strategy to self-organise information and clarify problems in preparation for solving them (Oviatt, Cohen, Miller, Hodge, & Mann, 2012).
All but one participant in Study-A groups used thinking marks to annotate the scaffolding printed pages containing the task requirements and information. In Group 1 Natasha was the only participant who did not create any thinking marks while both Grant and Judy underlined words and sentences, drew circles around words and terms and added annotations to the edges of the pages. In Group 2, Dom and Angus created minor, mostly underlining thinking marks, while Meg created more extensive marks. In Group 3, Darren made the greatest number of thinking marks. He underlined words and sentences, drew boxes around terms and wrote short notes on the edges of the scaffolding printed pages. Julia and Taryn only made minor thinking marks, mostly underlining some words and sentences. The thinking marks for Darren, Meg, and Judy are provided as examples in Appendix Four.

Thinking marks were not analysed in this study because they were mostly created by the participants when they were individually reading the task requirements and information at the beginning of the sessions and thus not part of the group work, which is the focus of this study.

**Study-A: Thin Description**

At this stage a thin description of the inscription development process for Study-A is provided. Each inscription is described separately. The description provides an account of how each inscription was created. It does not describe the entire design process for each group. Interpretation is only provided when it has been gained through observation of the visible interaction of the participants with each other and with the inscriptions.
The description for Group 1 provides slightly more details than the description for Group 2 and Group 3. This is to help the reader initially become familiar with the context of the study rather than just concentrating on the drawing actions.

The Development of Inscriptions in Study-A Group 1

Study-A Group 1 (Grant, Natasha and Judy) created five inscriptions. Three of the inscriptions were drawn on the whiteboard Wall A (see Appendix One) and two others on large sheets of paper. The two last inscriptions were drawn on paper because there was not enough space on Wall A.

The group began by reading the design task on the scaffolding printed pages. The scaffold given to this group instructed them to assume a specific role in the group. The roles included a designer, a member of the target audience, and subject matter expert. They then started looking at some web pages projected on Wall A that displayed information about the main environmental issues at the Murray Darling Basin area. Grant started underlining some of the terms and sentences on the projected screen on the whiteboard wall. This was a form of publicly-visible creation of thinking marks. He then drew an arrow going from the corner of the projected screen to the empty space on the right side of the wall. Here he started creating inscription SA-G1-A.

The Development of Inscription SA-G1-A

Inscription SA-G1-A in Figure 4 (and the enhanced version in Figure 5) initially started in order to extract the ideas from the website and record it on the whiteboard wall. Grant started with writing two headings: ‘Goals/issues’ and ‘Stakeholders’. He then added two empty bullet points under the first heading and one under the second.
Grant wrote ‘Environmental impact’ as the second bullet point under the first heading, and ‘Farmers’ under the second heading.

As Judy was explaining that sometimes the government might not consider all issues and focus mainly on environment and sustainability issues, Grant noticed that the issues were different than the goal for the tool they were designing. Accordingly, he erased the term ‘Goals’ from the first heading leaving the heading as ‘Issues’ and added a new heading ‘Goal of our Tool’ to the right of the wall. He then added ‘Maybe government doesn’t consider all issues’, as the first list item under the first heading and ‘Water supply’ and ‘Sustainability’ as the third and fourth items respectively.

After discussing the issues, Natasha asked who the target audience might be and if Judy was allowed to share this information as the task requirements advised not to share the different roles’ documents with the other team members. Judy thought that they could maybe share some of the information and that she was advised, in the document, to specify which target audience group she had decided to assume. Grant, who was still standing in front of the Wall A, pointed to the stakeholders heading and said “So, we can put the five here?” He then added four round bullet points under the first point and waited for Judy to list the rest of the groups in the target audience.

The group at this point agreed that they would need to share certain information to define the problem before a solution could be devised, however, they could not agree about how much information they were allowed to share. After considering the option of contacting the researchers and clarifying the issue, the group decided that they would compromise and share certain information needed for the definition of the problem.

Judy thought that before they identified the stakeholders, they needed to define the main aim of the tools as raising awareness of the issues at the Basin. Grant added
‘Rise awareness of water usage’ (sic) under the third heading as in Inscription SA-G1-A. Following this, Natasha and Judy tried to define the role they had assumed and how much information they could share with the team. Natasha stated that she was an environmental specialist. Grant placed a tick next to the second bullet point under the ‘Issues’ heading. There was still more discussion about defining the roles. For example, Judy asked if Natasha, as an environmental specialist, was living in the area of the Basin. While this discussion was happening, Grant added four groups of stakeholders to the empty bullet points under the second heading. These were ‘Aboriginal communities’, ‘Non-aboriginal Communities’, ‘Government’, and ‘Environmentalist ONG’ (sic).

As Natasha was describing her role, she referred to a website she was just looking at that showed how vast the Murray Darling River was and how big the environmental impact was in terms of the area covered and population affected. During this time, Grant drew boxes in red pen around the three headings on the wall. Natasha then stated that she would like to look at the Google document which was referred to in the scaffolding printed pages related to her role.

While Natasha was trying to log into the Google document (that was part of the scaffolding materials provided to them), Grant asked Judy “OK, I have a question for the stakeholder ... do you belong to any of these groups, I just made up”. Judy defined her role as a learner who could belong to any of the communities that Grant had listed. Grant first drew a box around the second and third bullet points under the ‘Stakeholders’ title, and then drew a bracket around the first three bullet points and labelled them ‘Learner’. Grant also wrote both Judy and Natasha’s names next to the stakeholders list inside parentheses. During this time, whenever the group discussed an
issue or made a decision, Grant would draw a tick next to the corresponding list point on the board. This was done as a reminder of the progress of the design process.

At this stage Grant tried to elicit more information from Judy. Judy defined her role as a Year ten high school student from a farming background living in one of the small cities near the Murray Darling Basin area. Grant asked Judy about the issues she was aware of and what was important to her about the Basin area. Judy stated that water salinity was one of the issues and as a result, farmers were losing their farms. Grant took a pink colour marker pen and added ‘water issues’, ‘too salty’, and ‘people losing their farms’ as three bullet points under the first heading ‘Issues’.

Grant then stated that it seemed that people in the area already knew what the problems were. He then asked Natasha what she thought was causing these issues and how they could be fixed. Natasha stated that one of the issues was that people were using too much water. Grant took a blue colour marker pen and added ‘people using too much water’ as the last bullet point under the first heading. As Natasha was explaining the issues and what needed to be done, Grant changed the marker pen colour back to green and extended the first bullet point under the third heading previously ‘Rise awareness’ (sic) to now include ‘of water usage’. Natasha then stated that one of the aims of the Blog should be to communicate the science behind why people need to better manage the Basin system. Grant accordingly added ‘communicate the science behind. Why do we need a sustainable water system’ as the second bullet point under the third heading. Judy then asked Natasha as the environmental expert what she meant by sustainable. Grant underlined and placed double quotation marks around the word “sustainable” that he had just added to the board. When Natasha started to respond to Judy, Grant anticipated that her explanation would also provide him with further
information that would help the progress of the design process. Grant went to the right side of the whiteboard wall that was still empty and said “give you the space”, to let Natasha know that that was where her contribution could be recorded.

![Figure 4. Inscription SA-G1-A](image)

![Figure 5. Inscription SA-G1-A (enhanced for legibility)](image)

Inscription SA-G1-A was not finalised yet when Grant started creating inscription SA-G1-B. He revisited inscription SA-G1-A while he was drawing the next two inscriptions and added more details to it.
The Development of Inscriptions SA-G1-B and SA-G1-C

Grant started drawing Inscription SA-G1-B in preparation for recording the information provided by Natasha in her role as the environmental expert. While Judy and Natasha were discussing what they meant by sustainability and the concept of time and duration in relation to it, Grant started drawing Inscriptions SA-G1-B and SA-G1-C as illustrated in Figure 6.

He first wrote ‘Tool’ and an arrow facing downwards to its left. He then added three empty bullet points. He wrote ‘Explain the causes of water issues in the region’ underlining the word ‘causes’ as the first point, and ‘What’s Sustainability’ as the second list item (see image 1 of Figure 6).

Following this, Grant asked Judy “OK I have another question for you (..) What kind of applications are you usually use? When you access the computer, what do you already use? How do you communicate with your friends?” Judy replied, mentioning tools such as Moodle, email, Skype, Facebook, and Minecraft. Grant went back to the previous list on the wall, illustrated in Inscription SA-G1-A, and drew a curved line and arrow from the list of stakeholders below and wrote ‘Tools they’ (see image 2 of Figure 6). He then followed the list by adding ‘Moodle’, ‘Email’, ‘Skype’, and ‘FB’ for Facebook but he was not familiar with Minecraft and asked Judy what it was. After Judy and Natasha explained that Minecraft was a game, Grant asked Judy if she was reading Blogs. Judy replied that she was not reading Blogs and only used these tools that she mentioned. At this stage, Grant briefly went back to Inscription SA-G1-B and drew a box around the word ‘Tool’ that he had written earlier. Grant again asked if
Judy, as the Year ten high school student, used Twitter and Judy replied “no”. Grant then wrote ‘No Twitter’ next to the list of other tools (see image 2 of Figure 6).

Grant suggested they run a survey to get more information about what the larger group of target audience were using and drew boxes around the words ‘Email’, ‘FB’ and the ‘No Twitter’ stating that these might be some of the more popular tools. Grant then suggested they have a Blog “but with connection to all those stuff” referring to the list of tools on the board. As he was stating this, he then went back to the right side of the board to above where Inscription SA-G1-B was and added the word ‘Blog’ and drew a box around it. This was the beginning of drawing the diagram of Inscription SA-G1-C. He then suggested that the Blog could have input from various sources such as the environmentalist, the government and even the university. While he was explaining this, he drew five little circles under the ‘Blog’ box to symbolise multiple input sources (see image 3 in Figure 6).

As Grant was explaining this, Natasha said “I just got an idea about the Blog”. Judy asked “Do you want to map it, or are you happy to speak it?”. Natasha replied “speak it”. Grant noticed that there was a long role of sketching paper on the table and, expressing excitement with an “Ahhhhhh”, started unrolling the paper and cut out a large piece of paper on the table. When Natasha saw Grant cutting the piece of paper she stated “at some point when we sketch we can use this stuff I suppose (...) but this is more ideas”.

Natasha explained that since their audience were young students they might not be as interested in reading Blogs as they are in Facebook, but the design brief asked them to make a Blog and not a Facebook page. Grant went back to the board and drew a line going down from the ‘Blog’ box. He then added three small boxes at the end of the
line and wrote ‘FB’ for Facebook, ‘Subscribe’ as in subscribe, and ‘Twitter’ in each box respectively. As Natasha and Judy continued brainstorming ideas for what the Blog should contain to make it attractive for a younger audience, Grant wrote ‘Content’ and drew four more lines with boxes at the end of each, above the ‘Blog’ main box. Natasha and Judy further discussed ideas such as including images, videos, infographics and short pieces of informational text on the Blog for the younger audience and Grant accordingly added ‘infographics’, ‘Videos’, ‘Images’, and ‘Short text’ inside the boxes (see image 3 of Figure 6). Grant then started explaining his ideas using the inscriptions. He pointed to the main box with the word ‘Blog’ and stated that they could create a Blog to use as an archival system for the information, but that the students would access the Blog through a web page. He then wrote ‘webpage’ next to the box with ‘FB’ while stating “so we need to create our web page”. He also wrote ‘Students’ below the box and drew a line and arrow going towards the ‘FB’ box (see image 4 of Figure 6). Grant then used the boxes he drew above the main ‘Blog’ box earlier to explain that the contents such as the images, videos and infographics would be located on the Blog and accessed through the webpage. During this, Grant was standing close to the whiteboard and used gestures to point to the corresponding sections on the inscription in order to explain his ideas. Grant drew an arrow going towards the five little circles he drew earlier below the main ‘Blog’ box, while explaining that Natasha, as the environmental expert, would be one of the people who would be populating the Blog with the contents.
Figure 6. The development of Inscriptions SA-G1-B and SA-G1-C including additions made to inscription SA-G1-A

The Development of Inscription SA-G1-D

For the next step, the group tried to define what the design concept was that they needed to produce. Judy read the scaffolding printed pages containing task requirements: “*In your design concept you should consider the goal, purpose and method*”. She asked “so how could we bring that together in some way of sort of (.)
framing it or conceptualising it that actually is inclusive of (.) you know goals purpose content methods”. Grant replied, while holding the large sheets of paper in front of him on the table, “what if we took two papers and we write down those things as you mentioned (.) to present”. This indicates that Grant started drawing Inscription SA-G1-D in order to present the group’s design concept to the researchers at the end of the design session.

Judy and Natasha continued to discuss whether a design concept was the visual appearance of the Blog or if it was about how a Blog functions and how users interact with it. Grant took a black pen and drew a box in the middle of the paper in front of him and wrote the word ‘Blog’ inside it, as seen in Figure 7. While discussing this, Judy said “you know, so I think it’s about... I don’t know, I’m not the Designer; should I be saying anything?”. Grant, while holding and positioning the sheets of paper in front of him on the table replied, “Well, I’m the Designer (.) what I suggest is to make something like (.) like this”. Judy asked “What’s your design concept?”. Grant replied “the design (.) I think everything is easier to see with a diagram (.) with pictures”.

Grant then explained his ideas by looking back and pointing at the inscriptions on the wall and then drawing on the paper. He first started describing the people who would be contributing contents to the Blog. He took a red pen and drew a line going towards the box with the word ‘Blog’ in it on the left side of the paper as in Inscription SA-G1-D in Figure 7. He then listed the contributing stakeholders while explaining to Judy and Natasha. Grant next took a green pen and drew a line going away from the ‘Blog’ box on the right side of the paper and wrote ‘Target’ above the line and ‘Audience’ below the line.
Grant tried to engage the other two members in this process but they were discussing that Natasha had a link in her scaffolding resources about the local university in the Murray Darling Basin area. Grant then noticed that because he was drawing on the paper on top of the table, the other two group members were not able to see it directly as they were sitting on a chair and a sofa on the other side of the room. Grant pointed to the whiteboard wall and said “would have been better to do it there”. Grant then added ‘~16 year old school kids’ to the end of the green line.

Natasha then started discussing ideas about the type of infographics that could be included on the Blog and Judy mentioned her experience from her high school when they used a computer game called The Toxic Swamp. In the meantime, Grant, looking back to the whiteboard wall and again to the paper, took a black pen and drew two lines going away from the ‘Blog’ box below and wrote ‘connected to’ and then three lines going further down to three boxes with the words ‘FB’, ‘Twitter’, and ‘Email List’ in each box respectively. He then wrote ‘webpage’ below the ‘FB’ box. While Judy was still describing The Toxic Swamp, Grant, looking at the whiteboard wall repeatedly, wrote the title for the diagram ‘Goal of the tool’ on top of the paper and then wrote ‘To communicate and rise awareness on why do we need sustainable water system in the Murray Darling area’ (sic) below it. He then wrote a small heading ‘ENTRIES’ above the red line to the left of the ‘Blog’ box and added bullet points below it to describe the contents of the Blog. He added ‘Infographics’, ‘Videos’, ‘Images’, ‘Games’, and ‘Some text’ as the bullet points. During this time, Grant was repeatedly checking the wall for information and then drawing the diagram. He then took the paper from the table and attached it to the whiteboard wall where the computer screen was projected. Later on
when Natasha was drawing Inscription SA-G1-E, Grant added two more list items
‘Infographic stories’, and ‘News’ to the above list.

![Inscription SA-G1-D](image)

Figure 7. Inscription SA-G1-D

_The Development of Inscription SA-G1-E_

After Judy described how The Toxic Swamp motivated the students in her high
school to learn about the environment, Natasha said “we’re just wondering how we can
translate that to this stuff here... and I guess because it’s a Blog there’s that difficulty
with interactivity you know”. To this Grant responded “No (.) it’s not difficult”. He then
explained that a Blog entry can be anything like an image or infographic, and not
necessarily text. This reminded Natasha of a Blog she knew about. She quickly went
online using the computer projected on wall B and found the Blog on the Internet. She
explained how the Blog was made up of just one large image and the entries were
spread along this landscape that let the user control where to go. Natasha thought that
this type of Blog would attract the younger audience. She stated “this went really viral
because it was just (.) it was just cool”.

For the next five minutes Natasha tried to explain how this creative image-based Blog could be used in this situation to attract the audience’s attention to the main issues in the Murray Darling Basin. There was confusion however with Grant not completely understanding how Natasha wanted to translate that design into what they were working on. Grant was under the impression that Natasha was translating the ideas into how to design only one entry into the Blog while he was more concerned with designing the architecture of the Blog as a whole.

Grant’s confusion prompted Natasha to draw her ideas on paper as in inscription SA-G1-E. Table 6 contains an extract of the conversation when Natasha decided to draw her ideas.

Table 6 - Event: Natasha from Study-A Group 1 Started Drawing Inscription SA-G1-E

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1136</td>
<td>1:43:02</td>
<td>Grant:</td>
<td>So, you need to design:: (3) a picture like that:: and::</td>
<td></td>
</tr>
<tr>
<td>1137</td>
<td>1:43:06</td>
<td>Natasha:</td>
<td>[Well no I wouldn’t use I wouldn’t use this design (2) That’s just showing you the image I mean this is a web comic]</td>
<td>Resource: scrolling down the Blog page which is projected on Wall B.</td>
</tr>
<tr>
<td>1138</td>
<td>1:43:12</td>
<td>Judy:</td>
<td>I like the fact that...</td>
<td></td>
</tr>
<tr>
<td>1139</td>
<td>1:43:14</td>
<td>Grant:</td>
<td>[Maybe I didn’t understand]</td>
<td></td>
</tr>
<tr>
<td>1140</td>
<td>1:43:14</td>
<td>Natasha:</td>
<td>[So actually maybe we should draw it because I think it’s sort of...</td>
<td>Posture: gets up from the couch and walks towards the main table.</td>
</tr>
</tbody>
</table>

At the end of the statement (transcription order ID 1140, Table 6) Natasha stood up and walked towards the main table in the middle of the room. She took the second
sheet of paper that Grant had already cut from the paper roll earlier. She then started
drawing the diagram in Inscription SA-G1-E (Figure 8).

She first drew a big rectangle on the page to represent the Blog page and then
separated the top section to create a space for the banner. She drew an image of a tree on
a slope and an image of a small animal below it in the banner to represent how the
image in the banner would depict the environment. She then drew a vertical line to the
right side of the page to separate the links section from the main Blog contents area.
Following this, she drew two horizontal lines across the main contents section to
illustrate how the Blog would contain separate stories or posts.

While Natasha was drawing this, Grant was still expressing his uncertainty about
how the ideas from this sample Blog could be implemented in their design. After
drawing the base structure for the Blog, Natasha stated “So, this is, kind of, how I see
it”. She explained how the movable image in the sample Blog could be adapted to set in
the banner for this Blog and act as link-holder for the posts in the Blog. She then started
writing and explaining in the meantime how the Blog entries could be news and events
happening in the Basin area. She first wrote the dates on top of each section starting
with ‘31 JAN’, then ’30 JAN’, and then ’28 JAN’ down below. She wrote ‘JOIN THE
CAMPAIGN’ in the first contents section for the Blog post and ‘MINISTER CUTS
RIBBON’ in the next section. She then drew a square in the third section towards the
bottom of the page and drew a picture of a small rabbit or similar animal with the text
‘water is good’ and ‘SCIENCE’. Next she drew some grass next to the animal. While
drawing this, she explained how occasionally there could be infographics that tell short
stories about environmental issues.
Grant was still not sure how Natasha was planning to connect the Blog posts to the movable image in the banner. To make her point clear, Natasha drew a curved line with an arrow at the end connecting the little drawing of an animal in the banner to the infographic square at the bottom of the page. She explained that when the user clicks on one of these images of the animals in the banner they would be taken to another page with the related story. She stated “so, you click on that and it actually gives you that as a whole page in itself, you know”, pointing to the drawing of the little animal in the banner and then the infographic square at the bottom of the page.

Grant was concerned that just because the users would find this banner cool did not mean they would keep coming back to it. Natasha then explained that the important thing to remember was that “these are infographic stories”. As she was saying this, she wrote ‘INFOGRAPHIC STORY’ above the square that represented the infographic. She emphasised that the infographic stories should actually contain a story and that this feature would keep bringing the user back to the Blog, because every time there would be a new story added. While Natasha was explaining this, Grant went back to the wall where the paper with Inscription SA-G1-D was hanging. He added ‘infographic Stories’ as another list item to the previous list of entries.

Grant then stated, “let’s say this things is that thing, so we’re going to have that here” (sic). When saying ‘this thing’, he pointed to the list of Blog entries ‘ENTRIES’ he wrote in Inscription SA-G1-D. When saying ‘that thing’, he pointed to the paper with Inscription SA-G1-E which Natasha had just made. And when Grant said “so we’re going to have that here” it meant that Grant wanted to hang the paper with Inscription SA-G1-E next to the other paper with Inscription SA-G1-D on it on the whiteboard wall.
As the last point, Grant explained to the other two members where he thought Inscription SA-G1-E fit. He read the list of entries on Inscription SA-G1-D and said “so we have this for stories. We have possible games like these ones, or different, some points of text, the news (.) local news”. As he read the entries he wrote the last list item as ‘News’ to Inscription SA-G1-D. Grant then suggested they display the two inscriptions together to show how the Blog entries would look in the context of the bigger Blog structure design. In this way, Inscription SA-G1-E, which started as an explanation, became part of the presentation to the researchers.

Figure 8. Inscription SA-G1-E
The Development of Inscriptions in Study-A Group 2

Study-A Group 2 (Meg, Angus and Dom) created a total of four inscriptions. The first inscription was created on a notepad and all remaining inscriptions were created on Wall A. The group started by reading the design task on the scaffolding printed pages. We provided this group with information on stages in the design process including ways of understanding the design problem, developing a plan and the design concept, and general strategies to deal with their specific design issues. The Group then looked at sample Blogs on the Internet using the interactive whiteboard. They mainly concentrated on the visual features of the Blogs and on their navigation systems.

The Development of Inscriptions SA-G2-A and SA-G2-B

This group was discussing their aim for the Blog and who it would target when Angus started writing on his own note-taking papers. When Meg saw that Angus was writing, she asked “are you going to be the scribe?”. This event is illustrated in the extract of talk in Table 7. Angus agreed and then decided to write on the notepad provided as one of the tools in the design studio (line 204, Table 2). This inscription is labelled Inscription SA-G2-A and is illustrated in Figure 9. Inscription SA-G2-A was initiated as a way to capture the group’s ideas but was never discussed in the group as a shared resource.

Table 7 - Event: Study-A Group 2 Initiated Inscription SA-G2-A

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>199</td>
<td>0:45:41</td>
<td>Meg:</td>
<td>Are you going to be the scribe</td>
<td>Posture: sitting across the table from Angus and turns face towards</td>
</tr>
</tbody>
</table>
When Angus was writing the list in Inscription SA-G2-A on the writing pad the other two members did not engage with the inscription creation process because they
could not see the inscription. After writing on the notepad for a while, Angus picked up a whiteboard marker pen from the table. He then turned around and looked at Wall A. After a few seconds he stood up and went closer to the wall. The point at which Angus decided to transfer his notes from the paper onto the whiteboard wall is shown in Table 8. Inscription SA-G2-B was initiated as a way to capture the group’s ideas in a more visible form. When Angus stood up to write the list on the whiteboard, he took the writing pad he had written on with him. He checked the list on the writing pad repeatedly as he was writing on the whiteboard wall. The other two members started commenting on the contents of the inscription as soon as Angus started writing on the wall. Angus incorporated the group’s ideas into the inscription, and the inscription evolved as part of the discussion. Inscription SA-G2-B was mostly used during the session for capturing ideas and decisions made.

Table 8 - Event: Study-A Group 2 Initiated Inscription SA-G2-B

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>301</td>
<td>0:52:35</td>
<td>Dom:</td>
<td>Yeah I guess(.) so the aim or the target(.) Water conservation or support the Basin plan</td>
<td></td>
</tr>
<tr>
<td>302</td>
<td>0:52:46</td>
<td>Angus:</td>
<td>Is it useful to start recording it {up here somewhere} rather than just so it’s all in here</td>
<td>Posture: getting up from the chair and going closer to Wall A D-Gesture: right hand touching Wall A.</td>
</tr>
<tr>
<td>303</td>
<td>0:52:47</td>
<td>Meg:</td>
<td>[Yeah</td>
<td></td>
</tr>
<tr>
<td>304</td>
<td>0:52:47</td>
<td>Dom:</td>
<td>[Yeah</td>
<td></td>
</tr>
<tr>
<td>305</td>
<td>0:53:02</td>
<td>Angus:</td>
<td>@<em>So</em>@ the aim</td>
<td>Drawing: writes the word ‘Aim’ and draws a line under it.</td>
</tr>
<tr>
<td>306</td>
<td>0:53:03</td>
<td>Dom:</td>
<td>I think support the Basin plan</td>
<td></td>
</tr>
</tbody>
</table>
To make Inscription SA-G2-B in Figure 10 (enhanced version in Figure 11), Angus wrote on the wall ‘Aim’ and then underlined it. He turned around asking the other two members, “So the aim?”. Dom replied, “I think support the Basin plan”. Angus added ‘Generate support for the MDB plan’. Meg stated “So it’s a public…”. Angus laughed and said “please any advice on refining”. Dom also agreed with the term and said “Yep that’s (.) yeah public support”. Angus erased the word ‘Generate’ and then added ‘Generate Public’ to the previous sentence. Angus then asked what the content type would be and if it would generate enough news to sustain the Blog. The group then discussed how the Blog could be used to generate support for the Murray Darling Basin Plan but that they also needed to listen to the views of the people in the area. Angus suggested that the Blog should invite debate and discussion. After a minute of discussion, Angus wrote on the wall ‘Open Forum’ and said “it’s kind of an open forum sort of”. The other two members agreed. Dom then suggested that the Blog could have a news stream of things such as for example “a farmer has done this kind of water saving measure and its meant that they’ve saved this much money on water and their farm is this much better because they’ve done” this and also “profile of a cute little animal that’s endangered”. Angus wrote ‘News Stream’ and ‘e.g. Farmer using water saving measure’ below it, and then ‘Cute animal’ at the bottom.

Meg then suggested that the Blog could have multiple target audiences. Angus drew a curved line as a bracket to contain the previous two lines of writing and then a line going out. At the end of this line he wrote ‘targets’ and ‘multiple’ below it and then ‘users’ at the bottom. Dom then suggested that if the Blog was targeting multiple users it could also have multiple themes such as “water conservation theme” or “farming
theme” etc. Angus said “and there might be a sort of tagging system in there to sort through the stories”. Dom and Meg agreed. Angus drew an arrow going down, below the previous terms that he wrote vertically on top of each other. He then wrote ‘topic’ and then ‘tagging’ below it and ‘system’ at the bottom, again each term was vertically below the previous one. Dom then opened a Blog page on the Interactive Whiteboard on the wall to show an example of a Blog with different themes and the way that users can choose to view a particular theme. During this time Angus turned back to the whiteboard and added a question mark to the term ‘Open Forum?’ that he wrote earlier. After watching the Blog for a while he again turned to the wall and added ‘/theme’ next to the word ‘topic’ that he wrote earlier.

For the next four minutes the group looked at the Blog on the interactive whiteboard while Dom described how the multiple themes might work to help a user choose specific content. Meg added “Or for the teacher, what to do in the classroom if there’s one on children. Things that children can do”. Angus looked around the whiteboard initially trying to find a space close to the inscriptions he made earlier. He then moved to the left side of the inscriptions he had already made and wrote ‘things for’ and ‘children to do’ below it. Above this he wrote ‘Teachers’, and then underlined it.

While Dom and Meg were still looking at the Blog on the Interactive Whiteboard, Angus finished the writing and then picked up the scaffolding printed pages, containing the task requirements, to read. He asked the other team members about how they would design the navigation when there were multiple themes. Dom and Meg started thinking about it and there was no response for over 20 seconds, when Angus looking at the scaffolding printed pages asked “So where are we up to exactly, or what haven't we
covered that we should be covering?”. After another ten seconds while Dom and Meg were looking at their copies of the scaffolding printed pages, Angus said “platforms”. The team then discussed how many of the Blogging platforms were similar. Dom suggested they choose WordPress because it offered more functionality, the user could have more control, and also add more modules to the Blog. Angus again went to the left side of the whiteboard and at the bottom of his previous writings added ‘Platform’ and then ‘Word press – functionality’ below it.

Dom looked at the Blog page and then at the scaffolding printed pages containing directions for the task. On the second page, there was a section suggesting what to consider when designing the Blog. One of the points asked: How many pages will you use to display your information? The team then discussed how the Blog should be organised and how many subsections it should have. Dom said that there was often an FAQ page and top level pages that stayed there permanently. Angus went to the far right side of the whiteboard and wrote ‘FAQ’ and then ’page’ underneath it. He then drew a circle around the ‘topic/these tagging system’ he had written earlier. He then drew a circle around the ‘FAQ page’ he had just written. Moving slowly in front of the whiteboard and looking at the inscriptions, he drew a circle around the term ‘News Stream’ that he had written earlier. At this stage, the green marker that Angus was using seemed to slowly lose colour, so Angus took another marker from the table.

The team then discussed the suggestions listed in the scaffolding printed pages provided to the group to see if they had addressed all the issues. They decided that the Blog should have multiple contributors who would add theme-specific contents to the Blog. They also decided that the contents should be concise and attract attention. Meg stated “And you’d want video”, Dom said “Make some videos yeah”. Angus who was
still standing in front of the whiteboard, turned around and on the far right side added ‘Video’ with the new blue marker and then drew a circle around it.

![Image of whiteboard with notes]

Figure 10. Inscription SA-G2-B

![Image of whiteboard with notes (enhanced)]

Figure 11. Inscription SA-G2-B (enhanced for legibility)

**The Development of Inscriptions SA-G2-C and SA-G2-D**

After the creation of inscription SA-G2-B, the group decided to type their design concept on the computer that was projected on Wall A. Inscriptions SA-G2-C and SA-G2-D were created during this time. The group was discussed the design concept for the Blog as Angus typed the design concept using Microsoft Word. Dom tried to describe
his ideas for the Blog but after a thinking gap of almost five seconds (lines 697 and 698 of Table 9), he decided to draw his ideas on the whiteboard wall.

Table 9 - Event: Study-A Group 2 Initiated Inscription SA-G2-C

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>691</td>
<td>1:19:17</td>
<td>Dom:</td>
<td>So do we need a section for students</td>
<td></td>
</tr>
<tr>
<td>692</td>
<td>1:19:22</td>
<td>Meg:</td>
<td>You don’t need to</td>
<td></td>
</tr>
<tr>
<td>693</td>
<td>1:19:24</td>
<td>Dom:</td>
<td>Because I mean they wouldn’t just be</td>
<td></td>
</tr>
<tr>
<td>694</td>
<td>1:19:25</td>
<td>Angus:</td>
<td>[Yeah yeah</td>
<td></td>
</tr>
<tr>
<td>695</td>
<td>1:19:25</td>
<td>Dom:</td>
<td>[going and looking at it</td>
<td></td>
</tr>
<tr>
<td>696</td>
<td>1:19:26</td>
<td>Meg:</td>
<td>Yeah (.) OK</td>
<td></td>
</tr>
<tr>
<td>697</td>
<td>1:19:27</td>
<td>Dom:</td>
<td>So there would be a:</td>
<td>Gaze: looking at the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>interactive whiteboard,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>the Word document</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>projected on Wall A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and then at the empty</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>space on Wall A.</td>
</tr>
<tr>
<td>698</td>
<td>1:19:33</td>
<td>Dom:</td>
<td>that’s almost where I want to start drawing up a Blog on</td>
<td>Posture: gets up from</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>the wall</td>
<td>the chair and walks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>towards Wall A.</td>
</tr>
</tbody>
</table>

When Dom first started drawing the diagram in Inscription SA-G2-C (seen in Figure 12), he erased the previous Inscription SA-G2-B from the wall. When Angus saw Dom wiping the wall he stated “yeah, yeah, I don’t think we need that anymore”. Dom replied “They’ve got all that” while pointing at the camera recording the design session on the ceiling. Angus continued finishing his statement “Just some idea generation” and Dom again replied “yeah and they’ve got photos of it...yeah we've got
most of that, over there now”. By “that over there now”, Dom meant that most of the information in Inscription SA-G2-B had been transferred to the Word document.

Dom then started drawing an outline for the Blog page with a line on the top and two sides. He did not draw a line at the bottom, leaving the space open for further additions later. He then drew a line near the top, separating space for the Blog banner, and wrote ‘Murray-Darling Plan’ inside it. The title extended almost to the end of the banner on the right so Dom erased the right side boundary line for the Blog and drew another one extending the Blog page to make it wider. He drew some wavy lines to represent a river in the banner with some frogs and fish floating through. Dom then picked up one green and one red colour marker and drew the trees in the banner and commented, “we don’t have the right colour textas”. He then added the image of a kangaroo and some more fish in the water. In the meantime, Angus was still typing on the computer projected on the wall while Meg suggested wording and terms to include in the document.

Next, Dom wrote ‘FAQ’ and ‘For Teachers’ and ‘Links’ on the far right side of the Blog page. Meg asked, “so is this the permanent stuff?”, to which Dom replied, “Yeah... so permanent stuff down... the links”. He then erased the underline from the ‘Link’ saying “that’s a heading so I shouldn’t underline it. That’s a link, that’s a link” pointing to and underlining the ‘FAQ’ and the ‘For Teachers’ terms he had written earlier. Below the ‘Links’ heading, he added ‘MDB Plan’ and ‘Dept site’, he then underlined them to show they were both links. Meg said that the scaffolding printed pages they had received also had more resources such as Save the Murray and also ABC Catalyst. Dom added ‘Save the Murray’ and ‘ABC Coverage’ as more links in this section. After briefly looking at the scaffolding printed pages, Dom stated “maybe
change links to more info or something” and erased the ‘Links’ heading replacing it with ‘MORE INFO’ and ‘blurb’ in smaller text below it.

Dom then moved to the middle of the Blog page and added the term ‘HEADING’. Meg asked “So what are our sections? So there’s one on teaching ideas (. ) one on resources”. Dom replied “So I guess in this section” pointing to the ‘For Teachers’ link, “that would then link off to another page” pointing to the empty space to the right of the Blog drawing “of those things” pointing to the Word document projected on the wall where Angus was occasionally adding more details.

Figure 12. Inscription SA-G2-C
At this stage Dom drew a small arrow from the ‘For Teachers’ link going towards the empty space on the right side of the Blog and then drew the outline for another page (see inscription SA-G2-D in Figure 13). He then stated that the page should have two sections; one on teaching ideas and another one about resources available. Dom swiftly drew a diagram (Inscription SA-G2-D) and stated “the thing is to have multiple {pages like this}”, pointing to Inscription SA-G2-D, “but follow a standard format but link back {to here I guess}”, pointing to the links on the right side of the Blog page (Inscription SA-G2-C).

Figure 13. Inscription SA-G2-D

Dom returned to inscription SA-G2-C and explained, “We had the consistent stuff down the left” pointing at the links section on the right side of the Blog page, “consistent banner across the top” pointing to the banner for the Blog, “so we’ve got a
consistent site”. Meg asked “and here would be our (. ) the aim of the site?” Dom replied “well this is the main page” stretching his arms across the space over Inscription SA-G2-C, “because it’s a Blog (. ) in here Blog entries” pointing to the middle of the Blog page.

Dom then concentrated on the contents section of the Blog where he had placed the term ‘HEADING’ earlier. He first replaced this term with ‘BLOG ENTRY HEADING’. Next, he added a bubble shape on the right of the headings and wrote ‘THEME ICON’ inside it, while he discussed how the Blog would have different themes to represent different issues such as farming or water conservation.

Following this discussion, he added another heading, ‘Content’, below the previous heading, and drew lines below it to represent text flowing on the page. He then drew two small boxes one vertically on the left and another one horizontally on the right side surrounded by the lines that represented text. He stated “typical Blog has at least one photo in it, or video” and wrote ‘photo’ in the first box and ‘VID” in the second box.

Angus then suggested that there should be a comments section at the bottom of the page and Dom added ‘Comments’ at the end of the contents section. Meg said “So there needs to be somewhere in, there needs to be part of the navigation I guess for the users to upload Blog entries, to add comments”. Dom replied “Yeah that’s for logged in users”. He then went to the links section on the right side of the Blog page and added ‘Log in’ between dotted lines on the top and below. Dom also suggested that the users who had logged in, such as students, should be able to see comments only from their own class so they could more freely discuss the issues among themselves. Next, Dom
added ‘Themes’ followed by four short horizontal lines below the ‘Log in’ link to represent another way that the users would be able to access different themes.

Meg suggested that a page footer should be included, stating “there needs to be at the bottom who this is, who this site is developed by”. Dom leaned down towards the bottom of the whiteboard wall and drew a horizontal line below the contents section. He then added ‘Who’ followed by ‘Privacy’ and ‘Contacts’ below the horizontal line.

Dom returned his attention to the Blog page that was displayed on the Interactive Whiteboard explaining that some Blogs had related stories at the bottom of the page that enabled the users to have access to large amounts of news stories. After showing the links to related stories at the bottom of the Blog site, Dom returned to the wall and added ‘RELATED STORIES’ to the right side of the ‘VID’ box and then drew four short horizontal lines below it.

The group then discussed how a user could have an option that allowed them to relate their Blog entry to previous themes, or even sub-themes, and how this process could also be automated for them. Dom added ‘(SUB THEMES)’ below the bubble with the term ‘THEME ICON’ inside. Next Dom asked “anything else we need in it?” to which Meg replied “minor stuff, you know date and all that kind of stuff, date and time”. Dom added ‘metadata’ in very small text below the ‘BLOG ENTRY HEADING’. The team then discussed that the purpose of the Blog needed to be clear since it is an educational Blog, and preferably the purpose should be included somewhere at the top. Dom wrote ‘A SITE FOR STUDENTS & TEACHERS’ in the banner on the far right side next to the trees and Blog title. At the end of the session, the group used inscriptions SA-G2-C and SA-G2-D to demonstrate their design concept to the researchers.
The Development of Inscriptions in Study-A Group 3

Group 3 (Taryn, Julia and Darren) created a total of three inscriptions. The following sections will describe how each of these inscriptions were created, the visible actions that influenced their development and progress, and how each ceased to be the focus of attention, and led to the creation of the next inscription.

This group started their design session by reading the scaffolding printed pages given to them as part of the design task. The scaffold given to this group provided suggestions about how to use the tools available in the Design Studio. They then used the computer that was projected on Wall A to search for types of Blogs, as well as interesting Blogs, as examples that they could follow.

The Development of Inscription SA-G3-A

The first inscription created by Group 3 was Inscription SA-G3-A illustrated in Figure 14. The group started the inscription as a way to capture ideas and extract information from a website that they had found, that was projected on Wall A. An extract of the talk (Table 10) illustrates how the participants decided to ‘catch’ ideas from a website that listed the major Blog types and provided advice on what should be included in each type that would target a specific audience, such as company Blogs versus private Blogs, or information Blogs versus creative rants. After discussing the information on this web page, Taryn suggested that they record the information and later added “we’ll catch those” (line 348, Table 10). Therefore Inscription SA-G3-A was primarily created in order to capture ideas.
<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>341</td>
<td>0:39:39</td>
<td>Darren:</td>
<td>So you think we have to {consider these three}</td>
<td>D-Gesture: touching Wall A where a Blog page was projected.</td>
</tr>
<tr>
<td>342</td>
<td>0:39:42</td>
<td>Taryn:</td>
<td>yeah</td>
<td></td>
</tr>
<tr>
<td>343</td>
<td>0:39:42</td>
<td>Darren:</td>
<td><em>CSAA criterium</em> create theory for what we are going to design right?</td>
<td>Reading: from the webpage about Blogs projected onto Wall A.</td>
</tr>
<tr>
<td>344</td>
<td>0:39:47</td>
<td>Taryn:</td>
<td>OK (.) do we want to write those</td>
<td>Resource: getting a marker pen from the main table.</td>
</tr>
<tr>
<td>345</td>
<td>0:39:50</td>
<td>Julia:</td>
<td>So it’s not the cultural</td>
<td></td>
</tr>
<tr>
<td>346</td>
<td>0:39:52</td>
<td>Taryn:</td>
<td>Now we’ll just make sure we’ve got white ones (.) <em>White board markers</em> there we go (.) You can write them on the wall</td>
<td>Reading: the label on the marker.</td>
</tr>
<tr>
<td>347</td>
<td>0:39:58</td>
<td>Darren:</td>
<td>So</td>
<td></td>
</tr>
<tr>
<td>348</td>
<td>0:39:58</td>
<td>Taryn:</td>
<td>we’ll catch those</td>
<td>Gaze: looking at the webpage about Blogs projected onto Wall A.</td>
</tr>
<tr>
<td>349</td>
<td>0:40:00</td>
<td>Darren:</td>
<td>So what title shall we put here haa: design consideration</td>
<td>Starting to write on Wall A.</td>
</tr>
<tr>
<td>350</td>
<td>0:40:04</td>
<td>Taryn:</td>
<td>Yeah</td>
<td></td>
</tr>
</tbody>
</table>

The process of creating inscription SA-G3-A is described in the following. After reviewing the information, the participants decided to follow the advice provided on the website about defining the purpose of the Blog. Darren started writing the title for these notes as ‘Design Considerations’ next to the screen projection on Wall A. He then started writing the points to define what the Blog will be designed to do. The first point
was that the Blog should be informative. The next point was voiced by Taryn who stated that the Blog needed to be emotive and they needed a rallying point. This, according to Taryn, was the central idea for why people would visit the Blog. Darren asked what the third point would be and Taryn stated that she liked the advice on the website that said a company website should be approachable. Taryn stated “it’s human but it does a good job of educating”. For the next point, Julia stated that she liked the website’s advice about taking into account cultural issues. After a brief discussion about the exact wording of the point, Taryn stated “maybe we can say (.) draw on the cultural significance”. Darren was recording all these points in a list format on the wall (Inscription SA-G3-A). After some further discussion about what other advice should be taken from the website, the team decided to combine points one and three in the list because they were both about educating people about the issues and problems at the Murray Darling Basin. Accordingly, Darren drew a line connecting points one and three, designating them both as point one.

After connecting points one and three, Taryn stated that they now needed another point that would account for how people would have a personal experience on the Blog. Darren reacted with confusion to this statement. He went to the wall, underlining the words ‘emotive’ and ‘rallying’, and asked “This one is emotive (.) What’s this what's this one”. This question prompted Taryn to draw another inscription in order to explain what these two points meant.
Chapter Seven

Figure 14. Inscription SA-G3-A

The Development of Inscription SA-G3-B

The second inscription by Study-A Group 3 was Inscription SA-G3-B, illustrated in Figure 15. As mentioned earlier, this inscription was initiated as an explanation of point 2 in the list in Inscription SA-G3-A. The following extract of talk (Table 11), in particular Taryn’s explanation while drawing (line 430), illustrates how the team started drawing the diagram in Inscription SA-G3-B as an explanation of ideas.

Table 11 - Event: Study-A Group 3 Initiated Inscription SA-G3-B

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>423</td>
<td>0:46:09</td>
<td>Julia:</td>
<td>Why don’t we combine number one and three?</td>
<td></td>
</tr>
<tr>
<td>424</td>
<td>0:46:13</td>
<td>Taryn:</td>
<td>OK (.) that would be (.) yeah</td>
<td></td>
</tr>
<tr>
<td>425</td>
<td>0:46:14</td>
<td>Darren:</td>
<td>Yeah</td>
<td></td>
</tr>
<tr>
<td>426</td>
<td>0:46:15</td>
<td>Taryn:</td>
<td>So we put one and three together</td>
<td>Darren draws a line</td>
</tr>
</tbody>
</table>
connecting items 1 and 3 in the list.

427 0:46:20  Darren: OK So we put @that as one_@  
Drawing: adds the number 1 next to the line.

428 0:46:23  Taryn: And then we have another one because {those ones are about educating and speaking out} 
D-Gesture: right hand with index finger extended points towards inscription SA-G3-B.

429 0:46:29  Darren: @_This one is emotive_@  
@_What’s this_@ what's this one Drawing 1: drawing a line under the term ‘Emotive’. 
Drawing 2: drawing a line under the term ‘Rallying’.

430 0:46:36  Taryn: OK:: I’m not very good at drawing but () if you think about (3) so you’ve got @_your Blog_@ and @_then the people out here_@ 
OK you’ve @_got readers_@ you’ve got @_people who live there_@ you’ve also got @_people who work there_@  
Drawing 1: drawing the Blog square box and writes the word Blog inside it. 
Drawing 2: drawing stick figures to the right of the Blog. 
Drawing 3: writing the word Readers under the stick figures. 
Drawing 4: drawing stick figures to the left of the Blog square and writing ‘people who live there’ underneath it. 
Drawing 5: drawing stick figures below the Blog square.
The process of creating inscription SA-G3-B occurred as follows. Darren’s confusion at the terms in item two of the list prompted Taryn to explain how she saw the connection of the stakeholders to the Blog and the private experience she imagined that the visitors to the Blog would have. She started a new inscription by drawing a square with the word ‘Blog’ inside and said “OK (.) I’m not very good at drawing but if you think about (.) so you’ve got the Blog and then the people out here” (see Inscription SA-G3-B, Figure 15).

Taryn then drew three sets of stick figures to represent people who live in the area of the Murray Darling Basin, people who would be the expected readers of the Blog, and people who work in the area, which she labelled as economic. Taryn then drew a circle round the stick figures representing the readers and stated “so that’s the Blog going out but then you’ve got @_ all these people _@”. She then continued while drawing a line connecting the circle to the square in the middle saying “@_ who bring in their experience here _@ which tends to be the (.) we call it private maybe but it’s not really private but private experience and they’re posting here”. Towards the end of this statement she wrote ‘private exp’ on top of the line she had just drawn.

Darren asked how they would bring the audience to the Blog. To this, Taryn replied “you get them coming in because they’re cross about something or they’re upset about something”. Julia who was listening to the entire conversation stepped in and pointing towards the private experience, then the readers’ stick figures, and then the people who live there figures, asked “Sorry by this one do you mean these people or these people?”. To this Darren replied “anyone” and Taryn said “anybody... So it goes both ways” and she drew another line above the private experience line to connect the
Blog square to the people figures. Taryn also drew two lines connecting the people who live there to the Blog and back again. Julia then asked “and where does the admin belong to (.) like to which group?”. The group then decided that they were, themselves, the admin group and so Julia took a pen and wrote the words ‘Admin’ and then in parentheses ‘(us)’ followed by a question mark, indicating she was still not sure who else should be in the admin group.

Julia then said “I think here we should have… like we’d better have one of these people in the group of admins”, pointing to the stick figures for people who live there. Taryn agreed and Julia drew a line and arrow connecting the stick figures to the ‘Admin’.

Darren asked where another group of people would belong; those who would not have anything valuable to contribute but who were visiting the Blog and who may even post comments. Taryn replied “we don’t want people who aren’t participating in this process”, by which she meant that they do not want people on the Blog who are not part of the rallying – finding information – process. After a short discussion, Taryn asked Julia “do you want to start a timeline of what needs to be done?”. Julia asked “so it’s a process?”, to which Taryn answered “process yeah”. This is when the group moved on to create the next inscription, SA-G3-C.
The Development of Inscription SA-G3-C into SA-G3-C1 and SA-G3-C2

The group discussed the stakeholders and how the Blog would address their specific needs when Taryn suggested that Julia should start noting how the Blog would function, such as where the contents would come from and how it would be implemented. The extract of talk in Table 12 illustrates how the group initiated the drawing of Inscription SA-G3-C. The inscription started as a way to capture ideas and decisions made during the discussion around the previous two inscriptions. Of particular interest are lines 467 and 471. In line 467, the talk is about capturing ideas about what needs to be done. In line 471, it appears that Taryn expects that the inscription will change.
Table 12 - *Event: Study-A Group 3 Initiated Inscription SA-G3-C*

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>467</td>
<td>0:51:36</td>
<td>Taryn:</td>
<td>So do we want to (.) do {you want to start a timeline of} what needs to be done?</td>
<td>D-Gesture: left hand pointing towards the empty space on Wall A next to inscription SA-G3-B.</td>
</tr>
<tr>
<td>468</td>
<td>0:51:40</td>
<td>Julia:</td>
<td>So it’s a process</td>
<td>Julia starts writing the heading ‘Process’ for inscription SA-G3-C.</td>
</tr>
<tr>
<td>469</td>
<td>0:51:42</td>
<td>Taryn:</td>
<td>Process yeah</td>
<td></td>
</tr>
<tr>
<td>470</td>
<td>0:51:55</td>
<td>Julia:</td>
<td>So should {I put this as the first one} or</td>
<td>D-Gesture: pointing with right hand towards inscription SA-G3-B.</td>
</tr>
<tr>
<td>471</td>
<td>0:51:57</td>
<td>Taryn:</td>
<td>We can change it so just start getting it written up and we can just</td>
<td></td>
</tr>
</tbody>
</table>

The process of creating inscription SA-G3-C started when Julia wrote the title “Process” to the right side of the two previous inscriptions as illustrated in Figure 16. At this stage, the group was discussing how they would gather the information for the Blog and who would be responsible to put it all together. Julia was recording these ideas (list item 1 to list item 1.3 in Inscription SA-G3-C).
During the time when the group was creating inscription SA-G3-C, they briefly redirected their attention to the previous inscription. Taryn recommended that the term admin should be changed to designer/moderator because she stated “then you’ve got the idea that somebody is responsible as opposed to just some boring admin person”. Julia accordingly crossed the word ‘Admin’ and wrote ‘Designer/moderator’ next to it (Inscription SA-G3-B).

At this point, Taryn diverted her attention to the scaffolding printed pages containing the design task. One page had information about the design process illustrated in a circular process diagram (see Appendix Three for the diagram). The diagram in this page showed a five stage design process; discovery, interpretation, ideation, experimentation, and evolution.

Taryn was worried that what they were doing was different than the advice provided for the process of design. She noted that the process they were following (as in Inscription SA-G3-C) was linear whereas the diagram in the scaffolding printed pages illustrated a non-linear process. At this point, Darren looked at the diagram on the printed page and went to the interactive whiteboard and tried searching for the ideation step.
Julia responded to Taryn’s concern by stating “I see this as quite matched with this. Like this can go like (.) like a circle kind of process”. Julia then drew three curved lines with arrows connecting back to point one, data gathering. She then stated that the second point could be the categorisation and classification of the data. At this stage the linear list in inscription SA-G3-C was transformed into a circular diagram in inscription SA-G3-C1, illustrated in Figure 17.

![Figure 17. Inscription SA-G3-C1](image)

Taryn then suggested that Julia take a different colour pen and try to map the diagram in the paper to the one on the whiteboard. Julia labelled point one as ‘Discovery’ and point two as ‘interpretation’. The group then discussed what the other steps in the process would be and how they would address them. Taryn pointed to the Inscription SA-G3-B and asked “So what would be the steps that we needed to do for 2 to get it done?”. This again indicates that Inscription SA-G3-B was the explanation of point 2 in Inscription SA-G3-A.
The group then had a discussion about how the Blog needed to communicate to all the stakeholders involved that the improvement of the environment at the basin was more important than economic and social issues. They also discussed whether the contents of the Blog would be sourced from scientific findings or from people or groups passionate about protecting the environment. They decided that there should be a balance of both sources.

For step three of the diagram, Julia suggested that the data could be gathered and then used as a call-for-action to involve the community to do further research. They called this stage ‘food for thought’. Julia then suggested that ‘experiment and update’ should be the final point on the diagram. As there was no space for point four on the wall, Julia wrote the term on a sticky note and placed it on the wall as point four (see image 1 of Figure 18).

The group were discussing the stakeholders and their interests when Darren asked “based on what we have all discussed can we start working on this now?”, pointing to the scaffolding printed pages about coming up with a design concept, goals and purpose for the Blog. Darren opened a PowerPoint file on the Interactive Whiteboard but had trouble typing as the program did not respond. The group spent the next two minutes trying to make the program work and then decided to move to another computer projected on Wall A and type the goals and methods for their Blog. At this stage Taryn was typing while Darren and Julia were providing ideas. Taryn repeatedly referred back to the inscriptions on the wall to try to copy the ideas and decisions made.

The group typed their ideas for the goal and decided to transfer the diagram from the wall to the Word document on the computer. However, the group experienced problems with the diagram feature/tool in the Word document. Consequently, they
decided not to re-create the diagram on the computer and instead to use the process diagram on the wall as their design concept sketch and present it to the researchers at the end. They erased Inscriptions SA-G3-A and SA-G3-B and Darren started to draw a new diagram where the previous two inscriptions had been. Taryn suggested they just ‘clean this’ and use the existing SA-G3-C1 diagram for presentation.

The group then decided to follow the diagram in the scaffolding printed pages further by mapping the stages in the design process diagram to the one on the wall. As a result, the step three ‘Food for thought’ was labelled ‘Ideation’, (image 2 of Figure 18). Julia also drew a circle around the sticky note. She then noticed there was more space on the wall now that the two previous inscriptions were erased. She removed the sticky note and wrote the term ‘experiment & update’ in its place on the wall as the fourth stage in the process (image 3 of Figure 18).

The group had a lengthy discussion about the ‘experiment & update’ stage. They discussed how this stage could be about the designer/moderator taking all the data and connecting it together to come up with ideas or experiments to run in the wild and then update the Blog about their results. And this process would loop back into collecting more data in the form of stories from the people living in the area. The scientist would collect evidence of environmental damage and then conduct more experiments in the wild. Consequently, they decided to divide the ‘experiment & update’ stage into two stages: ‘Connect’ as stage four and ‘update’ as stage five on the diagram (image 4 of Figure 18). At this stage, the researchers entered the Design Studio. Since the group was asked by the researchers to produce a design concept and a sketch for the Blog, the group used inscription SA-G3-C2 to demonstrate their ideas.
Summary of Results for Study-A

Inscription Information Flow

Information flow refers to how information was used and then re-presented by each group. Although each group was asked to produce only one design concept sketch, they all created more than one inscription throughout their design sessions. The participants moved from one type of inscription to another in order to better understand the design problem or to communicate their ideas. According to Lunsford and colleagues (2007), the longer the path to the ultimate inscription the more advanced the level of transformation skills required.

The diagram in Figure 19 visualises the information flow for each of Study-A groups. This diagram demonstrates how each group reached their ultimate inscription/s
that they used for demonstration of ideas to the researchers at the end. This will be
followed by a brief description of the information flow for each group.

![Diagram of Information Flow for Inscriptions Created in Study-A](image)

Figure 19. Inscription information flow for Study-A groups
Group 1

Study-A Group 1 started by looking at web pages about Blogs. The information extracted from these web pages was then recorded in inscription SA-G1-A and SA-G1-B. These two inscriptions were text-based. Inscription SA-G1-C was a summary of these text-based inscriptions represented in a more abstract graphical format. All the decisions made during the previous inscriptions were then summarised in inscription SA-G1-D. At the same time inscription SA-G1-E was created as a direct inspiration from a sample Blog. Some of the ideas discussed during the creation of SA-G1-E also inspired some features of SA-G1-D. This process is visualised in the diagram in Figure 19.

Group 2

Study-A Group 2 started by looking at some example Blogs. Some information and ideas captured from the Blogs were recorded in inscription SA-G2-A. Inscription SA-G2-A was then transferred to the wall creating inscription SA-G2-B. The ideas discussed during this time were recorded in a Word document. The Word document was created at the same time as inscriptions SA-G2-C and SA-G2-D and as a result the information flow was both ways. The ideas recorded in the Word document influenced some of the ideas drawn in the inscriptions and vice versa. At the same time the participants were also actively extracting ideas from the example Blog pages, which consequently influenced both the inscriptions and the information recorded in the Word document. This process is visualised in the middle section of the diagram in Figure 19.

Group 3

Study-A Group 3 started by looking at a website and information captured from this website was recorded in inscription SA-G3-A. Therefore inscription SA-G3-A was
an abstraction of the information in the website. Inscription SA-G3-B was an explanation of the second list item in inscription SA-G3-A and, as such, it was again an abstraction. It was like zooming in and selecting only one item from the list and then enlarging that item for exploration. Inscription SA-G3-C was the result of discussion about SA-G3-A and SA-G3-B and, as such, SA-G3-C was a summary of decisions made during the two previous inscriptions. Inscription SA-G3-C1 was created from SA-G3-C and inspired by the diagram in the scaffolding printed pages. The ideas discussed up to this point were recorded in the Word document and all of the ideas then led to the development of inscription SA-G3-C2 as the ultimate inscription. This process is also visualised in the diagram in Figure 19.

**Inscriptions Transition Process**

Scientists often create several inscriptions as they transition from one form of representation to the next. As they progress through this process, they translate inscriptions through other inscriptions creating cascades of inscriptions (Roth & Tobin, 1997). The translation from one form of inscription to another is not thought to be a conscious process (Roth, 2003a). The participants in this study created different types of inscriptions as they progressed and transitioned from one type of inscription to the next. The diagram representation in Figure 20 visualises the process of moving from one type of inscription to another as the meetings progressed. Text-based inscriptions are illustrated in blue and diagrams are in red. The types of inscriptions will be further explained in the semiotic analysis in Chapter Nine.
Study-A groups created mainly text-based inscriptions initially and more complex diagrams towards the end of the meeting. Although Figure 20 shows that Study-A Group 3 started with a text-based list and then moved to an abstract diagram and again reverted back to a pure list, since this pure list was later converted to a diagram, a claim can still be made that every group in Study-A moved towards more complex inscriptions as the meetings progressed. All of Study-A groups presented their design concept to the researchers at the end using some form of complex diagram. This may
provide some evidence as to how ideas in educational design team meetings start as simple and become more complex towards their completion.

**Influence of External Sources**

In Study-A, all three groups began by capturing ideas from outside sources such as a web page or an example Blog. This may indicate that the participants needed some form of a starting point. Group 1 captured their ideas from a website that was explaining the environmental issues at the Murray Darling Basin and thus this group mainly discussed these environmental issues during the creation of their first inscription. Group 2 looked at an example Blog and how it used different themes to target different audiences. As a result, Group 2 mostly concentrated on how the solution Blog would look visually. Group 3 captured their information from a webpage that explained the functions of different Blogs including an educational Blog. Thus, Group 3 mostly discussed how the Blog would be used to educate people about the environmental issues at the Basin.

In addition to the starting point, external resources also influenced the direction of design decisions during the meeting. For example, in Group 3, the participants changed the text-based list inscription in SA-G3-C to a process diagram in SA-G3-C1 as a result of seeing a similar circular diagram in the scaffolding printed pages. In Group 1, Natasha proposed a new idea about using a moving clickable image in the banner of the Blog after showing an example Blog to the other members with a similar clickable image. These examples demonstrate that educational designers’ ideas are influenced and can be even shaped by external resources.
The Influence of the Medium

The type of medium used for drawing inscriptions was important as it could influence collaboration. For example, in Group 2 Angus started creating the first inscription SA-G2-A on a notepad. The notepad was positioned on the main table in front of Angus. Although the other members could see the notepad they could not read the inscription written on it. During this time the other two participants did not comment on what Angus was writing. It was only when Angus started to transfer the ideas from this inscription to the wall (inscription SA-G2-B), that Meg and Dom started to provide feedback to Angus regarding what should be included, and even the wording, in the inscription. This changed inscription SA-G2-B from initially a copy of SA-G2-A to a record of collaborative idea generation by the group.

Can’t Say it in Words

Drawing inscriptions helped the participants to express ideas that they had trouble explaining with words and gestures alone. In Study-A Group 1, Natasha was trying to explain to the other group members how she would adapt the ideas from the example Blog into the design of the banner for their solution Blog when she realised Grant was still confused about what she meant. She stated "So (.) actually maybe we should draw it (.) because I think it’s (.) sort of..." and then she started drawing inscription SA-G1-E. In Group 2 Dom also had trouble explaining what the Blog would look like and realised he needed to show the other participants his ideas. He stated “that’s almost where I want to start drawing up a Blog on the wall” before starting to draw the diagram in inscription SA-G2-C. In Group 3, Taryn started drawing the diagram in inscription SA-G3-B as a way to explain how the Blog will attract users and contributors. She was responding to
Darren’s uncertainty about a term used in inscription SA-G3-A but had trouble explaining her ideas. After a while during the discussion she stated “OK (.) I’m not very good at drawing but if you think about...” and she started drawing inscription SA-G3-B. These examples illustrate how drawing can help the designers express their ideas, which can be challenging to express in words alone. Drawing is a way of expression that others can see. When ideas are expressed in such a public way they are made available to discuss, evaluate and debate.

**Inscriptions for Presentation are for Keeping**

The three Study-A groups were asked to produce one sketch for the Blog, however each group created more than one inscription. Group 3 created three inscriptions in total; however they erased two of the inscriptions and only kept the one they intended to present to the researchers at the end. Group 2 similarly erased inscription SA-G2-B from the wall before drawing the sketch of the Blog that they presented to the researchers at the end. Both of these groups utilised the inscriptions that they erased to share ideas, gather ideas as in brainstorm, to explain something they could not in words alone, and to capture ideas so they could hold them in place until they were used in the final inscription used for demonstration. Still, these inscriptions were erased; as if considered not important. These inscriptions had done their job and were no longer needed. Only the inscriptions used for presentation at the end were worth keeping.

In Group 1, Grant was the only one who did not erase the inscriptions he made. When there was not enough space on the wall to create inscription SA-G1-D, he looked around the design studio to find another space for writing and drawing. At one stage he
unsuccessfully tried to cover the light from the projector A in order to use that space on the wall for more drawings. When he realised he could not use the space on the wall, he again looked around the studio until he found the paper-roll on the main table. This may be important to note because Grant had a background in engineering and, as described in the background literature review for this study, sketching is a key feature and a fundamental process throughout all the stages of engineering design.

This concludes Chapter Seven. In Chapter Eight I am presenting the results, in the form of thin descriptions and a summary, for Study-B.
Chapter Eight: Study-B

This chapter presents the first set of results for Study-B. The chapter begins with an explanation of how the inscriptions created by the participants were separated for analysis. This is followed by the *thin* description. The thin description begins by providing an account of the meeting before the team separated into groups. Each group is then described separately. The thin description continues by describing the meeting after the groups joined together to finish the meeting. This is followed by a summary of what I see as significant in the results for Study-B.

**Separating the Inscriptions**

In Study-B, only Groups 1 and 2 created inscriptions. Group 1 created six inscriptions on Wall A (see the Design Studio map in Appendix One). Each inscription was identifiable, with a clear distinction from the surrounding inscriptions. Each inscription created by Group 1 was delineated by space and position on the wall, colour, as well as capitalising or underlining the titles for each inscription (see Figure 21). One group member created five of the inscriptions (with the exception of one point added to inscription SB-G1-A by another group member). A second group member created one inscription. The third and fourth members did not create any inscriptions.
Group 2 created inscriptions in a very interesting way. They used the images from PowerPoint slides projected on Wall B as the background for their drawings. During the meeting, the background slides changed a number of times while the drawings created over them on the wall remained. The inscriptions created in Group 2 could not be separated as easily as in Study-A groups or in Study-B Group 1. Nevertheless, for the purpose of analysis, the inscriptions in Group 2 were separated based on the following criteria:

- the author of each piece
- the type of inscription, such as diagram or text-based lists; and
- the background slide changes.

According to these criteria, Group 2 created five inscriptions. These are emphasised and numbered in Figure 22. The inscriptions are labelled using the following convention: SB (stands for Study-B) - G1 (Group 1) - A (the first inscription created by this group).
This part of the results provides a thin description of the way that the team in Study-B created their inscriptions. Study-B team was working on the design of an educational game where a polar bear, as the protagonist, would help children understand environmental issues that can be affected by humans. There were 13 members in Study-B team. Individual members arrived at various times before the team started to gather around the main table for their meeting. One member, Ghita, arrived later, when the team was already assembled around the main table and had started discussing the design of the game.

The first part or the title of the inscription on Wall A was written by Jarrod before the team assembled, during the preparation time when the rest of the team was introduced to the tools and technologies in the Design Studio and fitted with individual
microphones for the purpose of data gathering. During this preparation time, Kassidy asked Malcolm if they could set up different spaces for the three groups and load the prepared resources, such as the PowerPoint slides, on to some computers. Malcolm responded that it would depend on what needed to be displayed for each group. Kassidy looked up to Wall A and then to Wall B and said “I want to draw:: on the wa:ll”. Jarrod holding a marker pen up in his hand said “I’ve got a pen (. ) I am ready (. ) Is that the first thing (. ) draw on the wall?”. Kassidy replied “you could draw on the wall you could draw (. ) or we could talk about the first thing the IOS the tablet (. ) and the web (. ) what we are going to (. ) how they differ”. Here, Kassidy was standing at the main table, facing Wall A.

This is when Jarrod added the first title on the wall. He went to Wall A and as he was starting to write he said “ok (. ) so I write on the wall”. As Jarrod was adding the first part of the title ‘IOS’, he murmured to himself “Android”, as if he was intending to add it next to the ‘IOS’ in the title. Kassidy heard him and said “well its (. ) its phone tablet and web I guess”. Jarrod accordingly added ‘TABLET/PHONE/WEB’ to the title on Wall A. This title can be seen on the top section of Wall A in Figure 21, above all the inscriptions which were created by Group 1 later on. Group 1 did not erase this title and it remained for the duration of the team meeting.

In preparation for the design session, the team connected Kassidy’s laptop to Projector B. This laptop was used to display the PowerPoint slides, which Group 2 used in their discussion later. The interactive whiteboard was used to display the project management or progress chart as displayed in Figure 23. The Design Studio computer connected to Projector A was used to display the website where information about the game was presented, as illustrated in Figure 24. Malcolm also placed some printed
copies of the design brief/treatment around the main table for everyone to read during the meeting.

After the team assembled around the main table, Kassidy started by welcoming everyone and reminded them that one more team member was still on her way and would join them soon. She then stated that the main purpose for this meeting was to introduce the team members to each other and to gather ideas for the design of the game. She reminded everyone that there would be more iteration in this process and that their ideas were important for what she called “still a working document”.

After this initial introduction, each team member introduced themselves and stated what they would contribute to this project. When it was time for Jarrod to introduce himself, he also talked briefly about the background of the project. At one stage he pointed with his left hand to the website projected on Wall A (Figure 24), stating “It was looking more like photoshoppety, sort of photomontage when we started it off. We’ve ended up {more with this sort of} you know harder-edged look”. This prompted all the other team members to look at the projected website page on Wall A.

Figure 23. Study-B team Gantt chart displayed on the interactive whiteboard
After the introductions, Kassidy briefly discussed Ghita’s role in the project and stated that “we got some money some years ago to write up an animation series around this and we have a bible for that and the first script written”. She also talked about how the new design treatment document had changed to reflect the new developments after a series of meetings with some broadcasters and decisions made as the consequence of those meetings.

The team then discussed the need to define how the points and scoring system would operate in terms of what exactly would make the bear happy and how it would be measured. They also discussed the need to decide if the game would be made to influence real-world actions. Kassidy also wanted the groups to discuss how the players of the game would learn that their actions in the world influence the global environment. At around fifteen minutes into the meeting, Jarrod asked “Is it time to draw on the wall?”. Malcolm responded “Yeah, I think it’s time we started up a flow chart. I mean the next thing we’re going to be talking about in the next half an hour is looking at the data entry and the interaction. So we’re sort of moving along as per Kassidy’s
schedule”. Kassidy responded by enacting several deictic gestures towards Wall A (Line 62 Table 13). This further helped ground the discussion in the inscriptions on Wall A.

For around ten more minutes of the meeting there was no reference to any of the visual representations projected on the wall or the title inscription. During this time Kassidy called Ghita on her phone to help her find the design studio. As she returned from making the phone call, Malcolm asked her “Should we move on to the game play chart {on this: board behind everybody}?”. Here, Malcolm pointed with his entire right hand and index finger extended towards Wall B where the diagram was projected. Kassidy agreed. Jarrod suggested “You could switch {it to this one somehow}”, by which he meant to display the diagram on Projector A rather than Projector B at the back of the room. Here Jarrod used his gaze, looking at Wall A, and head gesture, moving his head slightly forward to point to Wall A. Tory was sitting with his back to Wall A and so anticipating that the diagram would appear on Wall A, he stood up, picked up his chair, and sat in front of the rails on the wall facing Wall A. Malcolm tried to display the diagram PowerPoint slide on the projector on Wall A, however he did not succeed and so Kassidy turned her face towards Projector B and started explaining the diagram. Although the diagram did not appear on the Wall A at this time, a few minutes later the diagram appeared and was displayed on both projectors in the room.

During this time, Kassidy’s posture and gaze both helped the team members to focus their attention on Wall B and the diagram. Some team members who had their backs to Wall B stood up and changed their position to face Wall B, so they could have a better view of the diagram being discussed. Kassidy also gestured with her hand several times towards the diagram projected on Wall B as in the following:
... so you can see the home screen and how that feeds into the glacier park and
part of what we were going to do was playing (.) I guess (.) mini games in the

game to keep the bear healthy. But you see {also on the left} you’ve got the...

As the discussion progressed, Kassidy enacted several deictic pointing gestures
towards the diagram. At one stage Kassidy pointed towards the diagram projected on
Wall B with her hand extended and fingers apart stating “I feel like {we should like
draw on it} (.) because we can”. The last team member, Ghita, also arrived during this
time. During the session, the team also made attempts to converse with Amelia, an
experienced game designer, for her opinion. Amelia was not present in the Design
Studio so the team used Kassidy’s laptop projected on Wall B and also the interactive
whiteboard to talk to her.

At this point the team had a break; however, some members spontaneously
formed groups of two or more people and started informally talking about the project.
Some members also started writing on Wall A, however this was not analysed in this
study for several reasons. The writings on Wall A were not discussed with the rest of the
team nor were they reported to the team at the end of the meeting. These writings were
erased before Group 1 started working on their ideas when they utilised Wall A for their
own inscriptions. Furthermore, the sound quality was reduced due to the close proximity
of other team members who were also having their own, at times unrelated,
conversations.

During the break, Malcolm also created two inscriptions on Wall B. These
inscriptions were created to the right and left of the projected diagram. These
inscriptions seem to have a function of recording ideas they discussed thus far in the
meeting. Malcolm took notes on paper during the initial discussion by the team before
the break and he used those notes to write the inscriptions on Wall B. The inscription illustrated in Figure 25 was written on the left side of the projected screen on Wall B and the inscription in Figure 26 was on the right side of the projected screen. Malcolm did not discuss or explain these inscriptions to anyone in the team. The inscriptions stayed on Wall B when Group 2 members started working on their own ideas for the game. The Group 2 members ignored the two inscriptions and did not discuss them in their group. These inscriptions were also not reported at the end of the design session; however, unlike the inscriptions on Wall A which were created during the break, these were not erased.

Galileo also wrote on Wall B during the break. He added terms, drew lines, arrows and boxes around text over the projection of the diagram on Wall B as illustrated in Figure 27. During the break Galileo only explained his inscription briefly to Bart who
was passing by to get some tea. It did not however generate a discussion between the two. The inscription was erased during the design process of Group 2, which will be described later.

After the break, Malcolm announced the designation of the team members into groups. The discussion in the group is presented in Table 13, below. In particular, this section is of interest regarding the way in which the members were placed in each group (lines 264 & 265 - 266) and the way in which the space was selected for each group (lines 266, 269, 270, and 271). Also of interest, Malcolm advised Galileo to explain his inscription to his group before rubbing it off (line 271).

Figure 27. Study-B inscription over the projection on Wall B during the break
Table 13 - *Three Events in Study-B*

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>62</strong></td>
<td>0:36:20</td>
<td>Kassidy:</td>
<td>Yeah, well I just figured we’d jumped over a couple of things but I guess { go back to looking at the deliverables is (.) what we (.) so Screen NSW has given us the money for this project and we have to deliver on the IOS the phone (.) oh sorry, the phone, the tablet and the web and so I guess they’re different factors to consider for the different build. So what (.) Bart maybe you want to start there? What we need to (.) and it seems that { most of our demographic is} mostly on a tablet now.</td>
<td>D-Gesture 1: slight pointing towards the paper in front of her on the table. D-Gesture 2: quick pointing towards Wall A, where the title inscription says IOS TABLET/PHONE... D-Gesture 3: pointing and holding right hand at the title written on Wall A. D-Gesture 4: short pointing with right hand with all fingers together at the title written on Wall A. Gestures 1, 2 and 3 all pointing to the title inscription on Wall A.</td>
</tr>
</tbody>
</table>

**Splitting into groups**

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Malcolm:</th>
<th>Talk</th>
<th>Non-verbal Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>264</strong> &amp; <strong>265</strong></td>
<td>1:41:18</td>
<td>Can I um...hi guys. Can I just interrupt everyone for a moment? I think we’re virtually doing this now as we’re having our coffee break, but I think we might start to break up into our groups where we can start to discuss thing individually.</td>
<td>D-Gesture 5: placing his left hand on Wall A. Gaze during gesture: looking at Kassidy.</td>
<td></td>
</tr>
</tbody>
</table>
So we’ve got 3 groups at the moment where we think some discussions need to take place. Once we’ve discussed people’s roles and how that’s all their sort of areas we’re going to come back and report and bring back those findings and talk about how they link into all 3 groups I suppose. So feel free if you think you should be in another group, but at the moment we got:: Group 1 which is Calvin and Jareth with Idris looking at the server development and I’ll jump in on that one (5) Group 2 is Bart and Hacket Films sort of anyone who wants to be involved in the front end, in the interface. And Group 3 is Ghita, Neville, Kassidy and Tory and looking at the marketing plan and the community and I suppose the interaction and things.

So {what space is this}?

266 1:42:20 Kassidy: You can go wherever you want and you can wipe off what’s there now because {they’ve taken pictures so} we can::

D-Gesture 6: pointing at the cameras in the studio.

Selecting the space for each group

269 1:42:50 Malcolm: So I suppose {front end should be over here because we’ve got this slide over here}

Posture: goes closer to the couch and turns around to look at the team members.

D-Gesture 7: extends
<table>
<thead>
<tr>
<th>Time</th>
<th>Character</th>
<th>Speech</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:42:58</td>
<td>Kassidy</td>
<td>Oh, does he want the couch? Sure: (everyone laughs)</td>
<td>his right hand holding papers towards Wall B.</td>
</tr>
<tr>
<td>1:43:29</td>
<td>Malcolm</td>
<td>I’m not part of that group. But Galileo’s actually written a little bit in terms of his audio components so I think front end and Galileo can be over there. Before you rub that off {you may want to talk to them} about that and then you rub it off. I think {this sort of looks to me more like server and algorithms and data collection} so Group 1 may as well {go here} And Group 3 can have the table and {the smartboard}</td>
<td>D-Gesture 8: extends his right hand holding papers towards the diagram on Wall B. D-Gesture 9: with his right hand holding papers points towards the projected screen but does not extend the hand as in D-Gesture 1. Posture: during D-Gesture 2 turns around to look at Wall B and Galileo who is standing to the right of the projection. D-Gesture 10: extends right hand holding papers towards Wall A with the papers almost touching the wall. Posture: during D-Gesture 3 facing the team. D-Gesture 11: waves right hand holding paper in front of Wall A. D-Gesture 12: places the paper on the main table and points</td>
</tr>
</tbody>
</table>
The Development of Inscriptions in Study-B Group 1

Study-B Group 1 members were Malcolm, Calvin, Jareth and Idris. Group 1 started their discussion in front of Wall A. Malcolm started by explaining what issues he expected Group 1 to look into. He mentioned that they might not be able to implement all of their ideas due to budget constraints in phase one but they might be able to take them into account in subsequent phases. The issues Group 1 were looking at were concerned with calculating points as the result of game usage and how these would be correlated with an action in the game, such as turning the lights on or off. Calvin wanted to show a spreadsheet he had on his laptop. He asked Idris if he had seen the spreadsheet and Idris answered in the negative. Calvin and Malcolm then looked around to see if they could use a larger screen to display the spreadsheet. At this stage the interactive whiteboard was used by Group 3 and both projectors A and B were displaying the diagram which Group 2 was using. Calvin stated “maybe we’ll just describe it first”. He then started by explaining what the spreadsheet contained and described how the data was displayed, using gestures.

The Development of Inscription SB-G1-A

Inscription SB-G1-A was created by two participants; Malcolm and one point added by Jareth. It was started by Malcolm when the group was discussing how they would measure reduction or increase in power consumption. This referred to the power...
consumption in the real world by the household of the game player. The group discussed how they would set a baseline for the initial power consumption and then measure the average usage over time. Malcolm stated that they would also need to take into account the time of the year, as power consumption might go up during winter months and this should be reflected in the measurement. Calvin suggested they take the quarterly consumption bill as the base point average by stating “most power bills have the average for the last four quarters (.) so you could put in that and that gives you the yearly average (.) I mean that’s a good thing to start with”. At this point Malcolm started writing the list in Inscription SB-G1-A. See Figure 28 for the inscription.

The group then discussed various issues such as whether the location of the game player could be recorded or if that would create privacy issues, and if it would be possible for the player to enter a list of major appliances operated in the household. During this time, Malcolm started by adding the title to inscription SB-G1-A in capital letters. He then added a bullet point ‘Full Footprint A survey to build profile’ to this first bullet point. He then continued and added points 1 to 5 of inscription SB-G1-A as in Figure 28.

Malcolm asked Calvin if their department would be interested in collecting data from the game stating “{are you guys interested in collecting this sort of data} because that does become expensive in the server side”. Here, Malcolm was looking at Calvin and moved his right hand from the top towards the bottom of inscription SB-G1-A. Malcolm, Calvin and Idris then started discussing what would need to be collected and how it could be made fair and less ‘cumbersome’ and less data extensive to implement on the server side. While Calvin was talking about data issues and what would be more beneficial and less problematic to collect, Jareth was looking at the wall and at one point
he took the pen from Malcolm’s hand and added point 6 to inscription SB-G1-A. He then handed the pen back to Malcolm. Calvin stated “you put in your baseline from (.) let’s say your electricity bills (.) that could be just averaged per day”. Malcolm hearing this added point 7 to inscription SB-G1-A as ‘Bills – Power, Gas, Water (Average per day)’.

![Image of Inscription SB-G1-A]

Figure 28. Inscription SB-G1-A

*The Development of Inscription SB-G1-B*

Inscription SB-G1-B in Figure 29 was created by Malcolm. After adding point 7 to inscription SB-G1-A, Malcolm asked Calvin how the game players would monitor their power usage and realise they were burning fuel. Calvin suggested they could check the meter over two weeks and record their readings in a graph. While Calvin was explaining this, Malcolm started writing the title for inscription SB-G1-B as
‘Monitoring’ and the first point as ‘Bills over 2 weeks’. He started writing inscription SB-G1-B to the immediate right of inscription SB-G1-A on Wall A. While Malcolm wrote inscription SB-G1-A in black pen, for inscription SB-G1-B he changed to a red colour pen. This helped distinguish the two inscriptions from each other.

Calvin then talked about encouraging action by awarding points to the players for monitoring their usage and that after two weeks they would see the results. Malcolm added ‘(encourage Actions)’ in parentheses and ‘earn points for actions’ as the continuation of point one. He then started a new line and wrote ‘2 weeks’. Malcolm then turned his face towards Calvin and said,

I mean this might be (.) yeah @_ but it might be (.) are you saying daily _@ I mean that’s the thing (.) like some kids(.) in terms of playability (.) some kids would be like didn’t do it yesterday: (.) games over sort of thing (.) or would they just have to enter it after 2 weeks (.) like every 2 weeks?

As Malcolm was stating this he turned briefly back towards the wall and added parentheses around the term ‘2 weeks’ that he just wrote on the wall. This was an interesting event in that Malcolm used drawing the parentheses around the term as a deictic action in order to bring into focus the duration of the calculation of average power usage. In other words, drawing was used as a method of focusing attention on a point.

Calvin suggested that the players could be given one week for each reading but that they could be encouraged to be more active by awarding them more points for daily recordings. Malcolm agreed and added ‘Rewards for daily monitoring’ under the term ‘2 weeks’ and then on a new line added ‘less points’ to inscription SB-G1-B as in Figure 29. Calvin continued, stating that there would be fluctuations with the readings
when, for example, there were visitors to the players’ house, which would increase their power use, but that the main point was for the game players to see the connection to their actions. Malcolm, hearing this, added the word ‘(Action)’ in parentheses next to the title of inscription SB-G1-B. He then returned to the end of the inscription and finished the last line by adding ‘less frequent monitoring’.

At this point Idris asked if the game would give an unfair advantage to those players who have more control over their power usage and also can access their meter, which would mean that every player would have a starting point that is different from other players. Calvin acknowledged that players who are living in a block of flats would not have access to the same controls, but the game could make it fairer by building these options into the game, which would add more complexity. Malcolm started looking back at inscription SB-G1-A. He then took the black pen from the main table and moved towards inscription SB-G1-A. At first he was looking at point 1 which said ‘Dwelling type’ but then added point 8 as ‘Owners/Renters’ to the end of inscription SB-G1-A. In this way, inscriptions SB-G1-A and SB-G1-B were completed in incremental steps.

Figure 29. Incription SB-G1-B
Chapter Eight

The Development of Inscription SB-G1-C

Inscription SB-G1-C in Figure 30 was also created by Malcolm. Inscription SB-G1-C is a short inscription and was written quickly. After adding point 8 to inscription SB-G1-A, Malcolm started writing inscription SB-G1-C to the right of inscription SB-G1-B at the same top starting level on Wall A. This inscription was written in black pen, which again helped to distinguish it from SB-G1-B next to it which was in red.

During this time, the group was discussing how the measure of the baseline could be compared to the national average. Jareth asked “Is there a way to do it Calvin (.) where it’s just like weighted compared with what you were before and also compared to the national average (.) it’s like an index or something or both”. Calvin stated that they could do that but they would still need a starting baseline in order to be compared to the Australian average as well as the relative change thereafter. During a short discussion of this issue Malcolm wrote inscription SB-G1-C on Wall A.

![Figure 30. Inscription SB-G1-C](image-url)
Malcolm also wrote Inscription SB-G1-D (Figure 31). As the group was discussing how the starting point baseline would be compared to the national average as well as the relative progress, Malcolm stated:

Yeah (.) and if you’re starting low you get rewarded with more points so you’ve got more in your kitty because I think at some stage {in this document} the more points means you can buy (.) which I think hasn’t been worked out properly: is you can buy things from the shop to improve the environment (.) So it might mean you can buy a solar lamp (.) Yeah (.) buy offsets (.) yeah. And actually use it for real money (.) That would be great

Here Malcolm pointed towards the main table with his left hand while holding some printed papers. His reference was towards the design treatment document that was given to the entire team at the beginning of the session. Malcolm then turned around to the main table where Group 3 was working and asked “Kassidy (.) you know how we’ve got the shop (.) Have we actually discussed buying offsets (.) As in the more points you earn: you use those offsets to buy trees: and then actually real trees”.

Kassidy provided a lengthy explanation of how the player would be able to gain points by doing certain actions like visiting real world locations such as zoos or tree pods around the city. During Kassidy’s explanation Malcolm started writing the title for inscription SB-G1-D (Figure 31). He then added a second line under the title: ‘allow users to buy offsets’. At this point Calvin, Idris and Jareth were all looking at Kassidy. Malcolm asked Jareth “real world offsets?” Jareth nodded and Malcolm added ‘* hopefully real world offsets’ to inscription SB-G1-D. Malcolm again tried to confirm with Jareth whether it would include planting a tree and after Jareth’s confirmation
Malcolm added ‘(plant a tree)’ in parentheses to inscription SB-G1-D. Up to this point, Malcolm was listening to Kassidy’s explanation and trying to record them in inscription SB-G1-D. From this point forwards, Malcolm started discussing some issues directly with Jareth while Calvin and Idris were still listening to Kassidy.

Malcolm asked Jareth “is there any sort of carbon trading schemes set up”. Jareth replied “yeah (.) there’s different certifications (.) I think there’s one REDD (.) So that’s like a certified way to buy the offsets”. Malcolm then asked for the exact letters (R-E-D-D) and Jareth pronounced each letter separately for Malcolm to write on Wall A as part of inscription SB-G1-D.

At this stage Calvin and Idris came back to join the group. Calvin made a joke about inscription SB-G1-D stating that adding these capabilities would be like phase 25. Everyone in the group laughed and Malcolm added ‘(Phase 25)’ in parentheses to inscription SB-G1-D.

Malcolm then asked Calvin “do you want to see if you can get up one of your documents (.) Yeah (.) people might be interested in looking at that”. Calvin sat down on the chair in front of the main table while Group 3 was still sitting on the other side of the table working on their ideas. Calvin opened his laptop and was discussing his spreadsheet with Idris enacting numerous deictic gestures towards the laptop screen. Malcolm announced around the Design Studio that the groups would need to finish in five minutes and come together again.
Chapter Eight

The Development of Inscription SB-G1-E

Jareth created Inscription SB-G1-E, shown in Figure 32. Jareth did not have a discussion with any other participant while writing the inscription. This inscription was written on the far right side of Wall A next to inscription SB-G1-C. The inscription was written in a red coloured whiteboard marker which helped distinguish it from the other inscriptions.

After Malcolm asked Calvin to open one of his documents on the laptop, he asked Jareth if he could “write up the categories” on the wall. By categories, Malcolm was referring to how the data was displayed in the spreadsheet on Calvin’s laptop. The conversation reported in Table 14 led to Jareth writing inscription SB-G1-E on the wall.

Table 14 - Event: Study-B Group 1 Created Inscription SB-G1-E

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>224</td>
<td>2:23:38</td>
<td>Malcolm:</td>
<td>do you want to [write up the] categories, like you were saying transport () or () just write the</td>
<td>D-Gesture 1: pointing with the right hand while holding a pen</td>
</tr>
<tr>
<td>Time</td>
<td>Counter</td>
<td>Speaker</td>
<td>Action</td>
<td>Notes</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>225</td>
<td>2:23:45</td>
<td>Jareth:</td>
<td>list of potential ... groups of action</td>
<td>towards Wall A.</td>
</tr>
<tr>
<td>226</td>
<td>2:23:46</td>
<td>Malcolm:</td>
<td>yeah yeah so there was transport</td>
<td>there was (.) obviously utility consumption or travel</td>
</tr>
<tr>
<td>227</td>
<td>2:23:56</td>
<td>Jareth:</td>
<td>yeah they do require transport for energy and water</td>
<td>Posture: standing behind Calvin, bends down to look at the laptop screen in front of Calvin.</td>
</tr>
<tr>
<td>228</td>
<td>2:24:04</td>
<td>Malcolm:</td>
<td>and they’ve all got like subcategories under there</td>
<td></td>
</tr>
<tr>
<td>229</td>
<td>2:24:06</td>
<td>Jareth:</td>
<td>yeah (.) that was kind of arbitrary way to categorise</td>
<td></td>
</tr>
<tr>
<td>230</td>
<td>2:24:12</td>
<td>Malcolm:</td>
<td>I think we will probably be using, well we use (.) well at the moment we don’t have a model but I was gonna say we may as well I will {clear that up} and if you would write it down</td>
<td>D-Gesture 2: pointing towards Wall A.</td>
</tr>
<tr>
<td>231</td>
<td>2:24:32</td>
<td>Malcolm:</td>
<td>yeah right around this side</td>
<td>Non-verbal action: Malcolm erased the previous writing on Wall A which was written by some participants during the coffee break.</td>
</tr>
<tr>
<td>233</td>
<td>2:24:40</td>
<td>Malcolm:</td>
<td>what would you call them</td>
<td></td>
</tr>
<tr>
<td>234</td>
<td>2:24:42</td>
<td>Jareth:</td>
<td>Actions (.) but</td>
<td></td>
</tr>
<tr>
<td>235</td>
<td>2:24:43</td>
<td>Malcolm:</td>
<td>[yeah (.) yeah that would be it</td>
<td></td>
</tr>
</tbody>
</table>
At the conclusion of this conversation Jareth started writing the title for inscription SB-G1-E as ‘Actions’. He then wrote the entire inscription without interruption.

Figure 32. Incription SB-G1-E

The Development of Inscription SB-G1-F

Inscription SB-G1-F in Figure 33 was also created by Malcolm. Before creating this inscription, Malcolm added one last point to inscription SB-G1-D. This was during a short discussion with Calvin and Idris when they were looking at Calvin’s laptop. They discussed how the players could count the number of lights in the house and record them. At the end of this discussion Calvin stated that what they would like to see as a result of playing this game was real world action, which would then become habits. Malcolm returned to inscription SB-G1-D on Wall A and added in a green pen
‘REWARDED FOR GOOD HABIT’ at the end of the inscription. At this time Jareth was still writing inscription SB-G1-E on the other side of Wall A.

Following this, Malcolm asked Calvin and Idris if the game would also include weekly push challenges that would ask them about their activities and actions in the real world. The three members then briefly discussed the technical issues with implementing such push challenges and notifications. Towards the end of this short conversation Malcolm stated “Well I suppose I’ll just write a heading at least (.) just push challenges or push questions (. ) push survey”. Calvin suggested “community suggestions”. Malcolm then wrote the short inscription SB-G1-F (as illustrated in Figure 33) on Wall A below inscription SB-G1-E in green colour pen. At this stage all the groups gathered to discuss their ideas with the team.

Figure 33. Incription SB-G1-F

**The Development of Inscriptions in Study-B Group 2**

This group created what I will call *hybrid* inscriptions; these were layered inscriptions comprised of both hand drawn and digital representations. The group used Projector B to cast some PowerPoint slides on Wall B in the studio, which they used as the backdrop to their drawings.
Group 2 members included Galileo, Jarrod, Gino, Shima and Bart. Three members of Group 2 created inscriptions. Group 2 gathered around the coffee table and couch area in front of Wall B where Projector B was used to project the screen from a laptop that belonged to Kassidy.

All members of Group 2 (except Galileo) were known to each other and had previously worked together. As advised by Malcolm earlier, Galileo started explaining the drawings he made over the diagram projection on Wall B (see Figure 27). He described his drawings as “just my initial ideas” which were to provide a draft of what Galileo called “the music map and sound effects” for the game. Galileo utilised a number of deictic gestures pointing to the different sections of his drawings on the wall. Galileo ended his explanation of the drawings by commenting on how it would be difficult to find an appropriate voice for the bear in the game. He then invited others to share their ideas and, together with Gino, started to wipe off the drawings from the projected screen area of the wall stating “You know we can wipe this off, and we can make our own”. As Galileo was wiping off the drawings from the projected screen area, he asked what would be presented to the user when the game was first started and if there needed to be some kind of status update about how the bear was doing in its home habitat. This was followed by Bart, Jarrod and Gino discussing different ideas for how the user might be able to find out about how the bear is doing.

For this initial discussion, the group members were standing in front of the projected screen and then Galileo pulled in a few more chairs for the group to sit on. Initially Shima and Gino were sitting on the couch while Jarrod was sitting on one of the chairs to the left of the screen and Galileo and Bart to the right of the screen. The group discussed how the game needed to influence the real-world actions of the player...
by encouraging them to make better choices. The challenge was for the group to make
the bear appealing to eight-year-olds so that they would come back to play the game and
also to be motivated to help save the bear’s environment. Galileo wanted a way to let
the users know what the game had to offer early on so that they would be motivated to
come back and play the game again. The group decided that it would be good to provide
hints for the user on the main home screen.

*The Development of Inscription SB-G2-A*

At this point the laptop used for the projection of the diagram on the wall went
into sleep mode and Jarrod stood up, took the laptop from the main table, and brought it
back to the coffee table. When he came back he said “over there at the other end of the
room they’re saying do we need an intro video (. ) So maybe we do”. This prompted
Gino to stand up, take a marker pen and start writing over the diagram on the wall.
Jarrod stated “I’ll swap spots with you because I’m no good at writing, my writing is too
messy” and he moved from the chair to the couch to sit where Gino had been sitting
earlier. Gino started writing inscription SB-G2-A (see Figure 22). He looked back to his
group and asked “so can we say hints? Like babies?” Shima answered “yeah babies and
toys and games”. Gino wrote these terms over the big box representing the Home
Screen. Jarrod suggested Gino write it in a larger size so that the camera in the Design
Studio could capture it. Gino accordingly wiped out his writing and rewrote in a larger
size. See Figure 34 for how the inscription was positioned over the diagram.
Figure 34. Inscriptions SB-G2-A drawn over the Home Screen box and SB-G2-B connecting the four main diagram boxes

Gino then questioned whether the entry screen had to be the globe logo. The globe logo illustrated in Figure 35 had been briefly projected on to Wall A during the team’s initial introduction to the project, but was never the focus of discussion.

Figure 35. The image of the globe logo for Study-B game
Jarrod suggested they assume it would be the globe logo for now. Gino replied
“So it’s like a park preview. I’m just going to write over the top of this stuff if that’s ok”
and he wrote ‘PARK PREVIEW’ on top of the ‘HINTS, BABIES, TOYS, GAMES’
that he wrote earlier. Jarrod asked “So park preview, hints, babies, toys. And you’re
saying that’s an intro video?”. Gino replied “That’s in the home screen. So in the home
screen we’ve got a park preview” and he added ‘LOAD SCREEN’ under the diagram
title (Figure 34). Jarrod asked “Park preview - but that’s an animation?” to which Gino
replied “It could be like a background thing. It could be like the bears just wander round
aimlessly”. Jarrod said “It’s an environment that you aren’t that interactive with (. ) it’s
like ...” and Gino replied " So you could have bears in front of it (. ) but you could do all
this stuff (. ) But in the background you’ve got a little looping animations”. As Gino was
uttering these words he added ‘GLOBE’ next to what he had just written under the
diagram title.

Bart asked how the transition from the load screen to the 3D world of the game
would happen. Gino, who was still standing in front of the wall, looked at Jarrod and
asked “Didn’t you have like a laptop. We’ve got artwork for some of that right?”. Jarrod
took the laptop that was projected on to Wall B from the coffee table and placed it on
his lap. He then searched through the PowerPoint slides to find the relevant artwork.
Jarrod first displayed the artwork that was aimed at giving the user a general overview
of the bear’s Study-B illustrated in Figure 36. The inscriptions that Gino had made
earlier over the diagram were still there when this new screen was projected over the
wall.
Gino pointed to the inscriptions he had made earlier and said “{these ones could be....} they could be the hint of a game or something. He then waved his hand over the lower part of the image and said “and in the {background there would be babies wandering around]”.

The Development of Inscription SB-G2-B

Gino suggested they could use the globe logo to give the user “a sense of being on the globe” by zooming into an activity or a game and zooming back out when selecting another activity. At this stage Jarrod returned to the diagram slide by projecting it on to Wall B again. As Bart and Jarrod discussed the technical aspects of the zoom feature, Gino went to the wall and drew a small globe over the diagram that linked the four major components of the game which included the home screen, player home, habitat shop, and the glacier park (see Figure 34). Jarrod was looking through the PowerPoint slides to bring back the globe slide again and stated “You’re saying that we could go, we pop out to that sort of world”, and while searching for the logo slide stated “Where has my thing gone?”. Once he found the logo slide he said “pop out to that?” and Gino
followed saying “and then zoom back in”. Gino then further explained his idea for the zoom feature by walking to Wall B and touching each section of the globe as exemplified in Figure 37.

The group then discussed the technical issues of the zoom feature with Bart and decided that it could be done easily so long as the visual images were not the highest quality. The group also discussed the merit of using 2D versus 3D features. They discussed how making the mini games in 2D could spare resources and make them cross-platform compatible.

Jarrod stated “I’m a bit confused by this diagram, why are there mini games over here as well?” pointing to the top right of the diagram projected on the wall. Gino stood up, went closer to the wall and expressed his understanding of the diagram’s relation to the navigation in the game. See Table 15 for this expression with gestures.
Table 15 - *Deictic Gestures by Gino in Study-B Group 2*

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>97</td>
<td>2:05:36</td>
<td>Gino:</td>
<td>Yeah, imagine that’s a screen. So you’re inside it but you start at the {Home screen} From there, there is a link to this screen. So {Player home} is where {access shared things} or {real world missions, play new games} or your eco footprint. From here you can go to the {Glacial Park} or you can go to {Habitat} and only in habitat shop do you get to {buy} So this is just {like imagine that’s a screen} So you’d click on the button on your browser like it was the internet. You’d click a link and you’re here. And {these are all the other links} that share that page.</td>
<td>D-Gesture 1 &amp; D-Gesture 2: pointing to the main large diagram boxes (Home screen and Player home). D-Gesture 3: pointing to the mini games shown as little circles on the top right section of the diagram. D-Gesture 4: pointing to the Glacier Park box and the Habitat box in the diagram. D-Gesture 5: pointing to the mini games shown as little circles connected to and below the Glacier Park box.</td>
</tr>
</tbody>
</table>

The topic of the group’s discussion changed to focus more on the navigation. As the group discussed the navigation issues, Shima asked whether the mini games on the top right could be accessed separately through the 3D world; holding her hands in a ball shaped gesture. Jarrod responded saying “I don’t know and I think it’s kind of up to us to decide”. Gino went to the wall and wrote ‘P’ on the Player Home box over the diagram and then drew an arrow connecting the Player Home box to the Home Screen box (Figure 34), stating “here’s this link (.) home screen and player home”.

Chapter Eight

The Development of Inscription SB-G2-C

As the group further discussed the navigation of the game, Jarrod continued to express confusion about why some of the mini games were separate from the rest on the top right corner of the diagram. He thought that it did not match the normal navigation of the game, which he stated would be “Home screen, Glacier Park straight to mini game”. Jarrod also referred to an old document that might explain it. As the discussion progressed Gino asked “So are the mini games going to be about the bears?”. Jarrod replied “Well from what I could tell from the way it would rollout was: if your bear is healthy enough, then it will breed, then you’ll have baby bears”. He then said “There is this...I’ll just grab this other document (.) this is Emily’s document. That’s real world missions yeah”. Jarrod got up and went to the main table and took some printed papers to bring them back. He sat on the couch and was looking through the papers while the group discussed how the mini games would be related to real-world missions.

Jarrod stated that the games should portray the bear as the hero and encourage an emotional response from the children, similar to that which a child might have in relation to their “favourite action hero or their favourite character from a story”. Jarrod also stated that they should keep the same theme throughout the game and portray a glacier-type environment where the users’ actions would result in consequences to that environment. He then reached out to the laptop on the coffee table and changed to the slide displaying the house in the glacier environment, as illustrated in Figure 38. Gino raised some concerns over the types of assets that they would need to design stating “if we have a game that’s turning off lights in an unrelated house, we now have to design an unrelated house”. Jarrod got up from the couch and went to the wall, standing to the right of the projected screen stated “like if we have this house is it like, to keep it on
theme with our bear, is there a rubber/eraser? Oh Malcolm stole it. I know that now we’re getting multiple screens and you might know a bit about this Bart, with like (.) So this is in the bear’s world and our bear comes along and here is our bear walking this way I suppose”. Jarrod then drew a little bear next to the house (seen in Figure 38). At this point the inscriptions that Gino wrote over the diagram slide were still on the wall, hence Jarrod’s comment about needing a rubber/eraser.

Figure 38. Inscription SB-G2-C added over house in the glacier slide

Gino responded “Someone freaking left the lights on in there”. Jarrod started
drawing a little window on the side of the house and said:

Yeah and we have some kind of way of yeah... well maybe if we design it with
windows down here, not up there. Then every time you control the bear, the bear
turns the lights off is what I’m saying. So you could still have a house that’s in the
bear’s world.
Jarrod then started walking back to the couch when Gino added “Yeah sure. It’s like the bear was wandering by the ranger’s house and he realises that the ranger is an idiot and he’s left his lights on. Yeah it could be like the bear’s got all these brilliant ideas and you’ve got to implement them. They need a solar heater and it’s like install a solar heater and...”. Jarrod, on hearing this, came back to the wall and drew a solar panel on the roof of the house.

The Development of Inscriptions SB-G2-D and SB-G2-E

For the next five minutes the group discussed how the users would earn tokens in the game and how the tokens would then be used to buy assets in the game. At two hours and eighteen minutes into the session, Galileo said “the two things we’ve got for making the bear happy so far is like controlling his environment, making his environment conducive and also rubbing his belly. There’s got to be more than that otherwise it’s a game that just comes with 2 dimensions”. Jarrod replied “I would have just thought that maybe there’s a way you could have a reasonable amount of bear happiness without tokens. So if you fish for it, you tend to them, you clean them, you feed them...but then maybe you’re fighting against global warming when you’re doing that, so tokens - if you go to the next level, like for the older user (.) the 10 year old user or something (.) or the 8 year old user that’s learning (.) they learn that if they really want to get on top of it, tokens are the way forward”.

Galileo then got up from the chair and went to the left side of the wall next to the projection and wrote ‘BEAR HAPPINESS = FOOD SHELTER TUMMY RUB’. He then added ‘EVERY DAY ACTIVITIES’ and drew a small arrow pointing to it from the left (see Figure 39 for this inscription). Galileo then moved slightly back towards the
couch when Jarrod, pointing at the inscription Galileo just added, stated “Did you write what I was supposed to write?”. Galileo explained, pointing to his inscriptions, stating “about what are the mini games and how does the bear interact and feature in the mini games... That’s a big question really”. Jarrod asked “Should I write that down?” and Gino answered in the affirmative. Malcolm from Group 1 called out to let Group 2 know they had only five minutes remaining for their group task.

Figure 39. Inscription SB-G2-D near top right corner of the illuminated screen and Inscription SB-G2-E outside the illuminated area on the left

Malcolm came over to Group 2 and shared the ideas that Group 1 had discussed. One of the ideas was that the user should be able to buy a real tree in the real world and then see that tree come down and plant itself in the game environment. While Malcolm was explaining these ideas, Jarrod stretched up and added on the top right of the projected screen ‘HOW DOES THE BEAR FEATURE IN THE MINI GAMES’.
Simultaneously, Galileo added more below his inscription on the left side of Wall B. He
wrote ‘EVERY DAY VISIT FOR GAMES’ with a small arrow pointing to it from the left side (Figure 39).

While Malcolm was discussing Group 1’s ideas, Jarrod wiped out the heading he had just added to the top right side of the projected screen and replaced it with the title stating ‘THE BEAR SHOULD ACTION CHANGES IN THE MINI-GAMES, IE BEAR TURNS OFF LIGHTS OF A HUT’. Galileo, looking at this new title, returned to his own inscription and added ‘DIRECT’ to the top of his writings from earlier. He then added a new title to the inscription in a slightly larger size stating ‘MINI GAMES’ and underlined it. Galileo tried to connect his ideas to those of Jarrod on the projected screen. For this, he drew an arrow going from the ‘MINI GAMES’ heading towards the top of the projected screen. He then paused slightly looking at the new title added by Jarrod and the earlier inscriptions still on the wall, and added ‘GLOBAL ENVIRONMENTAL’ followed by ‘HAPPINESS TEMP’ and ‘WATER LEVEL’ below it. He drew another arrow going closer to the title added by Jarrod (Figure 39).

At this stage the group slowly started to disintegrate and the members assembled around the main table, joining the rest of the team. The slides on the laptop were also changed several times and at one point displayed a Gantt chart for the project (Figure 23). Before leaving, Galileo did two things. He took a photo of the inscriptions on the wall with his phone, and then he returned to where Jarrod was standing and added ‘= ECO POINTS’ as a continuation of the title. This addition (see Figure 40) by Galileo however is not categorised as part of inscription SB-G2-D because it was not created during the team discussion and no one in the group noticed it or made a comment about it. Jarrod also photographed Wall B with his phone before joining the rest of the team around the main table.
Study-B Group 3 Design Session

Study-B Group 3 members included Kassidy, Ghita, Tory, and Neville. Group 3 was sitting around the main table. The group used the interactive whiteboard to type their ideas about marketing solutions for the game to attract sponsors. They did not draw any inscriptions and thus the process of their design discussion is not reported in detail here. There were, however, a number of interesting events and practices that are relevant to this study.

In Group 3, only Kassidy typed some text into the interactive whiteboard. Although they had access to a drawing application on the interactive whiteboard, and they could draw on it using their fingers or the stylus pens provided for them, they still did not draw on the interactive whiteboard during their group discussion. Before the team began their meeting, Kassidy did use her finger to draw on the interactive whiteboard to see how it worked. However, during the group meeting they used a textbox to type text into what was primarily a drawing application.

During the discussion in this group the participants used gestures extensively. They mostly used iconic gestures to communicate and enact ideas such as how the bear
will appear in the game. They used deictic gestures towards the interactive whiteboard to a much lesser extent. Most deictic gestures towards the interactive whiteboard were used as symbolic gestures, such as when Kassidy was saying “‘this isn’t that hard (.) we’ve just got to you know bring it all together’”. These deictic gestures did not attract focus to any specific parts of the text, as was observed with deictic gestures towards the inscriptions. The participants often did not look at the interactive whiteboard during these gestures. This is because they understood that these gestures did not literally highlight specific features of the text.

**Conclusion to Study-B Team Design Session**

After the three groups in the team came back together around the main table, each group reported what they had discussed and the ideas they had generated. Kassidy began by reporting Group 3’s discussion. She talked about how they had decided to create a new design document for the game, which they called a bible. The bible would describe what the game was trying to achieve and how it could be marketed to both users and broadcasting companies. She did not use any deictic gestures towards the interactive whiteboard, where they had typed their ideas.

Kassidy then asked Group 2 to report on their discussion. Jarrod and Gino reported their group’s ideas for the general navigation and the user interaction with the main character of the game. They used deictic gestures several times, pointing to Wall B where they had drawn their inscriptions over the projection of the diagram. For example, Gino described how one scenario could be that the bear was roaming around and noticed that the ranger had left the lights on in the house and that the user of the game could then turn these lights off inside the game. As Gino was describing this
scenario, Jarrod pointed with his left hand towards the drawing of the bear on Wall B (inscription SB-G2-C) and said “that’s what that illustration is”.

After Group 2 had explained their ideas, Kassidy asked Group 1 “Ok (.) so where did you guys get to (.) over here”. Malcolm and Calvin described their ideas for the types of data that would be collected and measured, and the award system for the game. This group also used several deictic gestures towards Wall A where they had written their inscriptions. For example, at one point when Calvin was reporting, he pointed towards inscription SB-G1-A on Wall A and said “so that’s the idea behind the baseline”.

At the conclusion of the meeting almost every member of the team took photos of the inscriptions on the two whiteboard walls using their phone cameras. The team did not set a date for the next meeting but individual members exchanged their contact details with those they had not worked with before. Malcolm also handed everyone a form to record their contact details as well as their availability for further work on this project.

**Summary of Results for Study-B**

*Inscription Information Flow*

In Study-B, inscriptions were created in a different way from those created by Study-A groups. The groups in Study-B team were not required to finalise their design ideas and create a final design concept. The aim of Study-B team meeting was to brainstorm ideas that could then be assessed, discussed and further developed at a later stage in the project. As a consequence, ideas were mostly captured in inscriptions and
kept for later use rather than being developed and expanded. The diagram in Figure 41 visualises the information flow for the two Study-B groups who created inscriptions. This will be followed by a brief description of the information flow for each group.

Figure 41. Inscription information flow for Study-B
Group 1

Five of the inscriptions created by Study-B Group 1 were directly influenced by what was discussed. These inscriptions were used to capture the discussion and the decisions made and record them for later use. Only inscription SB-G1-E was the representation of the categories in the spreadsheet on the laptop belonging to one of the participants. All of the inscriptions were photographed at the end of the meeting to be used as a record of the ideas generated during this meeting. This process is visualised in the diagram in Figure 41.

Group 2

Four of the inscriptions created by Study-B Group 2 were directly influenced by the group’s discussion. Inscription SB-G2-E was created to summarise the discussion as well as the main ideas of the previous inscriptions in a text-based list format for later use. This group also took photographs of their inscriptions at the end of their meeting to keep as a record of ideas they discussed. This process is also visualised in the diagram in Figure 41.

Inscriptions Transition Process

Study-B team participants mostly created text-based inscriptions such as lists (see Figure 42). This is because Study-B team meeting is a snapshot of a conceptual design process, whereas Study-A groups represent a model of a complete idea-generation design meeting. Study-A groups started with a design brief and were required to produce a design concept by the end of the meeting and thus can be said to have passed through the entire process of conceptual design. This may be one of the reasons why
Study-B team created very few complex diagrams since they were not reaching the end of their conceptual design process.

Figure 42. Inscription transition process for Study-B
The Development of Hybrid Inscriptions in Study-B Group 2

The inscription practices of Study-B Group 2 were very different to the rest of the design groups in this study. As mentioned before, the inscriptions created by Study-B Group 2 were *hybrid* inscriptions. This means that these inscriptions were created with a marker pen on the whiteboard wall *over* the projection of a number of PowerPoint slides. As a result, I have referred to these as *hybrid* inscriptions in this study because they were a mixture of both digital and non-digital visual representations. This created an interesting situation: if the slides were turned off, the inscriptions would lose meaning altogether. Figure 43 shows an example of when the projection of the slides was temporarily turned off during the meeting. The inscriptions remained on the wall scattered, and without any structure. The projection of the slides provided a ground for the inscriptions, against which the inscriptions became meaningful.

![Image of hybrid inscriptions without projected slides](image)

**Figure 43.** Study-B Group 2 inscriptions without the projected slides

The participants started drawing over the projection of the diagram initially, but during the meeting the slides kept changing according to what was discussed. Later on more inscriptions were added to the wall but this time over the projection of a different
slide with the house on it. This combination however did not concern the participants who seemed to work fluently through the constant change of the slides over the inscriptions.

The diagram in Figure 44 illustrates how the background PowerPoint slides projected on the wall transitioned from one slide to the next during the time when Group 2 was creating their inscriptions. The numbers next to the arrows represent the order in which the inscriptions were added and when the slides changed. For example, after inscription SB-G2-A was drawn over the diagram, the slides changed to two other images before coming back to the diagram, at which point one part of inscription SB-G2-B was added at step 4. The background slide changed again to the globe logo in step 5, and in step 6 the diagram was again displayed. At this step the rest of SB-G2-B was created, and in step 8 the slides changed to display the house in the glacier environment. From that point all of the remaining inscriptions SB-G2-C, SB-G2-D and SB-G2-E were added over the same background slide.

This illustrates that although the inscriptions in Group 2 were dependent on the background slides, the changes in the slides did not obstruct the process of drawing the inscriptions or the design task itself.
Inscriptions Grounding the Discussion and Focusing Attention

The first inscription written by Study-B team was the title ‘IOS TABLET/PHONE/WEB’ on Wall A. The title helped ground the discussion during the meeting and provided a reference point for communicating the relevant ideas. During the initial discussion before the team separated into the three groups, Kassidy repeatedly pointed towards this inscription when she was introducing the project to the members and setting a goal for the meeting. Most of the inscriptions facilitated the grounding of discussion and provided a focal point for the participants; this inscription is exemplified here because it remained on the wall for the duration of the meeting. The Gantt chart displayed on the interactive whiteboard and the diagram projected on Wall B provided a similar function.

Grounding the discussion means that the inscriptions were available during the discussion to help the participants’ discussion to stay on topic. When inscriptions
become the focus of attention they are more than just grounding the discussion, they alter the behaviour of the participants. The inscriptions become the main focus of the discussion and the design decisions revolve around them.

Most of the inscriptions created in both Study-B and in Study-A became the focus of attention and the discussion revolved around them for much of the meeting. However, in Study-B Group 2 an interesting event occurred that further illuminated this characteristic of inscriptions. When Group 2 started their discussion, the image of the diagram was projected on to Wall B. The group assembled in front of this projection. However, for approximately 12 minutes, the group members did not talk about the diagram nor did they explicitly pay attention to it or gestured towards it. The diagram only became the focus of attention when Gino started drawing the first inscription over it. This was as if the inscription made the diagram relevant. From this point forward, the projected slides and the inscriptions over them became the focus of discussion for the group, and this continued for the remainder of the group meeting. In another example, before writing the inscriptions on Wall A, Group 1 members were standing in a circle facing each other. Once there were inscriptions on the wall, the whiteboard wall became the focus of attention for the reminder of the group’s discussion. The group members turned their postures towards the wall and used pointing gestures towards the inscriptions when communicating their ideas. The inscriptions here became the ground against which the participants made sense of each other’s comments.
Inscriptions Created in the Foreground and Background of Attention Level

Earlier in Part 2 of this thesis, the concept of foreground-background continuum was described. Inscriptions created in the foreground are those that are created as part of group discussion. Most of the inscriptions created by Study-B team members were created in the foreground. Inscriptions created in the background were those generated by individual members without discussion with other group members. These inscriptions were in the background of the group’s attention level. In Study-B there were three inscriptions created in the background. For example, the two inscriptions written by Malcolm on Wall B illustrated in Figure 25 and Figure 26 were created in the background of the group’s attention. Malcolm did not discuss these inscriptions with other participants when he was generating them. He also did not explain these inscriptions to the team after he generated them. Although Group 2 was using Wall B for their inscriptions during their group discussion, they virtually ignored the existence of these inscriptions on the wall and utilised the space in between them for their own inscriptions. At the end of the meeting these two inscriptions remained unmentioned even at the last gathering of the team for reporting the groups’ ideas. This however does not mean that the inscriptions were invisible to the group or to the entire team. What it means is that they were aware of the inscriptions existing as part of the context. They were available to the participants if needed but they were not part of the discussion and thus were in the background of their attention level.

In another example Galileo created an elaborate inscription over the projection of the diagram on Wall B as illustrated in Figure 27. Galileo also generated this inscription on his own and without discussion with the other participants in the team. An interesting
event occurred when Group 2 was assembled in front of Wall B and Malcolm asked Galileo “before you rub that off you may want to talk to them about that and then you rub it off”. Here, Malcolm assumed that since Galileo alone created the inscription, it would have to be erased, and the group would create a joint inscription during their discussion. This is also interesting because Malcolm had himself created the two inscriptions earlier, which he did not discuss with the team members. However, Malcolm did not erase his own inscriptions. This may indicate that the two inscriptions Malcolm created were intended as the background context; as a reminder of the important issues to be discussed during the group design and not as a focus of discussion. Although Galileo explained his inscription over the diagram (Figure 27) to Group 2, it did not generate much discussion or enthusiasm from the other group members. In Study-A, all of the shared inscriptions were created in the groups’ foreground level of attention. Inscription SA-G2-A was not part of the background because the other two participants in the group were not able to see it.

*The Working Space*

In Study-B Group 2, the projected image in the PowerPoint slides dictated where the inscriptions were drawn on the wall. For example, the house was the base for the drawing of the bear and the solar panels and as such the panels were drawn on the roof while the bear was drawn to be next to the house. The projection was also seen as the space where ideas were shared and recorded as part of the group’s discussion. When Galileo started creating inscription SB-G2-E outside the area illuminated by the PowerPoint projection, Jarrod who was at the same time creating inscription SB-G2-D on the projected area asked “did you write what I was supposed to write?”. After
Galileo explained what he had written to Jarrod again. Jarrod asked, “Should I write that down?” This indicates that for Jarrod only the area of the wall illuminated by the projection of the slides was the space for sharing and recording the group’s ideas. Anything outside of this area was treated as extra resources and not the focus of the group’s discussion or output. In an earlier study in the Design Studio, we observed a similar event when school-age children used the walls for drawing (Thompson et al., 2013). They also made their drawings over the area of the wall that was illuminated by one of the projectors and disregarded what was around it. This might have been another reason why the inscriptions created by Malcolm on both sides of Wall B did not become the focus of conversation during this group’s design session. When Galileo connected his inscription using lines and arrows to inscription SB-G2-D, he might have realised that those inscriptions outside the illuminated area could be assumed to be part of the previous inscriptions by Malcolm. He therefore explicitly connected them so that they would be understood as part of Group 2’s ideas for the game.

No Drawing on the Interactive Whiteboard

In Group 3, the participants did not draw on the interactive whiteboard. This was interesting because the participants knew that they could use it for drawing. Kassidy had already done this before the meeting began. They were also in close enough proximity to the interactive whiteboard to be enabled to draw over it. Furthermore, they were using a drawing application that they could easily use by drawing with their finger or the stylus pens provided, instead they used a textbox to type their ideas in a drawing application.
One similarity Group 3 demonstrated with the other groups in this study is that they also typed their ideas in a non-linear way. Kassidy similar to Malcolm, or Gino, or Grant from Study-A Group 1 added text to different lines and list items. For example, during the group’s discussion Kassidy typed “Let’s make one small animation – allows broadcaster to see” as a list item into the interactive whiteboard. Later she added another list item below it as “bring to life tips life tips you see on the web eg we have 100 of those tips”. After adding the second list item she returned to the first list item and typed “the quality/idea of what we make” to extend the first list item.

When the three groups came back together, Group 3 did not use any deictic gestures towards the interactive whiteboard when explaining their ideas to the team. The other two Study-B groups enacted pointing gestures towards both walls several times and each time everyone in the studio turned around to look at what they were trying to show.

This concludes chapter Eight. Chapter Nine presents semiotic analysis of the inscriptions, where the visual elements in each individual inscription are analysed.
Chapter Nine: Semiotic Analysis of Inscriptions

The meaning of an inscription is highly dependent on context. Interpretation of an inscription may become difficult when it is taken out of the context in which it was generated. For example Roth (2013) states that in the domain of science inscriptions, it can be difficult to reinterpret if the scientists are not familiar with the setting from which the data was derived and with the entire transformation process. He also states that inscriptions become “alive” in use and once they are taken out of the context of use then they are difficult to interpret, especially for those unfamiliar with the meanings associated with the entities represented in the inscriptions (Roth, 2005).

The majority of inscriptions created by Study-B team were taken away as records of the discussion and ideas. These inscriptions would be used later to further develop the design ideas. Most real-world projects will go through a number of meetings in which people work on designing materials, tools, systems, and processes to help other people learn. Inscriptions and visual materials created at any stage of such projects would most likely be used in later stages and further meetings. When these inscriptions are taken out of the context of the meeting in which they were created, the only way to reinterpret them and make sense of them is if the people who were present at the meeting explain them, or if the inscriptions accompany clear written explanations. In instances when these two options are not available, clear and consistent visual elements in inscriptions can make reinterpretation easier. In domains such as architecture or choreography, the recognition of visual elements is easier, for those who know these languages, since these domains have standardised visual representations. In educational design, this is not the case.
In the absence of agreed visual language in ED, inscriptions capitalise on cultural conventions, such as placing an element higher to denote its importance (Hegarty, 2011). Some useful conventions can also be borrowed from language. For example, “concepts like more and better and stronger are associated with upward direction, and concepts like less and worse and weaker with downward direction” (Tversky, 2001, p. 99).

Semiotic analysis of the inscriptions created by the participants in this study will elucidate how space and visual elements were used to make specific meanings. The same visual elements could be used in different inscriptions to mean something entirely different. As Tversky states, “analyses of actual graphics gives clues to how they are used and produced by people and how they are used gives clues to how they should be designed” (Tversky, 2001, p. 106).

**Types of Inscriptions Encountered in this Study**

One of the reasons that participant-generated visual representations in this study were called inscriptions is that when they are categorised in this way there is no need to discriminate between mostly text-based and mostly graphic-based representations. The majority of visual representations produced in this study were a mixture of both text and graphic forms and separating them into different forms would have affected our understanding of them in their contexts of production and use.

The participants in this study utilised two types of inscriptions: participant-generated and pre-constructed. In Study-A, the participant-generated inscriptions were mainly drawn on the whiteboard walls and some on pieces of paper, while the pre-
constructed inscriptions were accessed from websites and the scaffolding printed pages. In Study-B, the participant-generated inscriptions were drawn on the whiteboard walls while the pre-constructed inscriptions were accessed from a PowerPoint presentation file located on a laptop belonging to one of the team members.

**Types of Content in Participant-Generated Inscriptions**

To facilitate analysis, inscriptions can be categorised into various types (Lunsford et al., 2007). The inscriptions created in this study were categorised as the following:

1. **Thinking marks/annotations**
2. **Composite Written**
3. **Pure Lists**
4. **Composite Lists**
5. **Abstract Diagrams**
6. **Concrete Diagrams**

The mainly text-based inscriptions were categorised as pure or composite. Diagrams were abstract and concrete. An explanation is provided below.

1. *Thinking marks* were simple annotations made on the scaffolding printed pages. In Study-A, these pages included task requirement, the specific group scaffold, and instructions for the completion of the design task. They were provided by the researchers.

2. *Composite written inscriptions* were instances when the text was supplemented with some form of diagrammatic features and spatial marks; such as lines connecting words to indicate relations, clustering text by enclosing them in
frames or brackets for categorisation, or highlighting and underlining terms for emphasis. These are what Tversky (2001) calls ‘schematic pictorial devices’.

3. *Pure list* was characterised by a structure such as a sequence of numbers, bullet points, or other sequenced arrangement.

4. *Composite list* was identified when a list also included schematic pictorial devices as described above in relation to *composite written*.

5. *Abstract diagrams* were categorised as symbolic notations representing concepts or ideas that have no perceptual relationship to the concepts they represent (Purchase, 2014). General examples include charts, graphs and overlapping shapes such as in Venn diagrams.

6. *Concrete diagrams* were categorised as having a direct perceptual relationship to the object they represented (Purchase, 2014). These are iconic in nature. General examples include schematic diagrams such as maps or architectural diagrams.

The pre-constructed inscriptions included photos and images on websites, example Blog designs, printed pages, and PowerPoint presentations. Although these images were not analysed in this study, they still comprise an important part of the design sessions and the *thin* description of the inscription development process indicated when and how these images were utilised by the participants.

Categorising inscriptions is a useful way to learn about them. This categorisation describes how the inscriptions here are different or similar to each other. This will help later when referring back to the inscriptions and discussing them in relation to specific ideas or concepts. The semiotic analysis that follows is organised based on the type of inscriptions.
Composite Written Inscriptions

Six inscriptions were categorised as composite written inscriptions. These inscriptions were mainly comprised of symbolic elements. They consisted of written text with schematic pictorial devices. For example, underlining indicating importance, lines and arrows indicating connection and relationships, forward slashes to indicate parallel structure of terms, parentheses used to contain additional information about a term, and geometric shapes to contain or group things together.

Inscription SA-G2-B

Inscription SA-G2-B, seen in Figure 10 is spread across three main sections, each with its own title. The titles are capitalised and underlined. Underlining the terms in this inscription is not used as a way to indicate importance, but as a formatting strategy to delineate the titles. Each title has one item written underneath it. Enclosing terms in circles was used to show importance, in this case for the design of the Blog. The examples of news stream are written as ‘e.g. farmers using water saving measure’ and ‘Cute animal’. These are then encased by a single bracket on the right and a line goes from the bracket towards the explanation ‘target multiple users’. The line connected to a single bracket makes this feature resemble the branches of a tree, as in diagrams. However, in this inscription it is only a bracket and a connecting line to show that the news stream should consider targeting multiple users. The line with the arrow at the end indicates an asymmetric relationship. Colour is not used intentionally to communicate meaning. The word ‘Video’ and the circle around it are written in a different colour to the rest of the inscription because the first whiteboard marker was running out of ink.
Inscription SB-G1-B

Inscription SB-G1-B, seen in Figure 29, has one title that is capitalised and underlined for emphasis. Although the text underneath the title starts with a number, indicating the start of a list, the remaining text does not conform to the structure of a normal list. There is no ordered form or sequence, and space or indention of text in space is used in an ad hoc manner. The inscription uses a different colour to that of the previous inscription in order to differentiate the two from each other. This inscription also features a number of parentheses. The first two parentheses contain additional information for the title and the first item, however the third parentheses that contain the term (2 weeks) do not. This use of parentheses is to show emphasis.

Inscription SB-G1-C

Inscription SB-G1-C, seen in Figure 30, does not feature a clear title however the first three lines of text are capitalised and appear more prominent than the rest of the text below it. Below the title there appears to be a list item demarcated by a hyphen, however, since no other items are added this inscription, it could not be categorised as a list. Parentheses are used here to encase additional information and a forward slash is used to indicate equal value of the two terms.

Inscription SB-G1-D

Inscription SB-G1-D, seen in Figure 31, features a clear title defined by capitalisation and size compared to the surrounding text. This inscription uses parentheses to present additional information and a forward slash to indicate
equivalence of the terms used in the title. Although some of this inscription is written in a different colour, it is not used in order to communicate meaning. The different coloured markers were not selected intentionally and were just accessible to the participant writing at the time.

_Inscription SB-G2-A_

The inscriptions produced by Study-B Group 2 are illustrated in Figure 22. Inscription SB-G2-A contains a descriptive title. This is indicated by the positioning of the text below the diagram title. The rest of the text in this inscription was added over the Home Screen box in the diagram. The first line of this text over the Home Screen describes what the home screen will contain. The second line starts a short list with three items. The list items start from the same position, indicating their equivalence. There is a colon added before the list items after the word ‘HINTS’. This colon functions the same way as indentation in list items to indicate sub-categorisation. In this instant it may mean that the list items belong to the main category of ‘HINTS’.

_Inscription SB-G2-D_

Inscription SB-G2-D contains a short descriptive summary of the discussion during the drawing of inscription SB-G2-C. The text in this inscription starts with an asterisk, which may indicate that the participant writing this inscription was trying to make sure it is not viewed as a title. In most inscriptions an asterisk is generally used to indicate a list item and thus the participant may have had the intention of adding more information as the discussion went on.
Pure List Inscriptions

Two inscriptions were categorised as pure list inscriptions. These inscriptions were in the form of classic lists where text is structured and organised hierarchically to indicate their relationship.

Inscription SA-G2-A

In inscription SA-G2-A in Figure 9, the term ‘Design Concept’ on the top is capitalised, which indicates it is the title for the list. There is also a subtitle for the list, which is the term ‘Task 1’. It has been capitalised to show that it is a title but also underlined to show it is a slightly different title than the main title. The general list items are all indented slightly and are starting from the same position as the other items in the group. In the ‘Task 1’ sub-list, there are two main items illustrated by the same level of indentation. The other items following these two main points are indented a bit further indicating they are subordinate to the two main points. Parentheses are used to contain information that is additional to the main points.

Inscription SB-G1-F

Inscription SB-G1-F in Figure 33 is composed of a title and two list items. The title is written in uppercase and underlined to indicate its function. The list items are demarcated by asterisks and are starting from the same position indicating they share the same value. A forward slash is also used to indicate equivalence of the two terms used.
Composite List Inscriptions

Although in total there were six inscriptions categorised as composite lists, only five are described under this heading. This is because one composite list was created in the background of an abstract diagram and so it is described together with SA-G1-C later in this chapter. The composite list inscriptions were comprised of structured text containing list items and a number of schematic pictorial devices.

Inscription SA-G3-A

Inscription SA-G3-A, in Figure 14, has a clear heading and a sequence of four list items arranged vertically. The four points or items are indented slightly and are all starting from the same vertical location indicating equal value. Some words are underlined to illustrate their importance to the discussion. Supplementary information to list items 2 and 3 are contained in parentheses. These are further descriptions of the main points. There is a line with arrows at both ends connecting list item 1 and item 3. The placement of number 1 within a small circle is meant to illustrate a numbered point, as is the common format for most sequenced lists. It is placed around half way between items 1 and 3 on the outside edge of the connecting line to indicate that items 1 and 3 are now combined into one list item. The arrows on both ends of the connecting line indicate this relationship as integrative, in that items 1 and 3 are of equal value. If for example the line contained one arrow towards one of the two items the relationship would have been asymmetrical, meaning that one of the items would have been dominant, absorbing the other. Colour is not used in this inscription in order to communicate meaning. After writing the heading and the first two items the marker ran out of ink and so items 3 and 4 were added in a different colour marker.
Inscription SA-G1-A

Inscription SA-G1-A, in Figure 4, consists of three separate lists each with their own titles. The first two lists from the left have the list items organised vertically starting from the same position. This indicates that all the items are of the same value. The third list items are not starting from the same position because these items were added at a later stage when the items from the second list were written and as a result there was not enough space on the wall to organise the list items vertically. Thus, the indention of the second item in the list does not denote sub-categorisation of the item.

There are a number of schematic pictorial devices used to communicate ideas in this inscription. For example, lines and arrows are used to illustrate relations and parentheses are used to encase supplementary information. Check marks are used as a way to keep track of progress during the discussion. Rectangular shapes are used in three ways. First, they are used to group items together, such as the two list items enclosed in a rectangular shape under the ‘Stakeholders’ title. Second, they are used to show emphasis, such as the last item of the first list. Third, they are used as a formatting device. For example enclosing the titles of the three lists in rectangular shapes identifies them as the titles for the lists.

In order to show emphasis, words and terms are underlined, placed inside quotation marks, or both, as in the term ‘sustainable’ in the third list. A large square bracket is used to group three items of the second list. Small circles are used as symbols to illustrate bullet point characters. Colour is used in an interesting way. Green ink marker is used to write the text for the three lists. Red ink marker is used to draw the rectangular shapes around the titles. This is a deliberate choice in order to help the titles
stand out and separate them from the list items. Three list items of the first list are also written in red ink. This was not a deliberate act. Grant was holding the red ink marker after drawing the rectangles around the titles and wrote the three items in red. It might also be because the green ink marker was running out of ink and the writing on the wall was not clear enough. The use of the blue ink marker was also not a deliberate choice. The blue ink marker was used after Grant started drawing the diagram in inscription SA-G1-B in blue and came back to inscription SA-G1-A and added those additional points.

_Inscription SB-G1-A_

Inscription SB-G1-A, in Figure 28, features a title, a subtitle, eight list items and two sub-items, and a number of schematic pictorial devices. The title is written in all capitals which delineates it from the rest of the list. The first two lines of text in the list are not part of the list items and are marked with an asterisk sign. These lines are describing the contents of the list and therefore could be a sub-title for the list. The main list items are starting from the same position, which indicates they share the same value. The two sub-items are slightly indented and are smaller in size than their parent list item. This makes it easier to identify them as belonging to the parent main list item. Parentheses are used to display additional information for one of the items and also the title of the list. A slash sign is used to indicate the equivalence of the two words in the last list item.
Inscription SB-G1-E

Inscription SB-G1-E, in Figure 32, has a clear title. This is indicated by the position of the title on top, capitalisation, and the larger size relative to the rest of the surrounding text. The list features well-organised five list items defined by hyphens. All list items are starting from the same position which indicates they share the same value or importance. Each list item is connected using lines and arrows to two or more sub-items. The main list items are all capitalised and are written in a similar form and size which indicates their relative equivalence. Parentheses are used consistently to display additional information which aids in better understanding of the items and a forward slash indicates equivalence of the two terms in the last item.

Inscription SB-G2-E

In inscription SB-G2-E (see Figure 22), the title is distinguished because it is written using all capital letters and larger size than the surrounding text. Although other lists analysed in this study use space, as in indentation of text, and symbols such as asterisks or hyphens to indicate order and sequence, in this inscription the order to indicate the structure of a list is represented differently. Each item in the list below the main title is separated with a line. The line directly below the title is longer whereas the other two lines separating the list items are shorter and similar in length. The last two items are not separated with a line and both are marked with a small arrow. This may indicate that both of these items are sub-categories of the previous item. This inscription is then connected to inscription SB-G2-D using two lines with arrows. Some descriptive text is added between the two connecting arrows. This text defines the nature of the connection to inscription SB-G2-D.
Abstract Diagrams

Five inscriptions were categorised as abstract diagrams. Where possible, it is also indicated what type of diagram they resemble. The different types of diagrams were introduced in the literature review in Part 1. Abstract diagrams were comprised of a mixture of iconic and symbolic elements. They used text, shapes, and schematic pictorial devices to illustrate abstract ideas and concepts.

Inscription SA-G3-B

Inscription SA-G3-B, in Figure 15, resembles an entity-relationship diagram, which is a form of association diagram. The diagram is visualising the relationship of the stakeholders in the project. Although the diagram includes some iconic elements, on the whole the diagram communicates an abstract idea. There are three sets of stick figures to represent three groups of stakeholders. These are the iconic elements of the diagram. Each group of stakeholders has a textual description underneath or next to the figures. The diagram also includes a number of schematic pictorial devices such as parentheses, circles, arrows, and forward slashes. There is a large rectangle in the middle of the diagram with the word ‘Blog’ inside it. This not only represents the Blog as a page itself but also the design of the Blog as the task. The square as the design task is connected with lines and arrows to some of the stakeholders. Two of the stakeholder groups are connected to the Blog square using two lines. One of the lines has an arrow pointing to the square and the second has an arrow facing the stakeholders. This format illustrates that the relationship between the Blog and the stakeholders is not equal. Each line represents one relationship. For example, the stakeholder group of readers of the
Blog has one relation to the Blog as the readers of the Blog who gain information from the Blog, and another relation in which they can contribute to the information on the Blog. The term ‘private exp’ written on top of the arrow connecting the readers to the Blog square applies to both lines and relationships; as consumer and contributors of information. The stick figures representing the readers of the Blog and the people who live there are both enclosed inside circles. This may indicate their importance for the design process as these are the groups with a bigger stake in the design of the Blog.

There is also a fourth group of stakeholders to represent the designers of the Blog and those who will then moderate the Blog. This group is not represented by stick figures because this group is a subset of the people who live there. Since the people who live there are represented with stick figures already, to show that they are a group of people, there is no need to draw another set of stick figures to represent this group. The arrow going towards the group of designer/moderator has its starting point at the stick figures representing the people who live there rather than the Blog square, indicating that the designer/moderator group is a subset of the people who live in the Murray Darling Basin area. The word Admin was initially designated to represent this group but was later replaced by the designer/moderator label. Interestingly, the word Admin was not erased but crossed out on the whiteboard. This might have been intended to show that the designer/moderators are doing the job of an admin as well. A question mark was used to indicate the participants were uncertain about admin as the group of stakeholders. Colour was not used in a way to indicate any special meaning. Taryn drew the diagram in blue colour marker and then Julia made additions in black ink.
Inscription SA-G3-C2

Inscription SA-G3-C2, in Figure 18, resembles a basic type of sequence and flow diagram. It consists of four stages in the process and the connection between them. This inscription mainly consists of symbolic elements. The inscription initially started as a list with four sequenced numbered points or items. Space has not been used consistently and the list items are not indented as is the standard with lists. Parentheses are used to contain additional information that gives details about the main point. The initial list was subsequently changed into a process diagram. This was done by adding curved lines with arrows at the ends to make a circle with four stages starting from the right side of the list and ending at the left side. The arrows are following one direction which denotes an iterative process. Colour was used intentionally to illustrate how the different stages in this diagram map to the diagram included in the scaffolding printed pages.

Inscriptions SA-G1-B and SA-G1-C

Inscriptions SA-G1-B and SA-G1-C illustrated in Figure 6 were drawn in very close proximity. As a result, the two inscriptions are analysed and described together. Inscription SA-G1-B is categorised as a composite list and is in the background of the diagram. Inscription SA-G1-C is categorised as an abstract diagram which is superimposed over inscription SA-G1-B.

The word ‘Tool’, which is enclosed inside a rectangular shape box, is the title for inscription SA-G1-B. An arrow pointing downwards towards the list items indicates that this word inside the box is intended as the title for the list. The same format was used to demarcate the titles for the lists in the previous inscription SA-G1-A that the group created. The list in this inscription has three small circles as the characters for the bullet
points, however only two list items are added. This indicates that the participant was preparing for more additions to the list. Underlining is used to show emphasis in this inscription.

The diagram in inscription SA-G1-C (Figure 6) resembles a basic flowchart. The squares represent the main entities and the lines are the connections between them. This inscription mainly consists of symbolic elements. The diagram in this inscription is structured vertically. There are two main parts; towards the top of the diagram and the lower section. The main square box in the middle of the diagram with the word ‘Blog’ inside represents the Blog itself. The four boxes on the top connected with lines to this Blog square are the main components of this Blog, which include short text, images, videos and infographics. These boxes have written descriptions inside them in addition to the descriptive term ‘Content’ above the boxes which illustrate their function in the diagram.

The lower section of the diagram is connected to the main Blog square using a longer line. This may indicate that the drawer was trying to leave space in case more additions were made to the list in inscription SA-G1-B. The three boxes connected to this main Blog square on the lower section of the diagram represent the social media links to the Blog. An arrow connecting the term ‘Students’ to these boxes illustrates how the students can be notified of the new contents on the Blog using these social media tools. There are five small circles underneath the main Blog square. These are a symbolic representation of the stakeholders in the Blog project. The idea illustrates how multiple people or groups of people will be able to contribute to the contents of the Blog which then can be accessed by the students using the social media tools.
Inscription SA-G1-D

Inscription SA-G1-D, in Figure 7, resembles a type of sequence and flow diagram. It illustrates the main input and output of the Blog. The diagram is structured both vertically and horizontally. The horizontal structure shows how the main stakeholders would be contributing to the contents of the Blog. This is illustrated with the list in red colour pen on the far left of the inscription. The list has a small title, ‘Input’, and all the list items are starting from the same position illustrating that the stakeholders will have equal access to the Blog as contributors. A red line and arrow connects this list to a rectangular shaped main box that represents the Blog. Another list is written over and below this red line using black ink pen. This list also has a title and all the list items are starting from the same position, indicating their equivalence. This list describes the format of the main contents of the Blog. As the red arrow is going into the main Blog box to show the input, another arrow drawn in green colour is going out of the Blog box to show the target audience. This is a type of symbolic representation to show that the input into the Blog is targeting 16 year old school kids.

The Blog box is also vertically connected to three boxes below which represent how the students will be able to access the contents of the Blog using social media tools as well as email. This inscription has a title that is also describing the main goal for the Blog. Colour is used intentionally to illustrate different features of the diagram. For example, red marker was used to show the input and green marker was used to indicate the target audience for the Blog. This diagram was intended to be used as a demonstration of the design concept to the researchers at the end of the meeting. As such, Grant took care in drawing this diagram on paper.
Inscription SB-G2-B

Although inscription SB-G2-B (Figure 22) contains the image of a globe, as in the earth which is an iconic element, however the inscription represents a symbolic abstract idea and thus the categorisation as abstract diagram. The image of the globe here is not intended to emphasise or communicate any physical resemblance to the earth but as an idea of having a main single entry point into the game which is then connected to all other screens, as indicated by the lines and arrows towards the diagram boxes. This inscription also features a line with the letter ‘P’ at the beginning and an arrow at the end drawn over the two main diagram boxes. This indicates a unidirectional link from the Player Home to the Home Screen of the game. This inscription is depended on the PowerPoint slide in the background to create meaningful elements. Without the background diagram the inscription would not make sense.

Concrete Diagrams

Four inscriptions were categorised as concrete diagrams. They used both iconic and symbolic elements. These diagrams mostly resembled what they were depicting.

Inscription SA-G1-E

Inscription SA-G1-E in Figure 8 uses both symbolic and iconic elements to illustrate how the Blog page will look. The diagram has an outline on four sides to make it look like a page. The top section is separated to show the banner for the Blog. The banner includes sketches of a tree and an animal. The tree is positioned on a diagonal line which stands for a hill. The aim for the banner is to contain images of nature. The remaining space of the page is divided into the main contents section and the links and
tags area. This structure is common with most Blog pages. The main contents area is also divided into three horizontal sections. The sections include the sample titles for the posts to illustrate how new events could be posted to the Blog and how and where they will appear. The date on the left side of each section shows that the most recent posts would appear on top of the page. The last section of the page also includes a video, which is represented with a rectangular shape box. Inside this box is an image of the same animal that appears in the banner and a line connects the two animals with the arrow pointing towards the video box. This indicates that the image of the animal in the banner will be linked to the relevant story in the main contents section of the Blog. The links and tags section of the Blog on the right is only divided into four sections. There are no details added in this section because Natasha assumes that the other members know what this area will include. Furthermore, adding details to the links section of the Blog was not important to the conversation at the time of drawing this inscription. This diagram also includes only information that is needed for the viewer to interpret and make sense of the inscription. Unnecessary details are omitted to reduce clutter and to help the viewer concentrate on what is important.

*Inscription SA-G2-C*

Inscription SA-G2-C in Figure 12 contains symbolic as well as iconic elements. The inscription on the whole depicts an iconic entity and therefore it is categorised as a concrete diagram. The diagram depicts a Blog page. The diagram is deliberately made to look like a page demarcated by lines on the top and each side. The header consists of iconic elements such as trees, a river, some fish, and a kangaroo, as well as symbolic elements such as the title and the description of the site. The main Blog contents are
located in the centre. They include both iconic and symbolic elements. The horizontal lines on the page denote lines of text on the Blog. Photos and videos on the page are represented using iconic elements with rectangular boxes. A visual icon on the Blog page is represented with an irregular shape similar to the shape of a cloud. The footer of the Blog is separated by a long horizontal line towards the bottom of the page.

All text that is intended to be a title is written in capital letters. This tells us that these are different from other text like the subtitles which are capitalised. Links are located on the right side of the page to comply with general Blog page formats. Links are also underlined to differentiate them from the normal text. This is a visual clue, as in many websites linked text appears as underlined when the mouse hovers over it. The dotted short lines in four sections on the diagram are intended to indicate separation of the sections by some form of subtle visual feature, which might be a dotted line on a Blog. The line with the arrow at the end going towards the right side of the diagram indicates that the link is connected to another page.

Colour in this inscription has been used intentionally to communicate meaning. The branches of the trees are in green and their trunks are in red. The river is drawn in blue with little fish in green and blue. This is to communicate the idea that the Blog header will contain images of nature, and perhaps, the image of the Murray Darling Basin itself. The header is intended to set the theme for the Blog. The rest of the contents will certainly be in different colours on the actual Blog page but including all those details here in the diagram are not necessary and may even add to the visual clutter.

Inscription SA-G2-C only represents information that is needed to correctly interpret the design. Space and elements are used effectively to communicate ideas
without distracting the attention of the viewer. For example, images and video on the Blog are represented with simple rectangular shapes and short descriptive text inside. These rectangles are meaningful because the diagram as a whole is able to communicate the idea that it stands for a Blog page. Every element in this diagram is relying on other elements to jointly communicate to the viewer that this is a representation of a Blog.

_Inscription SA-G2-D_

Inscription SA-G2-D in Figure 13 is illustrating what happens when a user clicks on one of the links in the main Blog page, as in inscription SA-G2-C. The arrow going out of SA-G2-C towards the right side of the diagram was pointing to this diagram. It represents a sub-page of the Blog where teachers would find extra resources to use when teaching their students about the Murray Darling Basin. This diagram is a perfect example of how concrete ideas can be represented by abstracting the information and presenting only that which can communicate the meaning without distracting the viewer. The diagram is again demarcated by lines on the top and both sides to make it look like a page. The banner for the page is only represented with the word ‘Banner’ instead of drawing the trees, the river and all the details of the main Blog page as in inscription SA-G2-C. The main titles are written and these communicate to the viewer what the possible contents are for this page. The contents of the page are represented by horizontal lines below each title. The links for this page are only represented by short horizontal lines. There is no need to write the links here as they are already included in inscription SA-G2-C. This illustrates that the participant drawing the diagram, Dom, understands the general conventions for good web design such as that links should be consistent on each page of the website (Krug, 2005). The arrow pointing left from the
banner of this page indicates that the banner is also a link back to the home page of the Blog.

**Inscription SB-G2-C**

Inscription SB-G2-C (Figure 22) features the images of a bear, a window, and a solar panel. This inscription uses the image of the house in the background PowerPoint slide as the base for the drawings. The image of the bear is drawn next to the house. The image of the window is drawn on the side of the house and the solar panel is positioned on the roof of the house. The inscription is trying to communicate concrete ideas for how the bear, as the main character in the game, would look inside the house in the glacier environment to see if the lights are on. The image of the solar panels is also an iconic element that would communicate to the user that the residents in the house are using renewable energy.

This is where the semiotic analysis of the inscriptions concludes. The next section presents a brief summary of the number of inscriptions created, their types, and the groups that created these inscriptions.

**Overview of the Inscriptions Created in this Study**

This overview is intended to give a broad picture of the types of inscriptions that were created in this study. Table 16 is a summary of the ‘thinking marks’ created by the participants in Study-A. The participants in Study-B did not create ‘thinking marks’.
Table 16 - Thinking Marks Created by the Participants in Study-A

<table>
<thead>
<tr>
<th>Thinking marks created by the participants in Study-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
</tr>
<tr>
<td>Grant</td>
</tr>
<tr>
<td>Judy</td>
</tr>
<tr>
<td>Natasha</td>
</tr>
</tbody>
</table>

In this study, the participants created slightly more abstract diagrams than concrete diagrams. A number of diagrams included both symbols and icons making them resemble complex signs (Connolly, 2000). However, abstract and concrete diagrams were categorised as whole; in that they were categorised based on what they depicted in their entirety not what the individual elements depicted. Although Cash, Hicks, and Culley (2013) state that designers in controlled experimental studies produce more sketches than designers working on real-world design problems in this study, both Study-B and Study-A groups produced similar total numbers of inscriptions. Table 17 presents an overview of the number and types of inscriptions created in this study.

Table 17 - Types of Inscriptions Created by the Participants in Study-A and Study-B

<table>
<thead>
<tr>
<th>Type of Inscription/Study</th>
<th>Composite written inscriptions</th>
<th>Pure list inscriptions</th>
<th>Composite list inscriptions</th>
<th>Abstract diagrams</th>
<th>Concrete diagrams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study-A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Study-B</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
This concludes Chapter Nine. In Chapter Ten I present a summary of the findings for both Study-A and Study-B resulting from the process of thin descriptions and the semiotic analysis of inscriptions.
Chapter Ten: Summary and Synthesis of Findings for both Study-A and Study-B

In this chapter I provide a summary of the significant findings for Study-A and Study-B. I begin by describing the function of inscriptions in this study, followed by a general overview of the inscriptions. The overview is presented in visualisations showing the types of inscriptions created, the participants creating the inscriptions, when they were created, and how they were used. This is followed by an explanation of the inscriptions’ development process. The development process is then visualised to provide a summary for each group in the two cases studied. I also present some interpretation of the results from the semiotic analysis. I will further explain the influence of the task for the two case studies and conclude with a discussion of the tentative nature of inscriptions in this study.

The Function of Inscriptions in this Study

In order to determine the function of inscriptions in this study, the design session recordings were analysed in an iterative manner to initially seek instances when the inscriptions were initiated. The participants’ utterances and actions were often a clue to the function of the inscription. After the initial creation, the inscription was followed through the design meeting to investigate how it was utilised. Finally, examining what happened to inscriptions at the end of the meeting also illuminated their purpose in the meeting. As a result, it was determined that in this study, inscriptions were created and
used to (1) capture ideas and decisions made; (2) inscribe solutions; and (3) demonstrate ideas.

Capturing ideas and decisions made was the main reason why most of the inscriptions in this study were created. Ideas were captured in order to hold them in place and make them available for discussion. Capturing ideas using inscriptions made it possible to have a visual record of what was being discussed in the meeting. Inscriptions were less fleeting than either words or gestures and provided a stable ground against which the participants discussed their ideas. Inscriptions were used as a way to offload a part of the working memory to an external medium that would hold the ideas in a state of flexible permanence. By flexible permanence I mean that most inscriptions, in particular those created on a whiteboard wall, were permanent in the sense that they were recorded in drawing or written form, yet flexible enough to be erased and rewritten. Ideas were captured as a first step of recording participants’ discussion, as well as planned discussion, and decisions were captured as a last step. The process was iterative in that most decisions were not final, and were open for further discussion, resulting in subsequent decisions.

The second purpose of inscriptions that was identified, inscribing solutions, refers to the process by which the participants created inscriptions in order to 1) describe an idea such as what the Blog would look like; 2) explain how something worked such as the system of input and output data from the Blog; and 3) question ideas such as pointing to a section of an inscription or drawing parentheses around a section such as a word or a term in order to question the contents inside. To describe and to explain ideas was to make them available for debate, discussion and evaluation. To question ideas
was to understand them or to propose new ones. Through this process of describing, explaining and questioning, the participants developed the ideas for their design.

Finally, inscriptions were used to demonstrate ideas. Once the inscriptions were drawn on the wall or on paper, the participants often referred to the ideas in the inscriptions during their discussions. To demonstrate ideas, participants used deictic gestures to attract the attention of the audience to specific inscriptions or to specific parts of an inscription. The inscriptions were also used in a more formal way by the groups in Study-A when they were asked to present their ideas to the researchers at the end. In this way, the inscriptions were used for both referring to ideas during their design discussion and the presentation of their ideas after the design session.

The majority of inscriptions in this study had multiple functions, and most of them were dynamic in nature. For example, the participants would create an inscription in order to capture ideas from a previous inscription, or from an outside source such as a web page. During the meeting however, the participants would use this inscription as a tool to inscribe solutions. Quite often the same inscription would then be used to present their ideas to the researchers. In this way, the same inscription would have been used for different purposes during the session. The inscription would have started as a record of ideas but then used for describing ideas, explaining, questioning and debating ideas, and at the end for presenting ideas discussed. The Inscriptions Overview section next presents visual summaries that illustrate this finding for each group.
Overview of the Findings Related to Inscriptions

The overview of the inscriptions is presented here in order to provide a general outline of some of the findings discussed so far. Furthermore, the overview shows some patterns that emerged in how the groups in the two case studies created and utilised inscriptions.

Study-A

Dynamic Function of Inscriptions

All three Study-A groups instigated and utilised the inscriptions in order to capture ideas, inscribe solutions, and demonstrate ideas to the researchers. The same inscription could serve multiple functions. An inscription could be instigated to capture ideas but then used for inscribing solutions during the meeting. Some inscriptions were not created with the intention of being used for the demonstration of ideas, but were used for this purpose regardless. This illustrates the dynamic nature of the inscriptions in this study.

Progression from Simple to Complex

The first inscriptions created by Study-A groups were in the form of one pure list and two composite lists instigated by a single participant in the groups. As the groups moved from one inscription to the next, the format of their inscriptions changed from lists to more complex and elaborated concrete and abstract diagrams. There may be some connection with the progress of ideas. As the groups progressed towards defining a solution their ideas became complicated and more elaborated. As a result, they needed
more complex forms of inscriptions to demonstrate their ideas to the researchers at the end.

The diagrams in Figure 45, Figure 46, and Figure 47 provide a summary of the types of inscriptions produced by the groups, the function for these inscriptions or how they were utilised, and the participants drawing the inscriptions in each group. The times noted for each inscriptions represent the timestamp in the transcription for when an inscriptions was instigated.

**Study-A Group 1 Inscriptions Overview**

<table>
<thead>
<tr>
<th>How was the inscriptions used?</th>
<th>Time</th>
<th>Label</th>
<th>Type</th>
<th>Participant Drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>- To capture ideas</td>
<td>0:53:09</td>
<td>Inscription SA-G1-A</td>
<td>Composite list</td>
<td>Grant</td>
</tr>
<tr>
<td>- To inscribe solutions</td>
<td>1:11:59</td>
<td>Inscriptions SA-G1-B &amp; SA-G1-C</td>
<td>Abstract diagram</td>
<td>Grant</td>
</tr>
<tr>
<td>- To demonstrate ideas</td>
<td>1:29:26</td>
<td>Inscription SA-G1-D</td>
<td>Abstract diagram</td>
<td>Grant</td>
</tr>
<tr>
<td>- To inscribe solutions</td>
<td>1:43:14</td>
<td>Inscription SA-G1-E</td>
<td>Concrete diagram</td>
<td>Natasha</td>
</tr>
</tbody>
</table>

Figure 45. Study-A Group 1 inscriptions overview
Figure 46. Study-A Group 2 inscriptions overview

Figure 47. Study-A Group 3 inscriptions overview
Study-B

Some patterns also emerged in Study-B. The majority of the inscriptions were created in order to capture the team’s ideas. These ideas were taken away for further development. There were more text-based inscriptions created in this study than diagrams. This may have been due to the phase of the design they were in.

The Influence of the Design Phase

Study-B team was working on a real-world project and thus their inscription related practices differed from those of Study-A. They were also at a slightly different stage of their design process. Some of Study-B team members had already attended previous meetings working on the same project. As such, the team did not start their design tasks from scratch. Most of the decisions were already made, such as the target audience, the platform, the main activities in the game, the general look and feel of the game, and other technical details. They were at a stage of the design where they already knew enough about the design problem and thus were mainly concentrating on brainstorming ideas for a solution. They also brought with them materials and resources they had designed previously to work with during this meeting.

Study-B team did not complete their design task at the end of the meeting, as was required of Study-A groups. The design task of Study-B team would continue beyond this meeting and would entail several future meetings and design sessions. For this reason, most of the inscriptions produced by the groups in this meeting were intended as a record of ideas and decisions made that could be used in future meetings and further design sessions. They mostly instigated the drawing of inscriptions in order to capture the group members’ ideas. Several members of the team took photos of the inscriptions
with them; presumably for future use in meetings and for further development of the design using the ideas discussed here.

The diagrams in Figure 48 and Figure 49 visualise the analyses of this section. The diagrams exhibit the types of inscriptions created by Group 1 and Group 2, the function of these inscriptions or how they were used, and the participant/s that created the inscriptions. The recorded time represent the timestamp recorded in the transcription for this meeting for when an inscription was instigated.

**Study-B Group 1 Inscriptions Overview**

<table>
<thead>
<tr>
<th>How was the inscription used?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>To capture ideas</td>
<td></td>
</tr>
<tr>
<td>To inscribe solutions</td>
<td></td>
</tr>
<tr>
<td>To demonstrate ideas</td>
<td></td>
</tr>
<tr>
<td>To inscribe</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Type</th>
<th>Participant Drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:57:15</td>
<td>Inscription SB-G1-A</td>
<td>Composite List</td>
<td>Malcolm and Jareth</td>
</tr>
<tr>
<td>2:05:13</td>
<td>Inscription SB-G1-B</td>
<td>Composite Written</td>
<td>Malcolm</td>
</tr>
<tr>
<td>2:10:54</td>
<td>Inscription SB-G1-C</td>
<td>Composite Written</td>
<td>Malcolm</td>
</tr>
<tr>
<td>2:14:29</td>
<td>Inscription SB-G1-D</td>
<td>Composite Written</td>
<td>Malcolm</td>
</tr>
<tr>
<td>2:23:38</td>
<td>Inscription SB-G1-E</td>
<td>Composite List</td>
<td>Jareth</td>
</tr>
<tr>
<td>2:31:20</td>
<td>Inscription SB-G1-F</td>
<td>Pure List</td>
<td>Malcolm</td>
</tr>
</tbody>
</table>

Figure 48. Study-B Group 1 inscriptions overview
Inscription Development Process

Non-linear Development of Inscriptions

The participants created the majority of inscriptions using a non-linear approach. This means that individual inscriptions were not created starting from the top left and ending in the bottom right as in, for example, written text. Instead, the participants added text and schematic pictorial devices in a non-linear way, as they were required, as the meeting progressed. For example, Grant from Study-A Group 1 created Inscription SA-G1-A by adding headings, list items, and schematic pictorial devices to different areas of the list, moving around and adding the information where appropriate, as the group discussed their design ideas. This process is illustrated with numbers in Figure 50, demonstrating how Grant added pieces of information to different parts of the inscription in a non-linear way. This figure only illustrates the first thirty steps of
additions made to the inscription. Small details and schematic pictorial devices, such as lines, circles for bullet points and ticks are not included in this illustration. Only three inscriptions were created in a linear manner. The process described here exemplifies how most other inscriptions were created in this study. Abstract diagrams and drawings of objects are usually drawn in a non-linear manner owing to their format; however it is interesting that text-based inscriptions such as the lists in Figure 50 were also created in a non-linear process.

Figure 50. The non-linear development of inscription SA-G1-A

**Incremental Elaboration of Inscriptions**

The participants in this study created the inscriptions in incremental phases. This means, at times, the participants gradually refined an inscription by revisiting it and adding more details to it after they had started drawing another inscription. For example, in Figure 50, steps 35 to 38 were added after Grant started drawing
inscriptions SA-G1-B and SA-G1-C. After adding the word ‘system’ as in step 30 in Figure 50, Grant started drawing inscriptions SA-G1-B and SA-G1-C, and after only a few additions, came back to inscription SA-G1-A and added the steps 35 to 38.

Incremental elaborations were enacted by the same participant. This means the same person was observed creating one inscription, moving on to create another inscription, and then returning to the previous inscription to add more details. Not all inscriptions were created in this way; some inscriptions were erased before the next inscriptions were created. All Study-A groups worked on at least two inscriptions incrementally during their design session. This process is visualised in diagrams later in this chapter.

**Simultaneous Development of Inscriptions**

Simultaneous development of inscriptions occurred when two different participants were working on two different inscriptions at the same time. In Study-A, only Natasha and Grant from Group 1 developed two inscriptions simultaneously. As Grant drew the diagram in inscription SA-G1-D using paper and attached it to the wall, Natasha used another piece of paper on the main table to draw the diagram in inscription SA-G1-E. While Grant was watching Natasha draw inscription SA-G1-E, he formed new ideas which he then added to inscription SA-G1-D (the diagram he had attached to the wall). In Study-B, the participants in Group 1 created three inscriptions and in Group 2 created two of their inscriptions simultaneously. In Group 1, Jareth started writing inscription SB-G1-E as Malcolm was finishing SB-G1-D. Malcolm then started writing inscription SB-G1-F while Jareth was still creating SB-G1-E on the same wall. They both worked on the three different inscriptions at the same time. In Group 2, Jarrod was working on inscription SB-G2-D when Galileo started writing inscription
SB-G2-E on the left side of the projected slides. This process is also visualised later in this chapter.

**Joint Development of Inscriptions**

Joint development of inscriptions happens when the same inscription is created by two or more participants in a group. Only three inscriptions were developed jointly by two or more participants, the majority of the inscriptions in this study were drawn by a single participant. In Study-A Group 3, inscription SA-G3-B was developed by two participants while all three participants in the group jointly added to inscription SA-G3-C2. In Study-B Group 1, inscription SB-G1-A was developed by two participants. Although SB-G1-A was mostly developed by one of the participants and the second participant only added one list item, this inscription can still be categorised as jointly written by two participants. This process is also illustrated using diagrams later in this chapter. Inscriptions drawn by Study-B Group 2 were separated for the purpose of enabling clear analysis. If the inscriptions by Group 2 are considered as part of one large inscription then we can say that Group 2 jointly developed a large inscription spread around the wall.

**Inscription Development Process Visualised**

During the design session in Study-A Group 1, Grant stated “I think everything is easier to see with a diagram”. A diagram can provide an overview which can be seen in its entirety for each different group. The following sections include diagrams created in order to provide this overview of the development process for each group that produced
inscriptions during their design sessions in this study. The diagrams demonstrate which inscriptions were developed in a non-linear way; which inscriptions were developed in incremental stages; and, which inscriptions were simultaneously developed during each of the design sessions. In addition, the diagrams also show the time in minutes when the participants started drawing the inscriptions and if or when inscriptions were erased and replaced by others.

**Study-A Groups**

*Group 1*

The diagram in Figure 51 visualises the inscription development process for Study-A Group 1. This group produced a total of five inscriptions, however two of the inscriptions, SA-G1-B and SA-G1-C were drawn in very close proximity, almost merged together, and so were analysed together. Inscriptions SA-G1-A, SA-G1-B and SA-G1-C were created on Wall A while SA-G1-D and SA-G1-E were drawn on large sheets of paper. All of the inscriptions were created in a non-linear way. Grant created SA-G1-A, SA-G1-B and SA-G1-C in incremental stages. He was moving around the whiteboard wall refining all of the three inscriptions concurrently. Two of the inscriptions SA-G1-D and SA-G1-E were also developed simultaneously by two participants in the design session.
Group 2

Group 2 produced four inscriptions; one list, one composite written and two concrete diagrams (see Figure 52). Inscription SA-G2-A was created on paper while the rest were all drawn on Wall A. Inscription SA-G2-B was erased before the next two inscriptions were created. All of the inscriptions created on the wall were drawn in a non-linear way, and none of the inscriptions were created jointly by more than one participant. Two inscriptions were developed in incremental stages in the following way. Dom started drawing the diagram in inscription SA-G2-C first. He then drew SA-G2-D and after finishing that came back to complete and further refine SA-G2-C.
Group 3

Group 3 produced a total of three inscriptions; one composite list and two diagrams (see Figure 53). The third inscription evolved from a pure list in inscription SA-G3-C to an elaborate complex diagram in inscription SA-G3-C2. Before the team transformed the pure list into the complex diagram, they erased the previous two inscriptions from the whiteboard wall. Only the pure list in inscription SA-G3-C was developed in a linear way. The rest of the inscriptions were drawn in a non-linear manner similar to that illustrated in Figure 50. Two of the group members, Taryn and Julia, jointly drew inscription SA-G3-B while all three members of the group developed inscription SA-G3-C2 together. The group developed inscriptions SA-G3-B and SA-G3-C1 in incremental stages.
Study-A Group 3 Inscriptions Development Process

![Diagram showing the development process of inscriptions]

Figure 53. Study-A Group 3 - inscription development process

**Study-B Team**

**Group 1**

Study-B Group 1 produced a total of six inscriptions (see Figure 54). Two of the inscriptions in this group were developed in a linear way, the remaining were non-linear, similar to the inscription in Figure 50. Only the first inscription, SB-G1-A, was developed jointly by two participants with the remaining created by individuals. Inscriptions SB-G1-A and SB-G1-B were developed incrementally. Three of the inscriptions in this group were developed simultaneously by two participants.
Group 2

The diagram in Figure 55 visualises the inscription development process for Study-B Group 2. This group created five inscriptions. Only one of the inscriptions was created in a linear manner; the rest were created in a non-linear way. All the inscriptions in this group were created by individual participants and thus there were no jointly created inscriptions. Inscriptions SB-G2-D and SB-G2-E were created simultaneously by two participants.

Figure 54. Study-B Group 1 - inscription development process
Emergent Patterns in Semiotic Analysis

The semiotic analysis illustrates that the majority of inscriptions spontaneously produced during educational design team meetings in this study were text-based. Abstract diagrams also featured strongly. The text-based inscriptions relied on the use of space and visual elements, such as signs, symbols, and the schematic pictorial devices, in order to communicate meaning. Most inscriptions used visual cues in a consistent manner, and this improved the readability of the inscription. For example, inscription SA-G2-C used underlining consistently to indicate linked text. This eliminated confusion and improved viewer interpretation.

There was no strict format for lists. For example the same participant in Study-B Group 1 created lists that used different methods for showing order and sequence. Some lists used shapes like small circles and some used symbols such as asterisks, hyphens, or numbers to indicate order and sequence. There were lists that used indentation of text in
space and still others used lines to separate list items. When these methods were used consistently the list format could be identified more easily.

Some inscriptions used colour to communicate ideas. However the use of colour does not seem to have been imperative to communicating meaning using inscriptions. In concrete diagrams, colour was used to make objects appear closer to the way they look like in real life. This may improve the readability of the diagrams in some cases. In abstract diagrams, colour was mainly used in order to differentiate visual elements such as the input and output of a Blog. In text-based inscriptions, such as lists and composite written, colour was used as a way to differentiate between the different inscriptions as they were written in a very close proximity on the wall. In some cases, such as inscription SA-G1-A, colour was also used as a formatting device to distinguish titles from the main text for example. In other words, colour was mainly used for specific elements to stand out and be distinguished from the surrounding elements. There were also instances where colour was used unintentionally, as when the ink of the marker ran out. In these instances, it did not seem to affect the interpretability of the inscriptions in text-based inscriptions or in diagrams.

The way the participants were reacting to the use of colour is also important. The use of colour did not bring any disruptions to the flow of the meeting. If the colour of a marker was not strong or visible enough, the participants did not insist on finding another marker of the same shade. They used any marker that was available. The participants did not object to inscriptions created in more than one colour. For example, in a number of the list inscriptions some list items were created in one colour while one or more items were in a different colour.
When inscriptions contained iconic elements, such as an image of a tree or a bear, these elements did not need to conform to exact form, shape, or details of the actual object. A general rough outline for most objects was sufficient to communicate the meaning. The elimination of details from the representation of the objects seems to be the strength of these representations rather than their weakness. A rough outline could easily be changed and was more flexible.

The most important finding of this semiotic analysis was that the meaning of elements used in inscriptions depended on the context of their use. For example, underlining words and terms in inscription SA-G2-C represented linked text while underlining words and terms in inscription SA-G3-A represented emphasis, as in attracting attention to those terms. This is because inscription SA-G2-C was a representation of a Blog page and most viewers would know that linked text may appear as underlined on websites and Blog pages. Similarly, viewers would not assume that the underlined text in inscription SA-G3-A was linked text since inscription SA-G3-A is a composite list and does not represent a hyperlink system. Any element could take on different meaning in different contexts. For example, the rectangular boxes in inscription SA-G1-A were mainly used in order to delineate the titles for the lists. The same rectangular box was used in inscription SA-G1-E to represent a video container inside a Blog page.

**Influence of the Design Task**

There were some differences between Study-A and Study-B in the reasons for creating the inscriptions. Study-A groups were asked to produce a sketch for the Blog
and as such they were inclined to make inscriptions that they could use to present to the researchers at the end of the meeting. Furthermore, Study-A groups had to come up with a solution by the end of the meeting and thus had to go through an entire ideation process. They needed to come up with ideas for a solution, evaluate different solutions and then refine one solution to present to the researchers. That is why Study-A groups created inscriptions for a variety of reasons such as to help them capture ideas so they could inscribe solutions and then present them to the researchers. The groups in Study-B on the other hand did not need to produce a sketch or present a design concept to the rest of the team. They mostly needed to brainstorm ideas that they would then take with them. The ideas did not need to be finalised and so these groups created most of the inscriptions as a way to capture the ideas discussed in the brainstorming.

**The Tentative Nature of Inscriptions**

The inscriptions that Study-B team took away were not fixed items, in that they were not final decisions, but would help guide some of the final decisions. The inscriptions were not the same as meeting minutes because a meeting’s minutes is a legally binding document which is often used in dispute resolution as evidence (Webster, 2006). The inscriptions are also not design contracts or work agreements. Such records as meeting minutes or design contracts recommend future action. Inscriptions have a more experimental nature. They are - just like design sketches - still a work in progress.

Some decisions had to be made in Study-A groups’ meetings, due to the nature of their design task requiring a design concept at the end of the meetings. Nevertheless, the
participants were aware that their design decisions were not going to be implemented. The tentative nature of inscriptions most likely influenced the interaction between the designers in this study. The participants did not disagree over what had to be recorded in the inscriptions. The inscriptions were exploratory rather than final absolute decisions. This is one of the benefits of inscriptions, which may help avoid premature fixation of ideas by allowing the designer to explore more ideas and different aspects of ideas before final decisions are made.

This concludes Part 3 of the thesis. In Part 4, I present the results illustrating how gestures were used in this study in relation to the inscriptions.
Part 4 – Gestures

This part of the thesis is presented in two chapters. In Chapter Eleven I present examples of the gestures enacted by the participants in this study. This chapter contains the main results for Part 4. In Chapter Twelve I provide a summary and a synthesis of the results presented in Chapter Eleven.
Chapter Eleven: The Gestures in this Study

Three types of gestures were observed in the design sessions. These were deictic, iconic, and metaphoric. The first example provided in this chapter is intended to illustrate how deictic gestures were used by the participants in relation to the inscriptions in this study. This is followed by an example of a cohesive metaphoric gesture that I call the ‘Process’ gesture. The next example is a cohesive iconic gesture that I have labelled the ‘Globe’ gesture. Finally, an example of a metaphoric gesture that was not cohesive and was enacted in the absence of the referent visual representation is provided.

A reminder to the reader that in the tables providing extracts of the data, deictic gestures are labelled D-Gesture, metaphoric gestures are labelled M-Gesture, and iconic gestures are Ic-Gestures. Images showing the stroke or highest point (the most visible point) of some gestures are also included to demonstrate what the gestures looked like to an observer.

Deictic Gestures

Deictic gestures are pointing movements. These gestures are often used with demonstrative pronouns such as here, there, or this, that and their plural forms. Deictic gestures create shared focus and draw attention to selective critical aspects of the message. Deictic gestures were used widely throughout each of the design meetings, and were used in relation to all of the inscriptions reported on in the previous section.
These gestures were often used to point directly to inscriptions or to specific parts of the inscriptions when the inscriptions were publicly visible. No deictic gestures were observed to point to inscriptions that were not publicly visible (such as, for example inscription SA-G2-A). Deictic gestures included the whole hand, just the index finger, or even holding and pointing with a pen. An example of the use of deictic gestures is provided in Table 18. In this single utterance by Natasha from Study-A Group 1, she enacts six deictic gestures towards inscription SA-G1-E. Similar instances of deictic gestures will be reported together with other gestures in subsequent sections.

In the data tables in this section, the onset of each gesture is indicated with an open brace and the termination of the gesture is indicated with a close brace sign. This is the stroke of the gesture. As discussed in Chapter Three, a gesture can pass through five phases, of which the stroke is the most visible phase.

Table 18 - Example of Deictic Gestures in this Study

<table>
<thead>
<tr>
<th>Timestamp on recording</th>
<th>Participant pseudonym Natasha</th>
<th>Referent inscription SA-G1-E</th>
<th>Transcription Order ID:1280</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line #</td>
<td>Talk</td>
<td>Non-verbal communication</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>So {this is actually explore the ecosystem} Right hand moving in small circles over the top banner in inscription SA-G1-E.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>and get that connection with the importance of you know {this is why you need to save the water it’s because you’re saving this stuff} Right hand quickly touching various parts of the inscription.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>and then {to build stories around each of these little elements around the ecosystem} Right hand pointing at the top banner section.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>so when you click {say when you click on this} Right hand index finger pointing at the image of animal in the banner.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>{you know you eventually get one of these} Right hand index finger pointing at the rectangular box at the bottom of the page.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The utterance in this event in Table 18 is an excerpt from a conversation between the participants in Study-A Group 1 and the two researchers at the end of the design task. In this example, one of the participants, Natasha, was demonstrating her ideas for the design of the blog. She used the drawing of a blog page (Inscription SA-G1-E) that she had made during the meeting in order to describe how the header image in the blog page could be designed and then linked to the individual blog posts. She used several deictic gestures to point to specific sections of the drawing. For example, she pointed to the image of the little animal in the banner (line 4, Table 18) and stated “say when you click on this” and then moved her right hand with index finger extended to point to another section of the drawing and stated “you know you eventually get one of these” (line 5, Table 18). She made several deictic gestures like these throughout this single utterance. In this highly situated conversation the inscription was the background against which the utterances made sense and the gesture was an indispensible additional communication channel, the omission of which could render the utterance meaningless.

The ‘Process’ Metaphoric Gesture

Metaphoric gestures present an abstract idea or concept. They are useful for making salient features of a concept that is not easily communicated in words. The ‘Process’ metaphoric gesture was enacted in relation to inscription SA-G3-C1, by all of the participants from Study-A Group 3. This gesture did not point to an aspect of the inscription, but occurred with the inscription as the ground against which both the
gesture and the talk could make sense. This metaphoric gesture was always blended with a deictic gesture; which means the gesture was often enacted with the hand extended towards the inscription on the wall. This helped connect both gestural and verbal narratives to the pictorial background (Roth, 2001).

The ‘Process’ gesture was a cohesive gesture, which means that the gesture was repeated in the same form and movement to show the continuation of the idea. Cohesive gestures were discussed in Chapter Three. The visual form of the ‘Process’ gesture resembled a clockwise rotation movement. Some of this gesture’s instances involved rotating the entire arm, while some instances were the rotation of just the hand with either holding and pointing with a pen or the index finger extended. Each ‘Process’ gesture comprised of two or more rotations. The repetition of the rotating act itself is most likely a reference to the iterative nature of the design process which the diagram was trying to depict. The gesture is classified as metaphoric because the referent of the gesture is an abstract concept rather than a pictorial concrete object.

The ‘Process’ gesture is reported in Table 19. The table illustrates how the gesture was instigated, how it developed throughout the meeting, and how it was linked to the diagram on Wall A. A visualisation of the gesture can be seen in Figure 56, where the stroke of the gesture (its shape and movement direction) is illustrated by a red line with arrow.

Table 19 - The ‘Process’ Gesture

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incubation and development of the gesture by Taryn and Julia</td>
<td>528</td>
<td>Taryn:</td>
<td>1. Yeah this {this process}</td>
<td>Posture: facing the main table, looking down at the papers on</td>
</tr>
</tbody>
</table>
3. it’s kind of (5) what { we started doing there was making a kind of linear progression of the things we might do } whereas these headings tends to be about what we’re doing now in terms of the process as opposed to what somebody will physically do to put the site up or the blog up the table. 

M-Gesture 1: right hand fingers touching the surface of the paper and rotating four times in a clockwise direction

Gesture 2: holding both hands in front of her face flat with palms facing Wall A

D-Gesture 3: holding hand pointed towards the wall and then moving it up and then down twice to show linear top to down progression.

Proxemics: Julia getting up and going towards the inscription on Wall A

D-Gesture 4: pointing with right hand towards inscription SA-G3-C on Wall A

D-Gesture 5: pointing right hand towards the printed pages on the table

Drawing: drawing the curved lines with arrows starting from the right side of the list and ending at the left side of the process list

529 0:58:48 Julia: 4. { I see this as (.) as }  

5. quite { matched with this } Like this can go like a (.) @like a circle kind of process @
<table>
<thead>
<tr>
<th>Time</th>
<th>Taryn:</th>
<th>Julia:</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:58:57</td>
<td>OK. Yeah.</td>
<td>6. That’s what I was thinking. I’m not sure if (2) {like the first phase} the whole thing that we talked about</td>
<td>D-Gesture 6: pointing to the inscription on the wall</td>
</tr>
<tr>
<td>0:58:59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0:59:08</td>
<td>[ok, right]</td>
<td>is it not like discovering the issues and problems</td>
<td></td>
</tr>
<tr>
<td>0:59:13</td>
<td>OK.</td>
<td>7. = which can be {gained by} 8. data gathering on different topics and at {this second stage} like interpretation] can be like classification of the data and the immerging categories</td>
<td>D-Gesture 7: pointing briefly at the inscription. D-Gesture 8: pointing at the printed papers on the table. Posture: moving towards the wall for D-Gesture 1, moving back to the table for D-Gesture 2.</td>
</tr>
<tr>
<td>0:59:30</td>
<td>&quot;OK, yeah.&quot;</td>
<td>9. {This will be repeated on the like second or third}</td>
<td>Posture: standing in front of Wall A M-Gesture 9: extending hand towards the inscription and rotating four times; two large rotations almost the size of the drawing and after that two smaller and quicker rotations while turning face back to the group. See Figure 56</td>
</tr>
</tbody>
</table>
Chapter Eleven

“for this gesture.”

538 0:59:35 Taryn: OK.

539 0:59:35 Julia: because it will have repeated categories I’m not sure if… that would be a good idea

540 0:59:39 Taryn: OK. Where would you like to put categorisation? If we were going to record it somewhere on the wall how would you draw it?

541 0:59:46 Julia: 10. The categorisation I would put it on like {number two here}

542 0:59:49 Taryn: OK (.) Why don’t you put it in there now so we don’t lose it

543 1:00:15 Taryn: And do you want to maybe if we… in different colour then we could… if you wanted to try and map it to this.

544 1:00:22 Julia: Yep

545 1:00:23 Taryn: Not that we have to

546 1:00:24 Julia: OK (.) Yep

547 1:00:24 Taryn: 11. Put next to {process discovery and then categorisation} would be interpretation. I don’t know whether that helps or whether it’s even necessary (7) Just kind of howl out if we haven’t done something.

548 1:00:41 Darren: ^That’s interpretation there^ yeah?

549 1:00:43 Taryn: Yeah

550 1:00:50 Taryn: 12. So what would be the steps {that we needed to do for two} to get it done? (8)

551 1:01:01 Julia: What is evolution here?

539 0:59:35 Julia: because it will have repeated categories I’m not sure if… that would be a good idea

540 0:59:39 Taryn: OK. Where would you like to put categorisation? If we were going to record it somewhere on the wall how would you draw it?

541 0:59:46 Julia: 10. The categorisation I would put it on like {number two here}

542 0:59:49 Taryn: OK (.) Why don’t you put it in there now so we don’t lose it

543 1:00:15 Taryn: And do you want to maybe if we… in different colour then we could… if you wanted to try and map it to this.

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545 1:00:23 Taryn: Not that we have to

546 1:00:24 Julia: OK (.) Yep

547 1:00:24 Taryn: 11. Put next to {process discovery and then categorisation} would be interpretation. I don’t know whether that helps or whether it’s even necessary (7) Just kind of howl out if we haven’t done something.

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549 1:00:43 Taryn: Yeah

550 1:00:50 Taryn: 12. So what would be the steps {that we needed to do for two} to get it done? (8)

551 1:01:01 Julia: What is evolution here?

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542 0:59:49 Taryn: OK (.) Why don’t you put it in there now so we don’t lose it

543 1:00:15 Taryn: And do you want to maybe if we… in different colour then we could… if you wanted to try and map it to this.

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545 1:00:23 Taryn: Not that we have to

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547 1:00:24 Taryn: 11. Put next to {process discovery and then categorisation} would be interpretation. I don’t know whether that helps or whether it’s even necessary (7) Just kind of howl out if we haven’t done something.

548 1:00:41 Darren: ^That’s interpretation there^ yeah?

549 1:00:43 Taryn: Yeah

550 1:00:50 Taryn: 12. So what would be the steps {that we needed to do for two} to get it done? (8)

551 1:01:01 Julia: What is evolution here?
<table>
<thead>
<tr>
<th>Time</th>
<th>Person</th>
<th>Transcript</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:01:04</td>
<td>Taryn:</td>
<td>13. How: our ideas change. {So as we go through the process} our original idea will either get better or disappear (.). get replaced by something else</td>
</tr>
<tr>
<td>1:01:13</td>
<td>Julia:</td>
<td>Yes (.). yes</td>
</tr>
<tr>
<td>1:01:14</td>
<td>Taryn:</td>
<td>14. {So if we keep going through the process} we might not end up... what we end up with might be different from what we started off thinking we'd do. So I guess in order to (.). do you want to put anything underneath categorisation?</td>
</tr>
<tr>
<td>1:03:36</td>
<td>Darren:</td>
<td>15. That thing would have been good for {the methods I think}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16. <em>Explain how your blog will address the problem</em> {So I think that that process would} {that process }</td>
</tr>
<tr>
<td>1:03:44</td>
<td>Taryn:</td>
<td>17. {would result in us getting that}</td>
</tr>
</tbody>
</table>

**Further enactment of the gesture by Darren**

<table>
<thead>
<tr>
<th>Time</th>
<th>Darren:</th>
<th>Transcript</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:03:36</td>
<td></td>
<td>15. {that process }</td>
</tr>
<tr>
<td>1:03:44</td>
<td></td>
<td>17. {result in us getting that}</td>
</tr>
<tr>
<td>Time</td>
<td>Speaker</td>
<td>Timecode</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>581</td>
<td>Darren</td>
<td>1:03:45</td>
</tr>
<tr>
<td>607</td>
<td>Taryn</td>
<td>1:05:59</td>
</tr>
<tr>
<td>608</td>
<td>Darren</td>
<td>1:06:35</td>
</tr>
<tr>
<td>609</td>
<td>Darren</td>
<td>1:06:38</td>
</tr>
<tr>
<td>610</td>
<td>Julia</td>
<td>1:06:40</td>
</tr>
</tbody>
</table>
The ‘Process’ gesture was first observed when Taryn noticed that the process list they had started on the wall in inscription SA-G3-C was linear whereas the example of a process diagram on paper that they were given by the researchers at the beginning of the session was a circular iterative diagram (Appendix Three). Taryn (Transcript order line 528, Table 19) touched the paper on the table in front of her; rotating her right hand with finger over the process diagram. Her finger moved along the trajectory illustrated by the circle in the diagram. As her finger moved she stated “this process” while rotating her hand in a clockwise direction over the diagram. Her gesture was
perceptually available to her audience while the talk provided a description of her action.

The ‘Process’ gesture was taken up by the group, as Julia responded by trying to match the diagram on the printed paper to the process list in inscription SA-G3-C that they had written on the wall (line 529, Table 19). Julia stated “I see this as (.) as” pointing towards the inscription on the wall, “quite matched with this” pointing towards the diagram on the scaffolding printed pages on the table. She then went back to the wall and drew curved lines with arrows at the ends going from the right side of the process list in a circle towards the left side of the list, turning it into a circular shape diagram. While Julia was drawing the lines she stated “like a circle kind of process”. This statement and Taryn’s previous comment when she pointed towards the diagram on paper saying “this process” associated the term “process” with both Julia’s drawing on the wall and the diagram on paper. In this way, a verbal association was made between the diagram on paper and the diagram on the wall that Julia had just drawn. Julia then continued explaining her idea for how the linear process list could be turned into an iterative process diagram similar to that on the scaffolding printed pages (lines 530-536, Table 19). As Julia repeated Tatyn’s rotating gesture, this time the ‘Process’ gesture was associated with the inscription on the wall (line 537, Table 19). She traced the curved lines she added to the list to make it a diagram in a clockwise direction. She rotated her arm four times (Figure 56 captures one of these movements). In this way Julia created a trajectory link between the process diagram on the paper and the one she had just drawn on the wall. The link was established between the term “process”, the diagram on the wall, and the rotating gesture.
Figure 56. The ‘Process’ gesture enacted by Julia in relation to Inscription SA-G3-C1 (gesture shape and direction is illustrated here with the red line)

The ‘Process’ gesture was used throughout the group’s design session (see lines 538 to 550, Table 19). Julia provided more clarifications of her idea in response to Taryn asking her how she would label the stages in the diagram so that the two would be closely mapped together. When Taryn was happy with Julia’s ideas she asked Julia to add her ideas to the diagram she had just drawn on the wall. Taryn also asked Julia to write the labels for the stages of the process that were shared between the two diagrams in a different colour so that the links could be clearly defined. By this time the concept was established. The group accepted Julia’s idea and the linear process list was transformed into an iterative process diagram. Of interest for this discussion was when Taryn repeated the ‘Process’ gesture. Taryn repeated the rotating gesture twice (line 552, and line 554, Table 19), seen in Figure 57 and Figure 58. However, both times Taryn used the rotating gesture in relation to the diagram on the wall not the diagram on paper. This indicates that Julia was successful in associating the rotating gesture
with the diagram she drew on the wall and that Taryn had accepted the association. The rotating gesture was also repeated by Darren (line 579, Table 19; Figure 59). This indicates that the concept had now been totally shared between the three group members.

Figure 57. The ‘Process’ gesture enacted by Taryn in relation to Inscription SA-G3-C1
Figure 58. The ‘Process’ gesture repeated by Taryn

Figure 59. The ‘Process’ gesture enacted by Darren in relation to Inscription SA-G3-C1
The ‘Process’ gesture continued to develop, and was first used without reference to the term “process” in line 610, Table 19. With this gesture, Julia looking at Taryn stated “So you think this doesn't satisfy” while pointing and rotating her finger towards the inscription she drew on the wall. Of interest is that Julia did not turn back to look at the diagram nor did she make larger rotations as had been seen with Taryn and Darren earlier (see Figure 60). Instead, she pointed towards the wall without turning back and made smaller rotations than before. At this time in the Design Studio there were three inscriptions on Wall A; all side by side. If the gesture had not been successfully associated with the process diagram, confusion could have risen as to which inscription Julia was referring to or pointing to.

The last cohesive ‘Process’ gesture in this series was enacted by Taryn (line 1027, Table 19, Figure 61). By this time the gesture had attained independence, and there was no need to accompany the gesture verbally with the term process. Furthermore, the clockwise rotation of the hand or finger became smaller. Taryn also did not directly look at the inscription on the wall to indicate focus of attention.
Figure 60. The ‘Process’ gesture repeated by Julia without looking at Inscription SA-G3-C1

Figure 61. The ‘Process’ gesture enacted for the last time in the group by Taryn
The ‘Globe’ Iconic Gesture

An iconic gesture bears a perceptual relation with the concrete entities or events depicted. This type of gesture is used when speech alone does not convey the same meaning or details. The physical form of the ‘Globe’ gesture was holding both hands facing each other to make a ball shape. This gesture often closely followed a deictic gesture. The deictic gesture was used to draw attention to the topic of conversation such as pointing to the diagram. It created a connection between the inscription and the ‘Globe’ gesture that followed. The gesture was used to refer to the loading screen for Study-B game, which contained an image of a globe representing the game’s environment as illustrated in Figure 35. The ‘Globe’ gesture is classified as iconic because it has a visual resemblance to its referent which is a pictorial concrete object.

The ‘Globe’ gesture reported in Table 20 was first enacted by one of the members from Study-B team before the team separated into groups. The gesture was then enacted by two members of Study-B Group 2 during their design session.

Table 20 - The ‘Globe’ Gesture

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>179</td>
<td>1:02:34</td>
<td>Kassidy</td>
<td>I’d love to see them (.) and I don’t know how we’ve done it, but it’s been a bit boring in the past and taking away from the bear, but give them the opportunity in the past to add to their footprint. You obviously can’t ask them 50</td>
</tr>
</tbody>
</table>
questions (.) but you can ask them
questions as they go you know (.)
keep them engaged with that
whole thing along the way.

180 1:02:52 Jarrod But how do you feel about the fun
angle as well?
1. You know, the bear having to do
some of the things in in (.) we’re
already [into stat document]
2. getting into non-bear behaviour.
Ahh I just thought that was a way
to reinforce that or to make (1.5)
make it a bit more fun, [just
totally]
3. {internally within the world}
with a view that you’re setting up
these concepts

D-Gesture 1: with his
right hand pointing
quickly towards the
Projector B.
Ic-Gesture 2: holding
hands to make a ball
shape with the left
hand on top (Figure
62).
Ic-Gesture 3: flips the
previous gesture -
holding hands to make
a ball shape with the
right hand on top
(Figure 63).

First Occurrence of the Gesture in Group 2

47 1:57:28 Gino 4. Look does it have to be {the
globe}
5. do you think for {home screen}
Posture: standing to the
left of the projected
screen, turns around to
face the group
Gaze: looks at Jarrod
Ic-Gesture 4: holds
both hands to make a
ball shape (Figure 64).
D-Gesture 5: pointing
at the diagram
projected on Wall B

48 1:57:31 Jarrod Yeah, it could be. That was the
original idea, but look it doesn’t
have to be
Posture: sitting, facing
the wall
Gaze: the diagram on
the wall
<table>
<thead>
<tr>
<th>Time</th>
<th>Character</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:57:42</td>
<td>Gino</td>
<td>Maybe that is the load screen or something? Gaze: looks at the diagram, then at Jarrod. Gesture: makes a rolling motion with both hands.</td>
</tr>
<tr>
<td>1:57:50</td>
<td>Jarrod</td>
<td>Yeah::: sure say it is for now Gaze: looks back, then looks at the wall.</td>
</tr>
</tbody>
</table>

**Shima’s Gestures in Group 2**

<table>
<thead>
<tr>
<th>Time</th>
<th>Character</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:06:18</td>
<td>Jarrod</td>
<td>So sorry Shima, you were saying? Gaze: slightly turning towards Shima, still looking at the diagram.</td>
</tr>
<tr>
<td>2:06:20</td>
<td>Shima</td>
<td>6. I was saying {do the mini games} 7. have their own {environments} as well? Gaze: looking at the diagram on the wall, then briefly looking at Galileo and then Jarrod. D-Gesture 6: pointing at the diagram with rolling hand and index finger extended. Ic-Gesture 7: briefly holding both hands in front of her with palms facing each other. Very close to the globe gesture shape (Figure 65).</td>
</tr>
<tr>
<td>2:06:25</td>
<td>Gino</td>
<td>[Yeah (.) the mini games... Gaze: looks at Shima, then looks at Bart.</td>
</tr>
<tr>
<td>2:06:25</td>
<td>Bart</td>
<td>[they’re not incorporated into the 3D world Gaze: looking at Shima and then Jarrod.</td>
</tr>
<tr>
<td>2:06:30</td>
<td>Shima</td>
<td>8. If we can access Player Home {through the 3D world} 9. then we can access {those environments} separately Gaze: looking at the wall and then Bart. Ic-Gesture 8: holds both hands to make a ball shape (Figure 66).</td>
</tr>
<tr>
<td>Time</td>
<td>2:06:40</td>
<td>Bart</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>Time</td>
<td>2:06:44</td>
<td>Shima</td>
</tr>
<tr>
<td>Time</td>
<td>2:06:50</td>
<td>Jarrod</td>
</tr>
</tbody>
</table>

**Last Occurrence of the Gesture in Group 2**

| Time  | 2:12:42 | Gino | 12 ...if we have a game that’s turning off lights in an unrelated house, we now have to design an unrelated house. If we have a pinball machine xyz, then we have to design all those things. So {keeping it within the world} 13. like {in the habitat} (.) 14. {the Glacier environment} then that’s great because it simplifies it in terms of design tasks for us | Gaze: looking at Jarrod and very briefly at others in the group. D-Gesture 12: pointing with right hand holding marker pen towards the diagram without looking at it. D-Gesture 13: the left hand joining the right hand and with open hand holding towards the diagram. Ic-Gesture 14: holds |
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Both hands to make a ball shape (Figure 68).

Inscription: the house in the glacier environment in Figure 38.

There was no single term or verbal description associated with the ‘Globe’ gesture, though some similarities were observed. For example, the first time the gesture was performed, the stroke of the gesture coincided with the verbal description {internally within the world}. Subsequent repetitions of the ‘Globe’ gesture coincided with {the globe}, {environments}, {the 3D world}, again {the Glob}, and {the glacier environment} for the last occurrence. Thus, the gesture was mostly associated with the terms ‘the world’, ‘the globe’, and ‘environment’. The ‘Globe’ gesture generally represents the idea of the game having a single entry through which other smaller activities and mini-games can be accessed. The objective for the game was that the user will be able to click on different spots on a globe image and will be able to zoom in and go to that section to access different games and activities there.

During the initial discussion before the team was divided into groups, Jarrod was trying to communicate his idea about integrating more engaging and ‘fun’ activities into the game (line 180, Table 20, Figure 62 and Figure 63). He held his hands like the shape of a ball with initially the left hand over the right hand and then flipping the hands and bringing the right hand over the left hand to make the ball shape again.
The second occurrence of the ‘Globe’ gesture was observed when Study-B team was divided into groups and Gino in Group 2 was trying to draw/write his idea about an entry loading screen on the projected image of the flow chart diagram on Wall B. He
turned around and asked Jarrod “Look does it have to be the globe”, while holding his hands in the shape of a ball (line 47, Table 20, Figure 64). When Gino asked “does it have to be the globe” he communicated two things to Jarrod; one, that he was talking about the loading screen as a single entry into the game; and two, that he was also adding the visual property of the loading screen to the discussion: the shape of the globe.

Figure 64. The ‘Globe’ gesture enacted by Gino in Study-B Group 2

The next occurrence of the gesture was observed in three consecutive turns by Shima, once in each of her utterances, as recorded in lines 102, 105, and 107 of Table 20. Shima asked whether the mini games would have their own environments (line 102, Table 20, Figure 65). She held her hands in a shape similar to the ‘Globe’ gesture. However, her hands did not fully display the fullness of the globe at this time; the hands were straighter, rather than curved as in previous versions of this gesture. The stroke of the gesture coincided with the word “environments”, which indicates that Shima was trying to find out whether the mini games would be self contained and have a single entry of their own, just like the globe screen was an entry to another self-
Chapter Eleven

contained environment. Shima took the gesture and all the meanings associated with it and applied it to assess the status of the mini games. Bart responded that “they’re not incorporated into the 3D world”. Here although Bart did not display the ‘Globe’ gesture, Shima understood the reference to the 3D world indicated the single entry globe loading screen.

Figure 65. The ‘Globe’ gesture enacted by Shima first time in Study-B Group 2

In her next turn, Shima stated “If we can access Player Home {through the 3D world} then we can access those environments separately” (line 105, Table 20, Figure 66). By “those environments” she meant the mini games displayed in the diagram with small circles. Here Shima displayed the gesture alongside the terms that Bart used earlier to refer to the single entry loading screen, as in “3D world”. The reason for displaying the gesture again here may be that Shima wanted to confirm her understanding of Bart’s response that the 3D world still referred to the globe entry screen. Bart did not disagree with Shima and stated “It’s whatever you guys want”. In this turn, Shima took the gesture and its associated meanings and applied it back to the
globe loading screen as a single point of entry into the main game. So after applying the gesture to assess the status of the mini games in her first utterance, here Shima brought the gesture back and applied it to the globe loading screen. By bringing the gesture back and applying it to the globe loading screen, Shima also separated the two different game environments in her comment. The gesture now accompanied “the 3D world” and a deictic gesture pointing to the small circles in the diagram accompanied “those environments”. Thus, the “3D world” referred to the globe loading screen and “those environments” referred to the mini games.

Figure 66. The ‘Globe’ gesture enacted by Shima second time in Study-B Group 2

Shima continued “Will they be very different? Like the mini game environments (. ) will they be very different to what’s on {the globe}” (line 107, Table 20, Figure 67). The stroke of the gesture coincided with “the globe” to which Jarrod responded “I don’t know and I think it’s kind of up to us to decide”. Although the gesture accompanied “the globe”, which referred to the globe loading screen, it was used again as a way to assess the status of the mini games. Since the first gesture determined that the mini
games would not be incorporated into the single entry loading screen and that the loading screen would be displayed in 3D, at this point, Shima wanted to know whether the mini games would also be in 3D just like the globe loading screen.

Figure 67. The ‘Globe’ gesture enacted by Shima third time in Study-B Group 2

The last occurrence of the gesture was observed when Jarrod suggested they focus more on the bear and everything should come back to the bear and what it does in its environment and in its own house and igloo. Gino agreed and stated that from a technical point of view it would be easier to design fewer game assets than many. In the last part of the utterance (line 133, Table 20, Figure 68), Gino stated “So keeping it within the world(.) like in the habitat(.) {the Glacier environment} then that’s great because it simplifies it in terms of design tasks for us”. The stroke of the Globe gesture coincided with “the Glacier environment”. The two other gestures in this utterance were deictic gestures pointing towards the projection of the house in the glacier environment on the wall. Although the ‘Globe’ gesture is the focus, the other two deictic gestures are also important in order to understand the context. In both the deictic gestures, Gino was pointing with first one hand and then both hands towards Wall B.
After a short pause he then used the ‘Globe’ gesture as well. The reason for using the ‘Globe’ gesture in combination with the other two deictic gestures may be that Gino felt his two deictic gestures did not fully communicate his idea thus he needed to clarify it with the ‘Globe’ gesture.

The ‘Globe’ gesture, although communicating the one meaning of a single entry into the game, also adds a slight variation to the concept. The gesture came to mean keeping things within the self-contained environment. In this way, the game was given a boundary, with the globe loading screen as the entry and everything within it is represented by the Globe gesture.

Figure 68. The ‘Globe’ gesture enacted for the last time by Jarrod in Study-B Group 2

The ‘Click’ Metaphoric and the ‘Layout’ Iconic Gestures

Metaphoric and iconic gestures are similar on the surface and the difference is in their referent. A metaphoric gesture represents an abstract concept or an action whereas an iconic gesture represents a concrete pictorial object.
The ‘Click’ and the ‘Layout’ gestures were enacted by Calvin from Study-B Group 1. The physical form of the ‘Click’ gesture was a quick movement of the index finger forward and was enacted only once (M-Gesture 1, line 5, Table 21). The physical form of the ‘Layout’ gesture resembled an up-and-down movement and was repeated several times (Ic-Gesture 2-6, line 5, Table 21). Although the ‘Layout’ gesture was repeated several times it was not categorised as a cohesive gesture because it was repeated by the same speaker in a single turn and not shared among the group.

Table 21 - The ‘Click’ and ‘Layout’ Gestures

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1:45:36</td>
<td>Calvin</td>
<td>You have seen the spreadsheet?</td>
<td>Gaze: looking at Idris.</td>
</tr>
<tr>
<td>4</td>
<td>1:45:40</td>
<td>Idris</td>
<td>[the spreadsheet? No I haven’t seen the spreadsheet (. ) no</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1:46:00</td>
<td>Calvin</td>
<td>Maybe we’ll just describe it first. Calculations don’t have to be...</td>
<td>M-Gesture 1: right hand with index finger slightly extended further than others. It is a quick movement of pushing the index finger forward and a quick retraction (Figure 69).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>That could be very much simplified.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. You know, just {a tick a box thing}.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. But it probably makes more sense to be based on some sort of measurement, and the factors and the calculations are quite straightforward. We can have a page of factors. {We can have a factor for water}</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. {We can have a factor for energy}</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. {We can have a factor for</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
measurement} \{ \text{We can have a factor for land} \}
5. and \{ \text{we can have a factor for footprint} \}
6. And it can all be done very systematically, generically. The calculations are not very involved, and \{ \text{then you can have different one for NSW and Victoria} \}
(\text{\text{.}}) \text{maybe this is phase 2} (\text{.}) \text{But there are important differences in states just as there} (\text{.}) \text{even in Australia. And so if you set it up quite generically you can have your national factors and you can have your state factors.}

The two gestures were first observed when the group had just started discussing their ideas for the game. They were all standing in a semi-circle in front of Wall A. The group was discussing the type of data that will be collected from the users of the game and how this data will be used. Calvin asked Idris if he had seen the spreadsheet. Idris replied in the negative. The group looked around the studio for a few seconds trying to figure out where they could display the spreadsheet so that Idris would see it. When they saw that the interactive whiteboard and the projectors on the walls were being used by the other team members, they decided to explain the spreadsheet in words. Calvin started by saying “Maybe we’ll just describe it first” (line 5, Table 21). He then gave a detailed explanation of what data will be collected.

Calvin was using many gestures during this explanation, two of the gestures were more prominent than the others, and they also referred to visual representations that
were not perceptually available at the time. In the ‘Click’ gesture he was trying to illustrate the ease of using the spreadsheet by holding his right hand index finger and quickly pushing it forwards and then retracting it back (Figure 69). The gesture signified the act of ticking a box as in clicking a check box on the computer screen. The physical form of the gesture resembled hitting something with the index finger while the other fingers were not completely bent but slightly open and hanging below the index finger. The gesture was enacting an action rather than displaying resemblance with any concrete objects and therefore was classified as a metaphoric gesture.

![Image](image.jpg)

**Figure 69.** The metaphoric ‘Click’ gesture

The second gesture was the ‘Layout’ gesture. It was also enacted in the same turn by Calvin as he continued explaining how the spreadsheet could display or hold the data. He raised his right hand up to around his forehead when he started saying “We can have a factor for water” and lowered his hand back when he reached the word
“water” in his statement. The highest point where his hand reached at the start of the utterance is illustrated in Figure 70, while Figure 71 illustrates the lowest point when his hand went down at the end of the statement. The rest of the ‘Layout’ gestures followed identical vertical trajectories. It is categorised as an iconic gesture in this study because the gesture is mimicking the physical layout of a spreadsheet illustrating how the columns are listing the categories starting at the top and going down the page. The top to bottom hand movement in this gesture had clear resemblance to its referent and was enacted at the same time that the speaker was naming each column in the spreadsheet.

Figure 70. The ‘Layout’ gesture hand in up position
What is interesting about these gestures is that they are both enacted in the absence of the referent visual representations. Calvin needed to show the group what each column in the spreadsheet holds. If the spreadsheet was perceptually available to the group, the most likely gesture would have been deictic. Calvin could have just pointed to each column in the spreadsheet to discuss the contents. It is also notable that Calvin in this utterance did not use pronouns to refer to the columns. Instead he described what each column would hold such as “factor for energy” and “factor for measurement” etc. The use of pronouns in utterances in this study was mostly observed when the participants were discussing visual objects that were perceptually available. Since the spreadsheet was not available, Calvin had to describe the contents of each column using words and supported by gestures as an additional communicative layer.
Chapter Twelve: Summary and Synthesis of Findings in

Part 4

In this chapter I first provide a summary of the findings from the previous chapter that I perceive to be significant. This is followed by the synthesis of these findings as I interpret these results.

Summary of Findings

**Gestures that Focus Attention**

The role of the deictic gestures, such as those reported in Table 18, was to bring the inscriptions into the discussion by focusing the groups’ attention. These gestures were often accompanied by demonstrative pronouns. This helped the speakers eliminate the need for lengthy and repeated verbal explanations. However, this also made the conversation highly contextual. Natasha’s explanation in Table 18 is an example of how gestures can refocus attention to different parts of the inscriptions even when the utterance is highly contextual.

**Gestures Animating Inscriptions**

The metaphoric ‘Process’ gesture was used as an additional communicative layer in order to add movement and trajectory to the static diagram in inscription SA-G3-C1. The gesture depicted movement that was absent from the diagram, and thus animated the diagram. The gesture made use of the inscription as the stable common ground
against which the participants made sense of each other’s talk to create more complex ideas. When speakers “have opportunities to draw on additional representational modalities, they can construct more complex explanation” (Roth & Welzel, 2001, p. 16). Tholander et al. (2008) also found that designers use gestures to add dynamic information to static drawings when they want to include an added layer of communication such as enacting the actions that would be performed on a system. The designers in this study were able to see each other and their drawings at the same time while listening to each other’s utterances. This environment created the opportunity to utilise verbal as well as non-verbal modes and thus discuss ideas at a higher conceptual level.

**Gestures as Substitutes for Visual Representations**

The ‘Globe’, the ‘Click’ and the ‘Layout’ gestures were enacted in the absence of the referent visual representations. These gestures helped the speakers refer to visual objects that were not perceptually available at the time of the utterance. They helped remind the audience of something they had seen before but were not visible anymore. If the visual referent was available, the most common gesture would have been deictic in order to bring the referent into the conversation. However, during the design sessions in this study there were instances when the participants were discussing a visual form that was not displayed on the walls or printed on paper. In such instances, gestures were used as a substitute for the visual representations.
Encapsulating Concepts

The ‘Process’ and the ‘Globe’ gestures were both cohesive gestures. The gestures were repeated in the same form and movement, establishing a link across the talk, and binding together the layers of utterance and inscriptions to encapsulate a concept. With each repetition the gestures accumulated further details adding more strength to the encapsulated concepts. The participants were able to evoke this rich history encapsulated in a gesture throughout the design session to help them communicate at a higher conceptual and communicative level.

Autonomous Gesture

When gestures, such as the ‘Process’ and the ‘Globe’, were repeated, they slowly became quite independent. The ‘Process’ gesture was first dependant on the term ‘process’. With further repetition the gesture no longer needed to be accompanied by the term. Furthermore, the physical form of the gesture became less strict with each repetition. At first the rotations were largely similar to Julia’s original enactment in front of Wall A. With each repetition, variations of the rotations were enacted until Julia rotated only her finger in small rotations.

The ‘Globe’ gesture was even more autonomous. The gesture, most likely established in a previous meeting, was no longer dependant on its referent visual representation and was enacted entirely in the absence of the globe logo image. The gesture was also not dependant on any specific words or terms to communicate the meaning. There were also several variations, with hands facing each other vertically or horizontally, indicating that the gesture did not need to follow a strict physical form in order to make sense to the audience. The strength of this gesture allowed it to be
applied to other entities and inscriptions and assess their status according to the same rules and ideas encapsulated in the gesture from its original referent.

**Synthesis of Results**

**Reducing Cognitive Load**

Entities represented in inscriptions do not need to be referenced in speech as well. They also do not have to be held in memory; thus reducing cognitive load (Roth, 2001). When talk and gestures are over inscriptions, the inscriptions provide the stable ground that adds meaning to both talk and gesture. When inscriptions are available, speakers use talk and deictic gestures towards them to convey their ideas. When inscriptions are not available, speakers often resort to using gestures that portray the phenomena visible in the air. This works best if the audience are familiar with the referent visual representation, for example when they know what a spreadsheet looks like and how data is organised in it.

For those entities not represented in inscriptions, such as movement, actions and trajectories, iconic and metaphoric gestures are used as an additional communicative mode. The joint representational function of the inscriptions and gestures scaffold the creation and discussion of more complex concepts because these modalities take on what would otherwise have to be explained during the discussion (Roth & Welzel, 2001).

In this study, the cohesive gestures were used as a way to communicate ideas that would otherwise require a lot of explanation and the presence of the referent visual representations. The explanations were provided as the gesture developed and stabilised
in the presence of the referent visual representations, but once that happened the gesture was then a type of abbreviation. Every time the gesture was used it carried with it a rich history and dense meaning. The gesture allowed the participants to refer back to ideas as they were first conceived, negotiated, and shared rather than starting the discussion of the same ideas all over again.

**Gestures are Context Dependant**

The ‘Process’ and ‘Globe’ gestures would hold little meaning for an audience unfamiliar with the context. In the case of the ‘Process’ gesture, the audience would need to at least be familiar with the referent diagram, what it represented, and how it was animated by the gesture. In relation to the ‘Globe’ gesture, the audience would be required to have at least seen the globe logo image in order to understand what the gesture stood for. Even then, the audience would also need to know about the function of the globe logo in the game in order to understand the gesture, in particular when it is applied to other objects, ideas, or representations. This type of gesture is called an “insider gesture” because it assumes a certain amount of background and context knowledge (Koschmann & LeBaron, 2002).

**Development of Gestures as Cognitive Artefacts**

The two examples of cohesive gestures reported here, provide an illustration of two important phases in the production and use of the gesture as cognitive artefact. The first example, the ‘Process’ gesture from Study-A Group 3, gives a picture of how a gesture is created from scratch and developed as a cognitive artefact. The ‘Process’ gesture was first created in order to communicate the idea of adding trajectory to the
static drawing of the diagram. The gesture animated the diagram, in that it added a movement to the diagram representing an iterative process. The gesture was accompanied by the term ‘process’ and the diagram on the wall needed to be pointed at during the initial stages until slowly the reliance on both the verbal cue and visual representation lessened. Every time the ‘Process’ gesture was repeated it gathered further conceptual complexity. The first and the last repetition of the gesture was therefore not the same because every repetition was enacted with a slight variation in the accompanying description as well as the participants’ progressive understanding of the design situation. This shows that when the gesture is first created it is heavily reliant on the presence of the referent visual representation. The gesture also needs to be accompanied with certain terms and verbal explanations in order to communicate the idea intended by the user. The gesture needs to be supported with these terms and the referent visual representation until it finds stability.

The ‘Globe’ gesture by Study-B Group 2 illustrates how a gesture was reused once a considerable amount of time had passed from its creation. All except one member in Study-B Group 2 had known each other and had previously worked on the same project. There were several references during the group discussion to visual representations they had worked with previously. For example, at one stage Gino asked Jarrod “We’ve got artwork for some of that right?” On another occasion Jarrod stated “Yeah like we designed that house which we looked at sort of (.) it’s was very Arctic Circle that (.) it was like Greenland or...I don’t know where they were but there was a whole lot of them”. The ‘Globe’ gesture was therefore most likely created and developed in one of the previous meetings between some of the group members. The gesture appeared every time in reference to the same visual representation of the globe.
logo. It was also used in discussing the same concept; that of a single entry loading screen into the game. The first and second time when the ‘Globe’ gesture was observed, the globe logo image had not been projected on the wall. The only possibility was that the group members had previously seen the globe logo and were familiar with the logo’s function in the game. As the discussion progressed between the group members, the globe image/logo appeared several times in the slides projected on the wall. However, none of the ‘Globe’ gestures were performed when the globe logo was projected. The ‘Globe’ gesture was always performed in the absence of the referenced globe logo. This illustrates the stability of the gesture which no longer relied on the presence of the referent visual representation. Furthermore, the gesture coincided with several verbal explanations and terms, which also indicates that the gesture attained considerable strength and was not reliant on specific terms in order to communicate the idea. The ‘Globe’ gesture reached significant stability which made it possible to be applied to other objects and assess their status, for example when Shima used the ‘Globe’ gesture to determine if the mini-games would have their own environments.

The Role of Words

Gestures can be on a subordinate, equal, or super-ordinate level with spoken words (Norris, 2011). In the examples reported here, gestures generally started on an equal level with spoken words but gradually increased in importance. In this study, the words accompanying the gestures never disappeared. Instead, the choice of words accompanying the gesture became more flexible and so it was not necessary to use exact words or terms in order to communicate the meaning. The ‘Process’ and the ‘Globe’ gestures are two examples where the gestures started on the same level with the
words but then slowly progressed towards becoming independent. However, these gestures still needed to be accompanied with words and were not enacted on their own.

**Inscriptions Can Distract Attention**

In some contexts visual representations may cause a distraction from the focus or flow of a discussion. For example, an alternative to the ‘Globe’ gesture would have been to search for and find the globe logo image in the PowerPoint presentation and display it on the wall. This would have caused an interruption to the flow of the discussion. At this time, the participants were discussing ideas that needed other visual representations to be displayed on the wall, such as the diagram, and this action would have meant that the diagram was no longer available for discussion. Bringing back the globe logo image every time would have made it very hard to apply the globe logo concept, that of a single entry into the game, to other objects and ideas. Gestures are fleeting and this can be their strength in some instances. They only need to cause a person to remember a concept and make the concept available for discussion and application to different issues and objects.

The main focus of this part of the thesis was on gestures, their forms, examples, and their status as cognitive artefacts. Gestures can focus attention, they can animate static inscriptions, gestures can be used to stand for absent visual representations, and they can encapsulate concepts. Gestures can reduce cognitive load, and become cognitive artefacts to help designers evoke rich shared history that helps them communicate at a higher conceptual level.

Next, in Part 5 of the thesis, I provide two examples where gestures and visual representations worked together to support communication in the meetings observed.
This part of the thesis is presented in two chapters. In Chapter Thirteen I describe how inscriptions can become ‘transparent in use’. In Chapter Fourteen I describe how gestures ‘orchestrate’ the use of inscriptions and other visual resources in the environment. In both of these chapters I discuss ideas about how inscriptions and gestures are used in partnership to make sense of the collaborative actions, including participant utterances.
Chapter Thirteen: Inscriptions Becoming Transparent in Use

In order to explain what I mean by inscriptions becoming transparent, I will first present a brief overview of literature about this concept. I will then present three examples of processes through which inscriptions created by the participants became transparent to them. I will conclude with a synthesis of the findings in this chapter.

Seeing Beyond the Inscriptions

Representation is something that stands for something else (Palmer, 1978). According to this definition, there are two worlds: one is representing and the other is the represented world (Palmer, 1978). Inscriptions reside in the representing world and they try to model aspects of the represented world. Inscriptions do not represent all aspects of the represented world. Similarly, not all elements of the inscriptions need to model aspects of the represented world. There needs to be some form of correspondence between the two worlds. Palmer (1978) states that:

In order to specify a representation completely, then, one must state: (1) what the represented world is; (2) what the representing world is; (3) what aspects of the represented world are being modelled; (4) what aspects of the representing world are doing the modelling; and (5) what are the correspondences between the two worlds. (Palmer, 1978, p. 262)
For inscriptions to become transparent, one needs to know what it is that the inscription is representing and how it is represented. Understanding the semiotics of visual elements such as knowing what a line or a shape stand for can help here. Furthermore, one needs to know the processes by which the represented world is transformed into inscriptions. It is then that the viewer may be able to see through the surface form of the inscriptions to the information they contain about the represented world. In other words, the inscriptions become transparent. Roth (2004) also agrees with this process. He states that scientists are able to perceive more relevant details when they are familiar not only with the phenomenon represented in inscriptions but also the processes that transform raw data into inscriptions.

Using Inscriptions as透明ent Tools

Inscriptions are situated, in that they find their meaning in the context of their use. They become meaningful when they are integrated into a familiar world (Roth, 2005). In a familiar context, inscriptions as tools can become transparent. This does not mean that inscriptions become invisible. What it means is that the user no longer notices the existence of the tool. This allows the user to deal directly with the phenomenon as if without any mediation. The concept of transparency is mainly studied in relation to inscriptions in science. The results from this thesis, however, indicate that visual representations can also become transparent in design.

Roth (2003a) describes transparency as “a type of relation between the user and tool, which no longer requires attention” (p.162). For inscriptions to become transparent, scientists need to be familiar with the inscriptions and how they were
generated and transformed. Roth and Bowen (2003) note that even expert scientists may not be able to see the phenomenon transparently through inscriptions they are not familiar with.

Roth (2003a) documents how scientists establish a one-to-one relationship between their inscriptions and the natural world. He suggests that with continued use, inscriptions, just like any other tool, no longer mediate actions and can allow direct access to the phenomenon. This was observed in his study of scientists working in an experimental biology laboratory where the results of the experimentation with physical objects under the microscope produced numerous graphs. The graphs were then used by the scientists in their discussions in a way that no longer made any distinction between the object under the microscope and a particular curve on the graph. The scientists were observed pointing to the graphs and using indexical terms such as “bleach that one”, which obviously referred to the physical object under the microscope not the graph (Roth, 2003a, p. 178).

In another study, Roth (2005) reports similar behaviour in a fish hatchery where several types of inscriptions were produced as part of everyday work practices. The inscriptions were produced for various purposes, such as to keep a record of the amount of food distributed to each pond or the amount of weight gained by the fish. In this context again, Roth reports observing one of the hatchery fish culturists named Erin pointing to a section in a histogram and remarking “I know the bulk of the population is here” (Roth, 2005, p. 91). By here, Erin means that the bulk of the fish population out in the ponds is within a certain weight group represented in the graph. Roth (2005) observed Erin comfortably alternating between using the different forms of inscriptions. She entered the raw data into tables and then plotted the data in the tables
into diagrams. She used the diagrams to quickly examine the status of the fish and to reflect on the general practices of the hatchery. However, when Erin was asked to explain her work practices to the researcher she used both the table and the diagram in similar ways by pointing to either a specific cell in the table or the corresponding point on the diagram. This account illustrates that to Erin, the cell in the table, a point on the diagram and the status of the fish in the real world out there are equivalent. It is Erin’s familiarity, not only with the context, but also with the process of how the data is transformed into inscriptions and how one inscription is then translated into another inscription, that has resulted in the transparency of the inscriptions.

How Inscriptions Became Transparent In this Study

In this study there were numerous instances when the participants engaged with the inscriptions and referred to them as if they were dealing directly with the phenomena represented by the inscriptions. There were several ways of achieving transparency. For example, some inscriptions became transparent through a process of explanation followed by clarification which then led to the inscriptions becoming transparent later in the meeting. For other inscriptions this process developed rapidly where explanation and clarification was offered at the same time as the drawings were made and then the participants transparently referred to the ideas represented by the visual elements without delay. A third process observed in this study was inscriptions becoming transparent without explanation or clarification provided by the drawers. Each of these processes is explained with examples from the data corpus.
**Explanation-Clarification-Transparency**

The first method of reaching transparency I observed was through a process of explanation-clarification-transparency. This means in order for the inscriptions to become transparent, the participants had to go through a process that first required the inscriptions to be explained. This explanation often happened at the time when the inscriptions were being created. Some instances I observed also included a stage where further clarification was provided about what the visual elements signified. When all the participants were aware of the meaning or ideas represented by the visual elements in the inscriptions, they could point to the inscriptions and talk about them as if they were dealing directly with the phenomena represented by the inscriptions; thus inscriptions would become transparent. This process is now illustrated with two examples from the data corpus.

**Example One: Jointly Created Inscription**

This first example is from Study-A Group 3. This is an example of an inscription that was jointly drawn by all the members in the group. The extract from the data is provided in Table 22. In this table, lines 467 to 472 represent the conversation when Julia began to write the list in inscription SA-G3-C. First Taryn asked Julia to start recording the group’s ideas by creating a timeline. The timeline would show the process of how data from the environment could be collected to be presented in the blog and who would contribute this data. Before starting to write the timeline, Julia asked “So it’s a process” (line 468). Taryn agreed and Julia started the timeline with the heading ‘Process’. Julia again asked “should I put this as the first one” as she pointed towards inscription SA-G3-B and she then started writing the list in inscription SA-G3-
C as illustrated in Figure 72. The list in the inscription demonstrates that Julia started noting the data gathering process that would contribute to the contents of the blog. This is because inscription SA-G3-B was a diagram that illustrated how the stakeholders in the blog would be able to provide scientific data and information which the blog users could use to experiment in the real world. Up to this point enough explanation was provided and the participants were aware that the list in inscription SA-G3-C is a summary of the diagram in inscription SA-G3-B. Following this and more than six minutes later, the group decided to change the linear process list into a circular process diagram that they had seen in the printed scaffolding pages (lines 528-530, Table 22).

In this part of the conversation Taryn started to explain her ideas for changing the inscription using a mixture of deictic and metaphoric gestures. She then clarified how she saw the list in inscription SA-G3-C by stating “what we started doing there was making a kind of linear progression of the things we might do whereas these headings tends to be about what we’re doing now in terms of the process as opposed to what somebody will physically do to put the site up or the blog up”. Julia then responded by drawing curved lines around the list to change the list into a circular diagram while also providing verbal explanation. The circular diagram was at the centre of the discussion in the group throughout the meeting and ample explanations and clarifications were provided during this time.
Almost 43 minutes after the list was changed into a diagram, the inscription became completely transparent. Lines 1171 to 1189 of Table 22 demonstrate several instances when the participants consecutively referred to the inscriptions using indexical and ambiguous terms which could only make sense in the presence of the particular inscription. For example, Darren stated “Does that mean that the thing that we gather here the blogger would actually do that” (line 1171, Table 22). In this instance by “the thing” Darren means the ideas that the blog would present to its readers as possible experiments to do in the real world. And by “here” Darren refers to the stage of the process. Darren was referring to the inscription as if dealing with the ideas represented directly. Taryn responded to Darren by further explaining her ideas for that specific stage of the process and this illustrates that she understood how Darren was referring to the ideas represented by the inscription rather than the visual elements themselves. Later, Darren stated “so what actually we are doing here is” (line 1171, Table 22) when Taryn quickly responded “thinking”. Darren again tried to clarify his
understanding by asking “what we’ve got here we match with what other people are
doing in the wild” (line 1179, Table 22). To this Taryn responded “No {we think here}
and then we {take all the thinking from here} and {from here} and the moderator then
tries to find a way of matching the {scientific people} and the people out there (.) the
ordinary people”. In Gesture 13 (see line 1180, Table 22), Taryn with both hands
pointed to and touched the inscription at the demarcated section ‘A’ in Figure 72. In
Gesture 14, her right hand moved to the demarcated section ‘C’. In Gesture 15, her
right hand moved towards section ‘D’ and in Gesture 16 her right hand moved back and
pointed to section ‘A’ in Figure 72. In this instant both participants were referring to the
different stages of the process diagram as “here”. This is another example of how both
participants are dealing directly with the ideas represented by the inscription. A further
example from this line of conversation is again provided in lines 1187 and 1189 of the
table, when Darren, further clarifying his understanding of the process, asked “So we’re
probably will use this one to connect”. This time Darren referred to the diagram stage
as “this one” but Taryn still understood what he meant by responding “So I would say
connect {happens here} and {then experiment happens here}”.

Table 22 - Study-A Group 3 - The Process of Transparency for Inscription SA-G3-C2

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Taryn:</td>
<td>1. So do we want to (.) do {you want to start a timeline of} what needs to be done?</td>
<td>D-Gesture 1: left hand pointing towards the empty space on Wall A next to inscription SA-G3-B.</td>
</tr>
<tr>
<td>467</td>
<td>0:51:36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>468</td>
<td>0:51:40</td>
<td>Julia:</td>
<td>So it’s a process</td>
<td>Drawing: Julia starts writing the heading</td>
</tr>
<tr>
<td>Time</td>
<td>Taryn:</td>
<td>Julia:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>--------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>469</td>
<td>Process yeah</td>
<td>‘Process’ for inscription SA-G3-C.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>470</td>
<td>2. So should {I put this as the first one} or</td>
<td>D-Gesture 2: pointing with right hand towards inscription SA-G3-B.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>471</td>
<td>We can change it so just start getting it written up and we can just</td>
<td>Drawing: Julia writing the list as in Figure 72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>472</td>
<td>Yeah</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Changing the direction of the inscription – Explanation and Clarification

<table>
<thead>
<tr>
<th>Time</th>
<th>Taryn:</th>
<th>Julia:</th>
</tr>
</thead>
<tbody>
<tr>
<td>528</td>
<td>3. Yeah this {this process}</td>
<td>Posture: facing the main table, looking down at the papers on the table.</td>
</tr>
<tr>
<td></td>
<td>4. is (.) doesn’t really parallel {what we’re drawing on}</td>
<td>M-Gesture 3: right hand fingers touching the surface of the paper and rotating four times in a clockwise direction.</td>
</tr>
<tr>
<td></td>
<td>5. it’s kind of (5) what {we started doing there was making a kind of linear progression of the things we might do}</td>
<td>Gesture 4: holding both hands in front of her face flat with palms facing Wall A.</td>
</tr>
<tr>
<td></td>
<td>whereas these headings tends to be about what we’re doing now in terms of the process as opposed to what somebody will physically do to put the site up or the blog up</td>
<td>D-Gesture 5: holding right hand pointed towards the wall and then moving it up and then down twice to show linear top to down progression.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proxemics: Julia getting up and going towards the inscription</td>
</tr>
</tbody>
</table>
Chapter Thirteen on Wall A.

529 0:58:48 Julia: 6. {I see this as (.) as} 7. quite {matched with this} Like this can go like a (.) @_like a circle kind of process_@

D-Gesture 6: pointing with right hand towards inscription SA-G3-C on Wall A.

D-Gesture 7: pointing right hand towards the printed pages on the table.
Drawing: drawing the curved lines with arrows starting from the right side of the list and ending at the left side of the process list.

530 0:58:57 Taryn: OK. Yeah

Transparency Achieved

1171 1:44:19 Darren: 8. So when you say about experimenting in the wild (.) Does that mean that the thing {that we gather here} the blogger would actually do that or someone else

D-Gesture 8: touching the wall at section A of Figure 72.

1172 1:44:30 Taryn: 9. The blogger would match {the people out there}

D-Gesture 9: gesturing away from Wall A pointing towards the opposite wall.

1173 1:44:33 Darren: OK.

1174 1:44:33 Taryn: with the Scientist people and together they'd come up with (.) with an idea to reduce salinity or you know something that people could do in the wild

10. So you don’t want just the information (.) you don’t want {the blog to just be the static thing}

D-Gesture 10: Holding both hands in front of her face with both palms facing Wall A.
<table>
<thead>
<tr>
<th>Time</th>
<th>Darren:</th>
<th>Taryn:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:44:47</td>
<td>Uh huh</td>
<td>you want it to generate ideas that produces action. So this is all the</td>
</tr>
<tr>
<td>1:44:52</td>
<td>11. = so what actually we are doing {here [is]}</td>
<td>D-Gesture 11: touching the wall at section A of Figure 72.</td>
</tr>
<tr>
<td>1:44:53</td>
<td>thinking</td>
<td>D-Gesture 12: touching the wall at section A of Figure 72.</td>
</tr>
<tr>
<td>1:44:54</td>
<td>12. what {we’ve got here} we match with what other people are doing in the wild</td>
<td>D-Gesture 13: with both hands touching the wall at section A in Figure 72.</td>
</tr>
<tr>
<td>1:44:58</td>
<td>13. No {we think here}</td>
<td>D-Gesture 14: right hand touching the wall at section C while left hand stays at section A.</td>
</tr>
<tr>
<td></td>
<td>14. and then we {take all the thinking from here}</td>
<td>D-Gesture 15: right hand touching the wall at section D in Figure 72 while left hand stays at section A.</td>
</tr>
<tr>
<td></td>
<td>15. and {from here}</td>
<td>D-Gesture 16: pointing with right hand towards section A.</td>
</tr>
<tr>
<td></td>
<td>16. and the moderator then tries to find a way of matching the {scientific people} and the people out there (.) the ordinary people</td>
<td></td>
</tr>
<tr>
<td>1:45:13</td>
<td>They connect</td>
<td>They connect it in but the connection is an experiment something to do</td>
</tr>
<tr>
<td>1:45:14</td>
<td></td>
<td>What can we do to solve one of those problems</td>
</tr>
<tr>
<td>1:45:21</td>
<td>17. So we’re probably will {use this one to connect}</td>
<td>D-Gesture 17: with right hand holding pen</td>
</tr>
</tbody>
</table>
points towards section B in Figure 72.

D-Gesture 18: with right hand index finger touches section A.
D-Gesture 19: with right hand touches section B in Figure 72.

---

**Example Two: Individually Created Inscription**

In this example from Study-A Group 1, the inscription under discussion was created by one of the participants and the other two participants were only marginally involved in the process, unlike the previous example. The extract of conversation is provided in Table 23, and lines 762 to 768 illustrate the process of how the drawing, that later would become transparent, was created. Grant provided an explanation of his ideas for how the blog should be linked to a webpage (lines 762-764, Table 23). The webpage would provide an interface which the students could use to link to from their social media tools, such as FaceBook, Twitter, and through subscription. Grant added to the inscription while also explaining this new addition (line 766) and drew the section that later became transparent (line 768). This section looks like small circles underneath a diagram box and is the designated area in Figure 73. When Grant was drawing this section he stated “So the content when someone publish something in the blog that there’s going to be specialist, the O.N.G (.) you and whatever we choose we need people here who is very good maybe a designer to design videos and to design info-graphics” (*sic*). Accordingly, this section of the diagram was meant to represent various groups who would be contributing contents to the blog.
Figure 73. Study-A Group 1 - Inscription SA-G1-C with sections demarcded

Around 11 minutes after the creation of this section, Grant referred back to this section during the discussion. Grant first stated “In this blog there is (. ) there’s going to be these people” (line 965, Table 23). At this stage he talked about the visual elements in the inscription transparently as if he was referring to the ideas directly. He referred to the idea represented by the small circles as in the contributors of the contents by calling them “these people”. However, he quickly followed with further clarification stating “who are going to be creating the content (. ) because we need a specialist (. ) something from science or designers”. The reason for this clarification after the transparency may be because the other participants were not notably involved in the creation of the
inscription and thus Grant might have thought they needed a reminder as to what these small circles stood for.

Table 23 - Study-A Group 1 – The Process of Transparency of the Inscription SA-G1-C

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>762</td>
<td>1:18:06</td>
<td>Grant:</td>
<td>1. So the thing with the blog (.), the thing with the blog is the blog is (.) let’s say the blog is the main space in {which people are going to place things for:: archival} means</td>
<td>D-Gesture 1: right hand touching section A in Figure 73.</td>
</tr>
<tr>
<td>763</td>
<td>1:18:16</td>
<td>Natasha:</td>
<td>mmm</td>
<td></td>
</tr>
<tr>
<td>764</td>
<td>1:18:16</td>
<td>Grant:</td>
<td>2. so {the blog is connected to} 3. a {favourite web page}</td>
<td>D-Gesture 2: right hand holding pen hovers over section A as if drawing a circle around it.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>765</td>
<td>1:18:20</td>
<td>Judy:</td>
<td>yep</td>
<td></td>
</tr>
<tr>
<td>766</td>
<td>1:18:22</td>
<td>Grant:</td>
<td>1. @<em>so we need to create our webpage</em>@</td>
<td>Drawing 1: adding ‘webpage’ to section B.</td>
</tr>
<tr>
<td>768</td>
<td>1:18:23</td>
<td>Grant:</td>
<td>2. So @<em>the students can have access to (.) OK students (.) or community</em>@</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. can put comments and stuff {So the content when someone publish something in the blog}</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. @<em>that there’s going to be specialist, the O.N.G</em>@</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. {you} and whatever we choose</td>
<td></td>
</tr>
</tbody>
</table>
6. {we need people here} who is very good maybe a designer to design videos and to design info-graphics illustrated in the designated area in Figure 73 near section A.

D-Gesture 5: right hand quickly pointing towards Natasha.

D-Gesture 6: right hand pointing to the designated area in Figure 73.

Transparency followed by clarification

965 1:29:29 Grant: 7. In this blog there is (.) there’s going to be {these people} who are going to be creating the content (.) because we need a specialist (.) something from science or designers

Posture: standing in front of the main table facing the table and then turns around towards Wall A for the gesture.

D-Gesture 7: left hand holding pen points towards demarcated section of inscription SA-G1-C on Wall A as in Figure 73.

Quick Transparency

The second process which led to the inscriptions becoming transparent in use was similar to the previous process, only faster. The ideas represented in inscriptions still needed some explanation as to what they signified, but the inscriptions became transparent very quickly. The achievement of the transparency was brought closer to the time of creation of the inscriptions. This process is now explained with two examples from the data corpus. The first is an example of how an abstract diagram
became transparent and the second example illustrates how a concrete diagram became transparent in use.

*Example One: Abstract Diagram*

This first example illustrates how the participants from Study-A Group 3 created and worked with the abstract diagram in inscription SA-G3-B in Figure 74. In Table 24, lines 430-432 are the excerpts from the transcript showing the participants discussing ways to attract users to the blog. This was when Taryn started drawing the diagram in Inscription SA-G3-B. As she was creating the diagram, Taryn explained what those drawings represented (lines 430 and 432, Table 24). As a result, the other two participants knew what the visual elements, for example each set of stick figures in the inscription, represented. Taryn made further additions to the diagram in inscription SA-G3-B as she continued explaining them (line 436, Table 24), however she made references to the previous inscription SA-G3-A in a transparent way. This indicates that, by this time, inscription SA-G3-A was well known to the participants, so they could deal with it in a transparent way.

The participants came to fully understand what the visual elements represented (lines 443-447, Table 24). An example of how the participants no longer saw any distinction between the drawings and the ideas they represented can be seen in line 446. This is when Julia pointed to the stick figures and asked “Sorry by {this one} do you mean {these people} or {these people}”. In this utterance Julia first pointed to the demarcated section ‘A’ in Figure 74, she then pointed to section ‘B’ and finally to section ‘C’ in Figure 74.
This process of inscription becoming transparent occurred much quicker than the previous examples. The creation of the drawing started at the 46th minute of the meeting recording and continued for the next two minutes. The inscription became completely transparent in the 49th minute of the recording.

Table 24 - Study-A Group 3 - The Process of Transparency for Inscription SA-G3-B

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>430</td>
<td>0:46:36</td>
<td>Taryn:</td>
<td>1. OK: I’m not very good at drawing but if you think about (6) @_ so you’ve got the blog @_ @</td>
<td>Drawing 1: adding the blog square box and ‘Blog’ word inside.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. and @_ then the people out here @_ @</td>
<td>Drawing 2: adding the stick figures at section C in Figure 74.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. OK you’ve got @<em>readers</em>@</td>
<td>Drawing 3: adding ‘Readers’ under the figures at section C.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. you’ve got @<em>people who live there</em>@ (11)</td>
<td>Drawing 4: adding the stick figures at point B.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. you’ve also got people who @_work there so there’s what (5) if you (2) so you’ve got economic _@</td>
<td>Drawing 5: adding section D in Figure 74.</td>
</tr>
<tr>
<td>431</td>
<td>0:47:30</td>
<td>Darren:</td>
<td>Social</td>
<td></td>
</tr>
<tr>
<td>432</td>
<td>0:47:30</td>
<td>Taryn:</td>
<td>6. @<em>This is social and cultural</em>@ (5)</td>
<td>Drawing 6: adding the text under the figures at section B.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7. @<em>these are people who are (14) plus other which could be like government or anybody doing research</em>@ Who else?</td>
<td>Drawing 7: adding the text under the stick figures at section C in Figure 74.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Further explanation with drawing</td>
<td></td>
</tr>
<tr>
<td>436</td>
<td>0:48:16</td>
<td>Taryn:</td>
<td>...so that’s the blog going out but then you’ve got</td>
<td>Drawing 8: adding the circle around the stick</td>
</tr>
</tbody>
</table>
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8. @ all these people _@ (2) figures at section C
9. @ who bring in their Drawing 9: adding the
call it private maybe but it’s not line between section C
10. @ which tends to be the (.) we and the blog square.
call private but private Drawing 10: adding ‘private exp’ over the
experience _@ and line
11. @ they’re posting here _@ so Drawing 11: adding the
they’re posting their stories arrow at the end of this
which then feeds into line.
1. {this} so the first thing is to D-Gesture 1&2: right
educate (.) having educated then hand holding pen
you want to pointing at item 2 in
2. {do 2} which is draw them in inscription SA-G3-A.

Transparency

443 0:49:14 Darren: 3. {Because that’s a blog} so D-Gesture 3: pointing
probably we have to entice people briefly towards the
to come in first blog square.

444 0:49:20 Taryn: 4. Yes but {this is what} you bring D-Gesture 4: pointing
(.)You get them coming in because with left hand holding
they’re cross about something or a pen towards the blog
they’re upset about something square.

445 0:49:26 Darren: OK (.) Oh yeah D-Gesture 5: with left

446 0:49:27 Julia: 5. Sorry by {this one } hand pointing to
6. do you mean {these people} section A in Figure 74.
7. or {these people} D-Gesture 6: left hand pointing to section B.

447 0:49:31 Taryn: Anybody D-Gesture 7: left hand pointing to section C in
Figure 74.
Example Two: Concrete Diagram

The second example in this process illustrates how the participants from Study-A Group 2 created and worked with a concrete diagram (inscriptions SA-G2-C and SA-G2-D). As this was a concrete diagram, not much explanation was needed. However, Dom did explain some of the visual elements he was adding to the diagram. For example, Dom stated “That’s banner” as he was drawing a section of inscription SA-G2-D (line 827, Table 25). More explanation was often provided for the elements that were perhaps considered more ambiguous by the participant drawing. The excerpts from the data in Table 25 illustrate that the process of the inscription becoming transparent closely followed its creation.

This example is different from the previous example in that the inscription being created and discussed here is a concrete diagram and so it was not difficult for the other two participants watching to understand what the visual elements represented. The diagram in this inscription represents a blog page with which the other two participants were familiar. Still, some ideas required that the participants watching be familiar with
the meaning associated with the visual elements. For example, Dom stated “that would then link off to another page of those things” (line 824, Table 25). This comment needed Angus and Meg to understand what the visual elements represented. They needed to know that the underlined text on the right side of the blog diagram was links, as in section ‘C’ Figure 75, and that these links could connect to other pages of the blog.

Table 25 - Study-A Group 2 - The Process of Transparency for Inscriptions SA-G2-C and SA-G2-D

<table>
<thead>
<tr>
<th>Order</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>815</td>
<td>1:26:02</td>
<td>Dom:</td>
<td>1. So then in {here you have articles}</td>
<td>D-Gesture 1: right hand holding pen moves towards section A in Figure 75.</td>
</tr>
<tr>
<td>816</td>
<td>1:26:06</td>
<td>Angus:</td>
<td>Uh-huh.</td>
<td></td>
</tr>
<tr>
<td>817</td>
<td>1:26:06</td>
<td>Dom:</td>
<td>1. So @_</td>
<td>Drawing 1: ‘BLOG ENTRY HEADING’ as in section A Figure 75.</td>
</tr>
<tr>
<td>818</td>
<td>1:26:13</td>
<td>Dom:</td>
<td>Heading _@</td>
<td>ENTRY HEADING’ as in section A Figure 75.</td>
</tr>
<tr>
<td>819</td>
<td>1:26:15</td>
<td>Meg:</td>
<td>So what are our sections (.) So there’s one on teaching ideas</td>
<td>Gaze: looking at section C in Figure 75.</td>
</tr>
<tr>
<td>820</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>821</td>
<td>1:26:20</td>
<td>Meg:</td>
<td>one on resources</td>
<td></td>
</tr>
<tr>
<td>822</td>
<td>1:26:22</td>
<td>Dom:</td>
<td>2. So I guess {in this section}</td>
<td>D-Gesture 2: left hand touching section C as in Figure 75.</td>
</tr>
<tr>
<td>823</td>
<td>1:26:24</td>
<td>Meg:</td>
<td>Yep</td>
<td></td>
</tr>
<tr>
<td>824</td>
<td>1:26:24</td>
<td>Dom:</td>
<td>3. {that would} then link off to 4. {another page} of 5. {those things}</td>
<td>D-Gesture 3: both hands touching the wall at section C.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D-Gesture 4: right hand then moves to the right</td>
</tr>
</tbody>
</table>
of inscription D-3 pointing to the empty space.

D-Gesture 5: right hand index finger extended pointing towards Wall A projected screen displaying the Word document where Angus was typing.

<table>
<thead>
<tr>
<th>Time</th>
<th>Action/Comment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:26:28</td>
<td>Angus:</td>
<td>Yeah</td>
</tr>
<tr>
<td>1:26:30</td>
<td>Meg:</td>
<td>OK</td>
</tr>
<tr>
<td>1:26:51</td>
<td>Dom:</td>
<td>@@ That’s banner @@</td>
</tr>
<tr>
<td>1:26:51</td>
<td>Meg:</td>
<td>So what have we got (.) ^we’ve got teaching ideas^</td>
</tr>
<tr>
<td>1:26:56</td>
<td>Dom:</td>
<td>Drawing 2: Started drawing inscription SA-G2-D on Wall A as in section B in Figure 75.</td>
</tr>
<tr>
<td>1:26:59</td>
<td>Meg:</td>
<td>6. Ah {teaching ideas}</td>
</tr>
<tr>
<td>1:26:59</td>
<td>Dom:</td>
<td>^Yeah^</td>
</tr>
<tr>
<td>1:26:59</td>
<td>Meg:</td>
<td>7. And then another one for resources. So obviously {they need to link} among (.) between themselves as well</td>
</tr>
<tr>
<td>1:26:59</td>
<td>Dom:</td>
<td>Gaze: looking at the Word document from projector A.</td>
</tr>
<tr>
<td>1:26:59</td>
<td>Meg:</td>
<td>Gaze: looking at the Word document from projector A.</td>
</tr>
<tr>
<td>1:26:59</td>
<td>Dom:</td>
<td>D-Gesture 6: briefly moving left hand towards the Word document projected on Wall A.</td>
</tr>
<tr>
<td>1:26:59</td>
<td>Meg:</td>
<td>Gaze: looking at the Word document from projector A.</td>
</tr>
<tr>
<td>1:26:59</td>
<td>Dom:</td>
<td>D-Gesture 7: right hand moving quickly from Word document displayed on the Wall A towards inscription</td>
</tr>
</tbody>
</table>
832 1:27:09 Dom: 8. We still have {this stuff} down the side

SA-G2-D and back again.

D-Gesture 8: while drawing inscription SA-G2-D, Dom quickly moves his right hand towards section C in Figure 75.

Figure 75. Study-A Group 2 - Inscriptions SA-G2-C and SA-G2-D with sections demarcated

**No Explanation Transparency**

The third way inscriptions became transparent in this study was when there was no explanation provided. This was often in relation to inscriptions that were self evident, and thus the person referencing did not see the need to provide explanation for
what the visual elements represented. This process will be illustrated using two examples from the data corpus, one showing how text-based inscriptions became transparent and the other, how a hybrid inscription was becoming transparent in use.

**Example One: Text-based Inscriptions**

Two instances will be discussed in which text-based inscriptions were referenced in a transparent way without providing an explanation of the visual elements represented. The first example is from Study-A Group 1. In it, Grant referred to the demarcated section ‘B’ in inscription SA-G1-A Figure 76, as “these people” (line 672, Table 26). He did not provide any explanation for how the inscription could be people because the text was self-evident; the inscription listed a number of stakeholders in the blog project. Grant also created what I would call *deictic drawing*, similar to in an event observed in Study-B Group 1 (line 674, Table 26). Accompanying the deictic drawing he stated “this is the main goal”. Again, he did not need to provide explanation because the heading for that list defined the items as the goal for the tool and Grant was able to distinguish the main goal from among them, without going into further details and explanations.

**Table 26 - Study-A Group 1 - The Process of Transparency for Inscription SA-G1-A**

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>672</td>
<td>1:11:15</td>
<td>Grant:</td>
<td>1. OK (.) so it seems that (2) we need something {to raise awareness}</td>
<td>D-Gesture 1: right hand holding pen touches section A in Figure 76.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. on: this (.) {all these people}</td>
<td>D-Gesture 2: right hand with fingers apart</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. that is important {a sustainable}</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. @<em>water system</em>@</td>
<td></td>
</tr>
</tbody>
</table>
B in Figure 76.  
D-Gesture 3: pen in the right hand pointing to section C in Figure 76.  
Drawing 1: adds the word ‘System’ as in section C in Figure 76.

Natasha: mmm

Grant: So we can say that _this is the main_@ goal

Deictic drawing: draws a small arrow as in section D in Figure 76.

Judy: Yep (.) yep

Figure 76. Study-A Group 1 - Inscription SA-G1-A with sections demarcated

The second instance occurred during Study-B Group 1 design session, in reference to inscription SB-G1-A. As in the previous instance, Malcolm did not provide explanation of the meaning of the referenced visual elements in inscription SB-G1-A. Malcolm referred to the inscription as “this data” (line 51, Table 27). Unlike the previous instance however, the way that Malcolm pointed towards the inscription, without specifying a section of it, created temporary confusion. Malcolm asked whether
the data would be entered into the game every two weeks for monitoring (line 51, Table 27). This produced instant disagreement from Jareth because Malcolm had pointed to the entire inscription, and some of the items in the list represented data that would only be entered once into the game, such as the dwelling type. When Malcolm specified the section of the inscription he intended by touching the wall at the demarcated section in Figure 77 (line 53, Table 27), the disagreement was solved and Jareth started explaining how users could monitor progress by entering this data into the game.

Table 27 - Study-B Group 1 - The Process of Transparency for Inscription SB-G1-A

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>2:05:13</td>
<td>Malcolm</td>
<td>1. So is the monitoring {entering this data}</td>
<td>D-Gestures 1&amp;2: right hand holding papers pointing towards inscription SB-G1-A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. {some of this data} every 2 weeks over a 2 week period</td>
<td>moving hand vertically from top of the list to bottom.</td>
</tr>
<tr>
<td>52</td>
<td>2:05:18</td>
<td>Jareth</td>
<td>No (.) [no this]</td>
<td>D-Gesture 3: touching the wall with left hand near section A Figure 77.</td>
</tr>
<tr>
<td>53</td>
<td>2:05:19</td>
<td>Malcolm</td>
<td>3. [{This stuff there}]</td>
<td></td>
</tr>
</tbody>
</table>
Example Two: Hybrid Inscriptions

Hybrid inscriptions created by Group 2 from Study-B were referenced in a transparent way dealing directly with the ideas represented, rather than the visual elements. As this example began, Gino pointed to the diagram projected on the wall in order to suggest how the two different screens in the game could be merged into one, stating “I feel like they could be united” (line 108, Table 28). Gino did not need to provide an explanation of what the boxes in the diagram represented because all participants were aware that the boxes in the diagram represented the different screens in the game. Gino then pointed towards various boxes of the diagram again and stated “and then that means that from {here} you can go: {here} and {here}” (line 110, Table 28).
28). In the first gesture he pointed to the demarcated section ‘A’ in Figure 78, the second gesture was towards section ‘B’, and the third gesture pointed towards section ‘C’ in Figure 78. Since the diagram, which was the background to the sketches the group created, was self-explanatory, the participants were able to reference it transparently, making their discussion much more fluent and efficient.

Table 28 - Study-B Group 2 - Using Inscriptions and Visual Representations as Transparent Tools

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-verbal communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>2:07:00</td>
<td>Gino</td>
<td>1. Would you ever have multiple players and that’s why you need specific player. Because I feel like they could be united</td>
<td>D-Gesture 1: pointing with left hand going from the home screen as in section A in Figure 78 to the player home as in section D twice in quick successions.</td>
</tr>
<tr>
<td>109</td>
<td>2:07:10</td>
<td>Jarrod</td>
<td>I think they could be united somehow. Yeah:</td>
<td>Posture: standing up and going closer to the wall.</td>
</tr>
<tr>
<td>110</td>
<td>2:07:12</td>
<td>Gino</td>
<td>2. and then that means that from {here}</td>
<td>D-Gesture 2: pointing with left hand to Home Screen as in section A Figure 78.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. you can go: {here}</td>
<td>D-Gesture 3: pointing with left hand to Glacier Park as in section B.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. and {here}</td>
<td>D-Gesture 4: pointing with left hand to</td>
</tr>
</tbody>
</table>
Vague Gestures

When inscriptions become transparent to the designers in a team meeting, the need to explain ideas verbally and repeatedly is diminished. The designers can simply point to the visual elements and discuss the ideas represented by them. The verbal communication in these situations can become highly contextualised. When utterances are dependent on the availability of inscriptions which provide a backdrop and a context to the conversation, gestures become an indispensable part of the conversation.

Synthesis of Results

Figure 78. Study-B Group 2 - hybrid inscription transparency
They are used to ground the conversation and provide relevant points of reference for utterances. Participants in such multimodal conversations, in the presence of inscriptions, can become particularly sensitive to deictic gestures towards inscriptions. Vague gestures may cause confusions, as was shown in the example from Study-B Group 1 pointing to inscription SB-G1-A. Deictic gestures need to reference the appropriate elements represented in the inscriptions.

**Three Different Visual Elements – Same Verbal Description**

An interesting observation in this section of the results was how different visual elements in inscriptions could be interpreted to represent the same meaning. There were three instances when the participants in this study pointed towards the inscriptions and called them “these people”. In the first example, Grant, from Study-A Group 1, pointed towards a section of inscription SA-G1-C that looked like small circles and called it “these people” (line 965, Table 23). In the second example, Julia, from Study-A Group 3, pointed towards the stick figures in inscription SA-G3-B and called it “these people” (line 446, Table 24). The third example is also from Study-A Group 1 when Grant pointed towards text-based list items in inscription SA-G1-A and again called it “these people” (line 672, Table 26). The main difference here is that the visual elements in each of these examples were completely different from each other. In the first example the circles were symbolic elements. They looked nothing like people and yet they were called “these people”. In the second example the visual elements were iconic, in that the stick figures resembled people with simplified bodies, hands and legs. In the third example the referenced visual element was text, a list of stakeholders. This illustrates that transparency of visual elements in inscriptions is not dependent on the form of the
visual element. The participants need to know the represented world and how it is being represented in the drawings and once this is established in the group, then the inscriptions can become transparent to them.

Factors Influencing Transparent Inscriptions

There are several factors that influence transparency. Concrete inscriptions with iconic visual elements that look like what they represent are simple to treat as transparent representations. This is because the participants assume that the other group members know what these visual elements stand for and do not provide additional explanations. Abstract visual elements may require more detailed explanations, however, if all of the group members are closely involved in the creation of abstract elements, then transparency can be achieved quickly. Text as a symbolic element is also treated as transparent because the words provide concrete explanations. As long as the participants in design team meetings know what and how the inscriptions represent, there is a greater chance that even the most abstract visual elements can become transparent in use.
Chapter Fourteen: Gestures Orchestrating the Multimodal Development of Ideas

In this chapter I will be discussing two new concepts: collaborative completion of utterances and gestures orchestrating interaction. I will first briefly discuss these concepts as they appear in the literature. I will then present a micro analysis of one key event that illustrates how the gestures helped to orchestrate the collaborative use of inscriptions and other visual resources in the environment. I will conclude with a synthesis of the findings in this chapter.

Collaborative Completion of Utterances

There is evidence in language-based studies of participant interaction that collaborative completion of utterances is used as a way to display understanding (Sacks et al., 1974). “By producing a collaborative completion of the speaker’s utterance, the recipient does not simply claim understanding of the other’s actions, but presents a clear evidence for it” (Bolden, 2003, p. 188). In face-to-face interaction, this type of collaborative completion will need to take into account a number of communicative modes, including gesture, gaze, posture, and the visible features of the environment, such as inscriptions. Bolden (2003) has given an example of how the interplay of multiple modalities is used to bring off a closely coordinated action as a co-construction of a single syntactic unit of talk. She closely analysed a short sequence of interaction between a physicist and a lab technician in which the lab technician was recommending changes to an existing machine. During the interaction, the technician was holding the
machine while describing the current issues with it, and suggesting further changes. Bolden (2003) demonstrates that the combination of the talk with relevant non-verbal communicative modes, embedded into a specific setting, and produced during a particular activity, can make it easier for participants in a face-to-face interaction to successfully predict and complete each other’s utterances, displaying their understanding. She concludes that “in face-to-face interaction, we may need to see collaborative completions not as exclusively verbal phenomena but as action embedded within a complex web of different meaning-making fields” (Bolden, 2003, p. 208). Jointly produced meaning is a hallmark of common ground understanding (Nomura & Hutchins, 2007).

**Orchestrating Interaction**

Orchestration is a term used by Dillenbourg (2013), who defines it as a regulation process by which a teacher in a classroom manages multi-layered activities in real time in a multi-constraints context. Gestures in face-to-face collaborative activities too can orchestrate the use of multiple resources, including physical objects and layout, as well as inscriptions. To bring into play and utilise any of these resources in an interaction, the participants can employ several modes of communication. For example, gaze direction and body orientation may tell us about the participants’ focus of attention at specific moments in an interaction and maintain a shared focus of attention between the participants. Touch, and object manipulation, can also introduce new resources into the interaction. While gaze and posture may be relatively subtle, gesture is the most prominent communicative mode for orchestrating interaction. Deictic gestures have
been shown to allow the coordination of talk about highly abstract concepts and visual displays simultaneously (Roth, 2001). Gestures are flexible enough to quickly refocus attention at any point in the interaction, making some resources important and others irrelevant, thus orchestrating interaction.

**Multimodal Development of Ideas in this Study**

**Microanalysis of an Event from Study-A Group 3**

In this section, a sample from the data is presented which illustrates how the participants in this study used gestures to orchestrate their talk and the use of resources. The resources included the inscriptions on the wall, the printed scaffolding pages, and the sample website displayed on the interactive whiteboard. This example is from Study-A Group 3, when Darren, Julia and Taryn were discussing how to align 1) the diagram they had created in inscription SA-G3-C1 on the wall with 2) the sample design process diagram provided on the scaffolding printed pages.

Table 29 - *Micro Analysis of an Event from Study-A Group 3*

<table>
<thead>
<tr>
<th>Order ID</th>
<th>Time</th>
<th>Participant</th>
<th>Talk</th>
<th>Non-Verbal Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>559</td>
<td>1:02:27</td>
<td>Darren:</td>
<td>&quot;This one has a different cycle&quot;</td>
<td>Gaze: Looking at the interactive whiteboard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Object handling: touching/moving the mouse on the table.</td>
</tr>
<tr>
<td>560</td>
<td>1:02:33</td>
<td>Taryn:</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>561</td>
<td>1:02:39</td>
<td>Darren:</td>
<td>1. {Define is I think discovery}</td>
<td>D-Gesture 1: left hand pointing towards the process diagram</td>
</tr>
</tbody>
</table>
Chapter Fourteen

inscription on the wall
See Figure 79 for this
gesture.

D-Gesture 2 & D-
Gesture 3: left hand
pointing to and moving

between the wall and
interactive whiteboard.

D-Gesture 4: left hand
towards interactive
whiteboard.

D-Gesture 5: left hand
towards inscription
SA-G3-C1 and then
quickly to inscription
SA-G3-B on Wall A.

D-Gesture 6: left hand
towards interactive
whiteboard.

D-Gesture 7: left hand
touching the printed
papers in front of him
on the table.

Resources: Scrolling
down the webpage
with mouse on the
interactive whiteboard.

Gaze: interactive
whiteboard.

D-Gesture 8: left hand
briefly points towards
inscription SA-G3-C1
on Wall A.
<table>
<thead>
<tr>
<th>Time</th>
<th>Taryn:</th>
<th>Darren:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:03:10</td>
<td>[I think we are (.) so we’ve got one o’clock so we’ve got 45 minutes I think that if we wanted to (1.5) if we had longer we could investigate all issues]</td>
<td>^Yeah and if we have some...^ Gaze: Looking through the pages.</td>
</tr>
<tr>
<td>1:03:21</td>
<td>9. We have to come up with a thing and</td>
<td>Gesture 9: Roles hands up and then down palms facing up while still holding pen in the right hand.</td>
</tr>
<tr>
<td>1:03:22</td>
<td>10. {this thing}</td>
<td>See Figure 80 for this gesture.</td>
</tr>
<tr>
<td>1:03:24</td>
<td>11. {this thing}</td>
<td>D-Gesture 10: left hand index finger touching the printed paper in front of him.</td>
</tr>
<tr>
<td>1:03:25</td>
<td>12. ={But I think}</td>
<td>See Figure 81.</td>
</tr>
<tr>
<td>1:03:27</td>
<td>13. {that would be a good thing for the process or the methods (.})</td>
<td>D-Gesture 12: right hand index finger touching the printed paper.</td>
</tr>
<tr>
<td>1:03:28</td>
<td>D-Gesture 13: right hand index finger</td>
<td>D-Gesture 13: right hand index finger</td>
</tr>
<tr>
<td>Time</td>
<td>Speaker</td>
<td>Line</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>578</td>
<td>Taryn</td>
<td>14.</td>
</tr>
<tr>
<td>579</td>
<td>Darren</td>
<td>15.</td>
</tr>
<tr>
<td>580</td>
<td>Taryn</td>
<td>16.</td>
</tr>
<tr>
<td>581</td>
<td>Darren</td>
<td>17.</td>
</tr>
<tr>
<td>582</td>
<td>Darren</td>
<td>18.</td>
</tr>
</tbody>
</table>

The conversation is when Darren drew the group’s attention to a website displayed on the interactive whiteboard that had a similar process to that on the scaffolding printed pages, but with different labels for each step. Darren stated “This one has a different cycle” (line 559, Table 29). At this point Darren was looking at the
interactive whiteboard and orienting his body towards it. This action clears the ambiguity that might have come from using the indexical pronoun “This one” without pointing or gesturing. Darren then suggested a mapping between this new process, described on the website, and the diagram they had created on the wall. He started by comparing the labels used for each of the steps in the two processes, commenting on how they were similar in meaning, and thus represented the same steps in the process.

He pointed with his right hand and index finger extended to each of the terms on the interactive whiteboard and then to Wall A (lines 561-563, Table 29). See Figure 79 for this gesture. He also pointed to the diagram in the scaffolding printed pages by stating how the label ‘prototype’ on the website can be similar to the ‘experimentation’ step in the printed diagram (line 563, Table 29). Darren scrolled down the website page with the mouse that was on the table in front of him and prolonged the word ‘then’ (line 567, Table 29). This provided an opportunity for Taryn to complete his utterance by immediately reading the next step in the process described on the web page (line 568, Table 29). Taryn’s assumption was immediately confirmed and accepted by Darren (line 569, Table 29), demonstrating joint understanding and progress through the conversation.
In this event, there were two more collaborative completions of utterances, both highly dependent on the visual resources in the setting, as well as the inscriptions on the wall. After the first instance discussed above, Taryn stated “We have to come up with a thing” (line 572, Table 29), and as she started to utter these words she was holding both hands flat in front of her with the palms facing upwards (see Figure 80). She then rolled her hands up and back to the original flat position as she finished the utterance. While this was happening, Darren quickly looked through the scaffolding printed pages and brought up the page that had the task information for the group - asking them to come up with a design concept and a sketch for the blog.
At this point, Taryn was trying to continue her statement by adding “and” while moving her hands, still in the flat position with the palms of her hands facing upwards, slightly towards the left as if trying to show something (end of line 572, Table 29). See Figure 80 for the position of Taryn’s hands. At this point, Darren interrupted by saying “this thing” (line 573, Table 29; Figure 81).
Taryn, hearing this, quickly moved back towards Darren, with her hands still in the flat position and looked at the scaffolding printed pages where Darren was pointing. She then pointed with this flat-hands gesture towards the paper and repeated “this thing” (line 574, Table 29; Figure 82). At this stage the flat-hands at Figure 80 became a deictic gesture at Figure 82.

Figure 82. Gesture 11 at line 574 of Table 29

The next collaborative completion came 12 seconds later at lines 579-580. After clarifying and further defining the problem and the deliverables, Darren redirected the group’s attention to inscription SA-G3-C1 on the wall. He stated “But I think that would be a good thing for the process or the methods” (line 577, Table 29). He produced two gestures here; first gesture, pointing with his right hand index finger towards the scaffolding printed pages on the table, and a second gesture pointing towards the process diagram inscription on Wall A. He held the second gesture for a short pause after the utterance. Taryn quickly agreed by stating “Oh absolutely”. She then continued, trying to understand exactly how the process diagram would satisfy the requirement for the task they were given. She continued “So we’ve got to (2)” -
pointing with the pen in her hand towards the process diagram inscription SA-G3-C1, and then looking towards the scaffolding printed pages Darren was holding. This pause of about two seconds indicated to Darren that Taryn was still not sure about his suggestion for the process diagram. Darren then tried to further explain his idea by stating “That thing would have been good for the methods I think”, while pointing with his right hand index finger at the scaffolding printed paper. By “that thing” Darren meant the process diagram inscription SA-G3-C1 on the wall. He then read the text from the printed paper as “Explain how your blog will address the problem” while still holding the pointing gesture. Next Darren moved the same hand towards Wall A where the process diagram inscription was and stated “So I think that that process would”. For this gesture Darren’s hand was open with his fingers apart while rotating his hand three times in a clockwise direction (see Figure 83). Darren then continued repeating the last part of his utterance by stating “that process” when Taryn completed his utterance by saying “would result in us getting that”, pointing to the scaffolding printed pages and overlapping Darren’s utterance before it. Darren accepted her comment (line 581, Table 29) indicating that Taryn now understood his idea.
Synthesis of Results

The Role of Visual Representations in Collaborative Completion of Utterances

This event, with three instances of collaborative completion, indicates that visual resources in the environment play a vital role in the process of meaning making. The participants in this example relied on several visual resources in the environment to help them reach joint understanding. (1) They pointed to the interactive whiteboard, where they were displaying information from a website about the different stages in a design process diagram. (2) They used the scaffolding printed pages on the table in front of them, which they read from and pointed to several times. (3) They pointed towards inscription SA-G3-C1 on Wall A, which was the topic of their discussion. (4) Moreover, the participants also pointed towards inscriptions SA-G3-A and SA-G3-B
on Wall A that they had created earlier. All of the visual resources were located in near proximity; they could point to them during their conversation. This created a situation where the participants smoothly brought each visual resource into the foreground of the conversation and then moved on to the next resource in the same utterance.

**Gesture Orchestration**

Visual resources play an important role in the meaning-making process in collaborative group design meetings. In the example provided, deictic gestures were used to orchestrate the fluent use of these resources. These gestures were enacted in several forms, including whole hand or only index finger extended, pointing with a pen in the hand, open hand with fingers apart, or holding both hands flat with palms facing upwards. Sometimes posture and gaze were used to communicate the focus of attention. However these modes were often too subtle to be used when there were several visual resources as the focus of attention in the same turn of talk. For example, Darren used a total of six deictic gestures to point to three different resources that included the interactive whiteboard, the inscription on the wall, and the scaffolding printed pages on the table (line 563, Table 29). In particular, in Gesture 5 of this single utterance in Table 29, Daren pointed to two different inscriptions on the wall: SA-G3-B and SA-G3-C1. This shows how the flexibility and swiftness of the gesture allowed Darren to bring the focus of the group to two inscriptions at once, in addition to the other two resources. Gestures are quick and flexible and can refocus attention swiftly to whatever the speaker deems important at the specific point in time. Gestures can bring visual entities into focus, regardless of their location and proximity. As long as the entity is perceptually available it can be pointed to and talked about.
**Highly Contextual Utterances**

The talk in this event was highly contextual. Language was used as shorthand to refer to different resources in the environment calling them ‘this thing’ and ‘that process’. Without taking into account the gestures, and in some instances the gaze and posture as well, the conversation would make little sense. It is only through analysing the different modes together that this event can be identified as a collaborative completion and thus important, in that it shows the participants were reaching consensus and shared understanding.

This is the end of Part 5. In Part 6 of this thesis I present the concluding Chapter Fifteen where I discuss the main findings, their implications, and recommendations for further research.
Part 6 – Conclusion

Chapter Fifteen is the concluding chapter of this thesis. I will present the main findings and their implications, identify the limitations of the study, make recommendations for further research, and provide a structured summary of the contributions made by this study to knowledge in the field.
Chapter Fifteen: Main Findings and Implications

This thesis began as an exercise to explore the drawing and sketching practices of educational designers during team meetings. Faced with a relative paucity of literature showing an interest in drawing in educational design, I examined the literature on drawing practices of architecture and engineering designers. Following the preliminary analysis of a pilot study, I noticed that the drawing forms produced by the participants in my study differed from those commonly created in other design domains, such as architecture and engineering. The drawings produced by the participants in this thesis are an amalgamation of various geometric forms, lines, arrows, and text. In most cases, I could not make a clear distinction between text and drawings. In order to understand this form of drawing, I ventured into another area, science, which also has a rich history of using visual representations. I found more similarity with inscriptions produced by scientists than drawings produced by designers in other domains. At this point I decided to reconsider the drawings I was analysing as inscriptions. Inscriptions include much wider forms of drawings and visual marks. By focusing on inscriptions I was also prompted to analyse the drawings as part of the social and collaborative context rather than as stand-alone entities, complete in themselves. I employed ethnomethodology to understand the nuances of collaborative sketching and drawing in educational design, and multimodal interaction analysis to examine the non-verbal communicative modes in face-to-face meetings. In contrast to other widely used approaches to study design, such as protocol analysis, ethnomethodology provides a lens to study drawing in design as a situated activity. When inscriptions are analysed as part of the wider multimodal
Communicative system, gestures become an important, and at times prominent, communicative mode.

My aim for this thesis was to develop a better understanding of the drawing and sketching practices during the early phase of educational design (ED) so that we can engage in more effective communication and build better design tools. In this chapter, I will use the results of this research to provide suggestions to help educational designers engage in more effective communication and for the development of more sophisticated design tools. In addition, I will suggest that rather than a single tool, an ‘educational design space’ would better facilitate access to the multitude of resources, and provide support for, and capitalise upon, the non-verbal interaction between participants in an educational design team meeting. I will then discuss some of the limitations of this thesis, make suggestions for future research, and summarise the contribution that this thesis makes to knowledge in the field.

**Educational Design Tools**

Paying attention to what and how educational designers draw in team meetings can provide guidance to the creators of new generation tools to help designers work more productively. Two aims of this thesis were: 1) to identify the types of inscriptions created by the participants in the studies, and 2) to reveal how and in what ways these inscriptions were developed.

This section does not provide precise specifications for how to build such tools. Rather, it provides higher-level suggestions, about how new tools might support educational designers’ intuitive drawing activities. It is important to support the
intuitive interaction designers have with the drawings, tools, and resources. Designers should not be forced to adapt their normal practices, because this can affect the quality of their designs and stultify their design process.

**What Educational Designers Draw**

The participants in this study produced inscriptions in the form of composite written, pure lists, composite lists, abstract diagrams, and concrete diagrams. The range of drawings identified in these educational design sessions was small, which supports the results of Stubbs’ (2006) study. I agree with Stubbs that in general there are not many forms of drawings produced by educational designers; the findings presented here showed that the types and complexity of drawings might also be related to the type of design work and activities. For example, in this thesis Study-B Group 1 mostly produced text-based inscriptions, whereas Study-B Group 2 created different types of drawings, including objects such as animals and solar panels. The reason may well be that the two groups were working on different aspects of the design. Group 2 was designing the front-end of the game, where the users would access and interact with visual features, and thus they produced inscriptions related to the visual features on the interface of the game. Further research into this phenomenon can shed more light on how the topic or design focus can influence the types of drawings produced.

The ideas that educational designers can express are not limited by the forms of drawings they produce. The educational designers in this study utilised a limited number of graphic forms interchangeably to mean different things. For example, sometimes underlining was used to denote a linked text while at other times underlining was used to show emphasis. Graphic forms such as square boxes were used to group
text together, or to resemble a page, or to resemble a video player/box on a web page. This is a strength, rather than a weakness, of the graphic forms. They are flexible and can be used to express different ideas and concepts. Colour in inscriptions was similarly used flexibly, sometimes to denote specific meaning and sometimes due to usability or readability issues (such as the brightness of the pen). Issues arise, however, because the use of these limited forms of drawings is not standardised in ED. In most other design domains graphic forms are used in a consistent manner. For example, in architectural floor plans specific symbols are used to show doors and windows in a wall. Architects even have different symbols for types of doors such as single doors, double doors, or sliding doors. These symbols appear in similar forms in both hand drawn sketches, that may be created when an architect is trying out ideas on a piece of paper, as well as more formal floor plans that are created later for presentation to clients and other stakeholders. The use of colour too can be standardised to eliminate confusion and make communication easier.

The present research indicates that not only do educational designers assign different meanings to the same visual element they also assign the same meaning to different visual elements during the early conceptual design stage. This is related to how educational designers interpret visual elements. Because the use of visual representations is not standardised, educational designers in this study could use various forms of visual representations to represent the same idea. There were three instances in this study when the same term “these people” was used to refer to three different visual elements. All three examples were depictions of different visual elements (an abstract, a concrete and a text inscription) that looked nothing like each other and yet they were all called “these people”. Future research in ED should
experiment with graphic forms and visual elements to see how educational designers understand them, how they respond to them and whether standardisation of graphic forms is preferred, or even possible, in the conceptual phase of educational design.

Most of the drawings of objects in this study excluded the details that would be present in other forms, such as in a photo. When educational designers in this study drew objects such as a tree, a bear, a kangaroo, or some fish, these drawings did not need to conform to exact form, shape or details. This finding has implications for the design of tools to support the work of educational designers. The level of details in visual representations may not always be a positive feature in a tool. A drawing can help focus attention on what is important and relevant while omitting other features that might exist but are not relevant. The rough and simple construction of the hand-drawn visual forms encourages further exploration and may reduce the risk of premature fixation of design decisions.

**How Educational Designers Draw**

When I examined the design activity in Study-A and Study-B, employing an ethnomethodological perspective, I understood that it was important to know *how* these educational designers draw, in addition to *what* they draw.

I described in Part 3 of this thesis the way in which the participants in this study created text-based inscriptions such as composite written, pure and composite lists, as well as abstract and concrete diagrams. In the three Study-A groups, the participants created text-based inscriptions in the initial stages of their team meetings and then progressed towards more complex forms such as diagrams. This finding aligns with Stubbs (2006) who discovered that drawings in educational design tend to move
through a progression from simple to complex. More research into this progressive sequence is needed in order to strengthen the findings and also to understand the connections between early design phases and the production of inscriptions.

One of the benefits of drawing mentioned in Part 1, is that information can be added where it fits best to convey meaning in face-to-face meetings, rather than forcing words into a linear format (Hansen, 2000). The majority of the inscriptions produced in this study were created in a non-linear format. The participants added information and further details to inscriptions where they were needed, as the discussion progressed. Furthermore, even Study-B Group 3, who used the interactive whiteboard to type their design ideas, added the text in a similar non-linear way to those creating inscriptions using marker pens on the walls. This finding indicates that educational design tools have to be flexible enough to allow non-linear methods of adding information, in iconic or symbolic text-based formats, where it is needed in the context of the discussion during face-to-face meetings.

The results from this thesis indicate that educational designers develop inscriptions jointly, sometimes simultaneously, and in incremental phases. Although only three inscriptions were developed jointly by more than one participant, this finding indicates that for certain design tasks and in certain contexts educational designers might develop inscriptions jointly in a face-to-face team meeting. In this study, seven inscriptions were developed simultaneously and nine inscriptions were developed in incremental phases, which indicate there is a strong possibility that these results might hold true for other educational design meetings. According to these findings, educational design tool(s) and environments need to accommodate collaborative creation of inscriptions. Furthermore, if such tools are to accommodate the
simultaneous development of inscriptions, a larger working space is probably needed. One of the findings of this study was that the participants would often refer to inscriptions that they had created earlier during their discussion. To accommodate the incremental refining of inscriptions the tool would also need to provide quick access to earlier inscriptions, or to make inscriptions visible at all times.

The drawing medium can influence the drawing activity. As stated earlier, the decision to interact with a visual representation, and the level of interaction, is based on the knowledge of the characteristics of the medium on which the visual representation is drawn (Hegarty, 2011). There were a number of events in the design meetings where the characteristics of the drawing medium came into focus. The participants were more willing to change the contents of the inscriptions they created on the walls since they could easily erase and then replace the information. This was not possible for inscriptions that were created using the sheets of paper. Apart from the ability to change, the visibility of inscriptions was another factor that emphasised the role of the drawing medium. For example, the first inscription produced in Study-A Group 2 was created on a notepad. There was no involvement from the other participants until the inscription was transcribed onto Wall A. In another example, Study-B Group 3 used the interactive whiteboard for recording the ideas they discussed in their group session. However they did not produce any drawings. This was interesting because the software application they were using to type their ideas was essentially providing better tools for drawing than for typing text. One possibility may be the lack of familiarity with the characteristics of the tool. Further research is needed to investigate how educational designers perceive the specific characteristics of different drawing tools, including digital tools.
Educational Design Communication

When one of the researchers at the end of the design meeting asked Taryn from Study-A Group 3 to describe her group’s design concept, she stated, “when we started we thought we’d end up with a thing to show you but we don’t have a thing to show you (.) we have scribblings on the wall”. What seemed like “scribblings” to Taryn was an elaborate and complex abstract diagram that helped the group make the most of their design decisions. This supports the finding from the study by Stubbs (2006), that educational designers do not recognise the benefits of drawing in their design process. These drawings that Taryn called “scribblings” are often discarded while drawings created for presentation are retained. Presentation drawings are also created with more care. This is in contrast to architecture, for example, when the initial drawings, no matter how vague or messy, are retained as a record of the idea development process (Lawson, 2004). In educational design we need to develop a better understanding of the benefits of drawings for the early design process. Early educational design drawings need to be retained and recorded. This will help in training newcomers to the area, and aid in the development of a better vocabulary to discuss and talk about the drawings in educational design.

One of the aims of this thesis was to determine for what purpose inscriptions were used. Educational designers need to know that inscriptions can serve multiple functions. The inscriptions presented here were created and used for three different purposes; in order to capture ideas and the decisions made, to inscribe solutions, and to demonstrate ideas to other members of the team. This finding is similar to the function
of drawing in architecture which is broadly defined as a medium for communication, a medium for design, and a medium for analysis (Petherbridge, 2008; Unwin, 2007). Furthermore, in this study, each inscription in itself was found to serve multiple functions. The inscription could start as a way to capture ideas from an external source; however, during the meeting, the same inscription would be used for inscribing solutions or to demonstrate ideas for the researchers at the end. In engineering design, Ferguson (1992) similarly reported how the same drawing could be used as a thinking-sketch but then when it is used in discussion with other designers the sketch would change to a talking-sketch. When educational designers recognise that the drawings they create in order to help them explain their ideas can also be used for other purposes (such as for presentations), they might reconsider discarding their drawings and assign them more value.

In this study educational designers created drawings when they had trouble describing an idea verbally, just like architects and engineering designers in the pre-verbal phase (Hansen, 2000). Drawing can become an indispensable tool when a designer needs to explain an idea and recognises that the other participants do not fully understand his/her verbal explanation. In Study-A, Natasha, Dom, and Taryn all resorted to drawing their ideas when they had trouble describing them or when the other participants expressed their confusion. Most humans draw intuitively and their ability to use drawing to communicate ideas is far more sophisticated and nuanced than technological tools can currently support (Snyder, 2012b). The challenge is to provide educational designers with the right tools that can support and enhance their ability to express ideas naturally using talk, drawing, gesture, and other communicative modes. A further challenge is to help educational designers become aware of the multiple
communicative modes at their disposal so that instead of just drawing intuitively, they would actively seek a more appropriate drawing tool to express their ideas.

The educational designers in this study engaged deeply with their drawings. Evidence of such engagement was identified, in the present study, through the analysis of the terms designers used to refer to their drawings. These designers called visual representations of stick figures, circles, and written list of stakeholders “these people”. The drawings became transparent tools (Roth, 2003a), and the designers were able to look beyond the drawings and directly discuss the phenomena represented by the drawings. The majority of the inscriptions created by the participants in the design meetings examined in this study eventually became transparent to the users. The specific contribution of this thesis to this line of research is the ways that the inscriptions can become transparent to the users. We know from the studies of inscriptions in science that the users need to be familiar with the domain, the contents, and the way the raw data is translated into inscriptions (Roth, 2004). However, the finding in this thesis also suggests that there are different ways to reach transparency, and that these might be influenced by the forms of contents in the inscriptions. For example, concrete inscriptions with iconic visual elements that look like what they represent are more easily treated as transparent representations when compared to abstract concepts drawn using geometric shapes.

In educational design, inscriptions are used to ground the discussion. As mentioned in Part 4 of this thesis, inscriptions create the perceptual ground against which other forms of communication make sense. In these design meetings, inscriptions provided a reference point for the participants to stay on the topic. The first title created by the participants in Study-B served as the focus for the entire meeting to
refocus the participants and remind them of the design target. In another example, when
the participants in Study-B Group 1 started creating inscriptions on the wall they
changed their posture and turned towards the inscriptions for the remainder of their
group discussion. In Study-B Group 2, the participants started talking about the
diagram projected on the wall after they started creating drawings over it.

When inscriptions are the perceptual ground, other forms of communication such
as gestures, gaze, and posture also come into play. These forms of communication are
an important part of the educational design environment.

As mentioned earlier in this chapter, an educational design tool or environment
needs to accommodate the joint and simultaneous development of inscriptions as well
as their incremental elaborations. To accommodate simultaneous development, a tool
needs to provide larger space where two or more participants can create two or more
inscriptions at the same time. For incremental elaboration, the participants need quick
access to previous inscriptions they created. For some incremental elaboration to
happen, the participants need to have all the inscriptions visible so that they can move
between them and refine each inscription as the need arises during the discussion. It
would be difficult to provide such a tool in current desktop computing environments,
given limitations in size and display options. Most current desktop tools would also
impede the smooth occurrence of gestures, which are an important intra-group
communicative mode observed in this study. This may mean that educational design
may benefit from an educational design ‘space’ rather than a tool.
Educational Design Space

A multi-surface, digital-material hybrid educational design space, similar to the Design Studio, would support the drawing and sketching practices, as well as accommodate the smooth enactment and visibility of other communicative modes, such as gestures.

Gestures enacted in relation to inscriptions can reduce cognitive load in collaborative design work and allow easier and faster discussion of more complex concepts. Earlier, it was mentioned that using inscriptions in collaborative work can free up working memory for other aspects of thinking, since the entities represented in inscriptions do not need to be discussed (Hegarty, 2011; Roth, 2001). When the speakers use gestures in the presence of visual materials, they add another layer of communication which further reduces cognitive load because each mode will assume part of the representation (Roth & Lawless, 2002). In science this has been shown to allow the creation and discussion of more complex concepts (Roth & Welzel, 2001). In this thesis, similarly, the educational designers used gestures in relation to inscriptions to discuss concepts which would otherwise take much more effort to explain in words alone. In Chapter Eleven I described how Julia used the ‘Process’ gesture in relation to the static diagram. She added another layer to the meaning without giving detailed verbal explanations. Further research in this area could include post-design session interviewing in order to assess the influence of inscriptions on memory and the reduction of cognitive load during ED.

Both gestures and inscriptions need to be seen in order to be effective in reducing cognitive load. When language is used as shorthand to refer to different visual resources, gestures need to be sufficiently precise and of course they need to be seen by
the other people involved. In Chapter Fourteen I discussed the way that gestures can orchestrate the use of different visual resources. This orchestration is dependent on the perceptual availability of the visual resources and the gestures to the other participants. When gestures are seen in relation to all the various visual resources, the participants can collaborate more effectively and display their collaboration and understanding by completing each other’s sentences. In addition, some specific gestures are context-dependent. The ‘Process’ and ‘Globe’ gestures would hold little meaning for an audience unfamiliar with how the gestures were instigated, and how they developed during the meeting/s. Such gestures in particular need to be seen because they can encapsulate concepts which can be recalled later. The repetition of these gestures can also indicate the successful accomplishment of common ground understanding in collaborative face-to-face activities. The two cohesive ‘Process’ and ‘Globe’ gestures in this study are examples of abstract concepts that were encapsulated in a gesture form, then recalled during the same meeting or in other meetings after some time had passed.

Although both gestures and inscriptions are important and work in concert to help designers communicate their design ideas, gestures can stand for inscriptions but inscriptions cannot replace the need for some gestures. In Chapter Eleven I discussed how the ‘Globe’ and the ‘Layout’ gestures are examples of when gestures are used as substitutes for visual representations. This finding reflects Stubbs’s (2006) discovery of similar gestures in his study of educational designers. He called these unanticipated gestures “gestured drawings” and “momentary drawing-like place-holders”. This finding indicates that gestures can be used as substitutes for visual representations by educational designers.
In order to account for these findings in recommendations for a tool, environment, or a design space, it may help if we imagine four participants in educational design team meetings using a computer tool collaboratively. They would have to position themselves in such a way that each person is able to view the computer screen directly. In such arrangements it would be difficult to notice most gestures, in particular those that are not prominent. It would be even more difficult to notice more subtle communicative modes such as gaze, which is sometimes used as a way to direct other people’s attention to what a person is looking at, and eye-contact, which is often involved in establishing agreement, or indicating a need for further clarification. An educational design space, with digital and material tools (such as movable computer devices, iPads, laptops; fixed tools such as interactive whiteboards, projectors connected to computers; and material tools such as writable walls, drawing equipment, paper, etc) where the participants in a team meeting can sit around a central hub, are free to move around, and are surrounded with various resources at appropriate distances, can better accommodate the mix of verbal and non-verbal communication.

Resources to facilitate an educational design team meeting need to be made available on different levels of perceptual access. I reached this conclusion after contemplating the design sessions in this study in their entirety, in relation to how the participants used the visual digital and material resources available to them. As the educational designers progressed through their design task, they moved from using one visual resource to the next and often returned to visual resources they had used earlier. For example, at any point in time, one inscription would be in the foreground of their attention, the inscription they were working on and discussing. The designers would
soon direct their attention to another visual resource, such as the interactive whiteboard or a webpage projected on the wall. At this time, the inscription they were working on would move to the background of their attention level, but still remain accessible. Even when the designers paid no direct attention to, or discussed, a visual resource, such as occurred in the Study-B meeting, the resource still needed to be perceptually available to guide the designers towards the previously agreed goals and targets for the project. An educational design space can facilitate the availability of resources at different levels of perceptual access thus providing a better support system for educational designers.

**Limitations and Specific Suggestions**

Some of the limitations of this study, which could be taken into consideration in future research in this area, are:

- The research studies were conducted in the Design Studio, a physical environment which is intended as an evolving prototype workspace. Although observations in the Design Studio can inform the development of future collaborative work, design tools, and spaces - observation in everyday workplaces where design is part of the naturally-occurring project work in teams is also of value. Future research can be undertaken in real-world educational design environments and workplaces to observe drawing and related practices.

- I did not examine the drawing practices of the Study-B team throughout the entire conceptual design phase. Future research would benefit from following
designers through an entire conceptual design process, which may be conducted over several meetings.

Although I provided many suggestions for future research throughout the previous sections, some more detailed suggestions for future research are:

1. In engineering design, early conceptual sketching has a positive impact not only on the quality of the designed solution, but also on the experience of the design process (Schütze et al., 2003); and better design outcomes are associated with higher volumes of sketches produced in the early conceptual phase (Yang, 2009). Future research to understand how drawing can improve the educational design process and whether higher volumes of drawings produced are also associated with better design outcomes in educational design, is needed.

2. Future research in educational design would also benefit from understanding how computer tools have advanced other design domains such as architecture or engineering, and what we can learn from their experiences, particularly to utilise computer tools that can more effectively support the idea generation phase of the design process.

3. Although the focus of this study was on the use of inscriptions in educational design teams, educational design is also practiced as individual activity and is thus worth exploring how inscriptions are used and produced by individual designers to support their design activity.
Summary of Contribution to Knowledge

The contributions to knowledge made by the present research are summarized under three main categories. These include contributions that: (i) make advances on current knowledge in educational design, (ii) confirm existing knowledge in educational design and/or (iii) add to current knowledge in the design field as a whole. I adopted the following approach to classify the contribution to knowledge of this thesis.

1. If a finding in this study does not have comparable results in the extant literature, the finding is classified as an ‘advances in current knowledge’.

2. If there is a similar finding in the literature on educational design, the finding is classified as ‘confirmation of current knowledge’.

3. If there is a similar finding in the literature on design drawings in other domains such as architecture, engineering, product design, or from the literature on inscriptions in science, the finding is classified as an ‘addition to current knowledge’.

Advances in Current Knowledge

I found that educational designers developed inscriptions jointly when two or more people were working on the same inscription at any one time. Educational designers also worked on inscriptions simultaneously when two different designers were creating two different inscriptions at the same time. Other inscriptions were created in incremental phases when a participant returned to further refine an existing inscription. In this study the participants would also often refer to inscriptions that they had created earlier during their discussion.
Another new finding is that educational designers interpreted different visual elements in inscriptions to represent the same idea. This was discovered when I noticed that on three occasions two of the participants from Study-A groups referred to three different visual elements (stick figures, text, and geometric circular shapes) as “these people”.

And finally, one of the new findings from this study is that resources in educational design team meetings need to be available on different levels of perceptual access. To put this simply: educational designers need different resources to be available to them but not all at once. Some resources will be at the foreground of their attention while others will move to the background of their attention level at any one time. They move swiftly between refocusing their attention, so they need quick access to the resources throughout their design session.

**Confirmation of Current Knowledge**

Findings from this research confirm previous findings on educational design, particularly those by Stubbs (2006). Like Stubbs, I found that educational designers created and worked with few types of visual representations, and in all Study-A groups, drawings tended to move through a progression from simple to complex forms. In this thesis, similar to the study by Stubbs, I found that drawings created for presentation are retained and valued while those created for working out initial solutions are discarded. Finally, I found that gestures were used as substitutes for visual representations. While I did not apply a formal label to these gestures, Stubbs called them ‘momentary drawing-like place-holders’.
Chapter Fifteen

Additions to Current Knowledge

A large number of findings from this thesis have similar results in the extant literature reviewed from other design domains such as architecture and engineering, as well as the literature on inscriptions in science. Since these findings are already described throughout this thesis, a list is provided here as a summary:

- Inscriptions serve multiple functions.
- Inscriptions are used to ground the discussion.
- Educational designers draw in order to describe ideas.
- Educational designers create inscriptions in a non-linear format.
- Educational designers use various graphic forms interchangeably.
- In educational design drawing of objects does not need to conform to exact form, shape or details.
- The drawing medium can influence the drawing activity.
- Inscriptions created in a familiar context can become transparent to educational designers.
- Gestures enacted in relation to inscriptions can reduce cognitive load in collaborative educational design work and allow easier discussion of more complex concepts.
- Gestures can encapsulate concepts which can be recalled later.
- Inscriptions and gestures need to be seen to be effective in supporting communication.

Providing support tools, or environments, without a deeper understanding of how educational designers use visual representations would most likely rigidify fluent
processes. Often when tools introduce limitations to the normal practice and communicative modes, the users adapt, however they adapt at a cost. Collaborative educational design is accomplished through complex verbal and non-verbal interaction with various tools, resources, and representations. In particular, the three modes of talk, gestures, and inscriptions could not be separated; they work in concert to develop meaning. Paying close attention to how educational designers create and use drawings and sketches can yield interesting insights into the nature of educational design.

There is still a lot to learn about the relationships between the designers, the tools, the resources, and the space within which designs for learning are created and evaluated. This is the space where ideas are communicated verbally as well as through the use of gestures, posture, gaze, object handling, and of course drawing and sketching. The research reported in this thesis helps advance our understanding of how hybrid design spaces – containing digital and material resources – can be configured to support the fluent communication and collaborative improvement of design ideas.
References


Herold, J., & Stahovich, T. F. (2011). Using speech to identify gesture pen strokes in collaborative, multimodal device descriptions. AI EDAM, 25(Special Issue 03), 237-254. doi: 10.1017/S0890060411000060


Ikeya, N., Luck, R., & Randall, D. (2012). Recovering the emergent logic in a software design exercise. Design Studies, 33(6), 611-629. doi: http://dx.doi.org/10.1016/j.destud.2012.06.004


Martin, D. (2012). The cooperative use of material resources and contextual features in graphic design work. *Design Studies, 33*(6), 589-610. doi: http://dx.doi.org/10.1016/j.destud.2012.06.007


Purcell, A. T., & Gero, J. S. (1998). Drawings and the design process: A review of protocol studies in design and other disciplines and related research in cognitive


Snyder, J. (2012b). *Image-enabled discourse: Investigating the creation of visual information as communicative practice.* School of Information Studies, Syracuse University.


Appendices

Appendix One: Design Studio Map

[Diagram of Design Studio Map showing various sections such as Whiteboard Wall A, Projector A, Main Meeting Table, Storage/Buffet/Tea and coffee, Equipment Storage, and Interactive Whiteboard (IWB).]
Appendix Two: D3 Interface
Appendix Three: Scaffolding Material for Study-A Groups

INTRODUCTION TO THE DESIGN STUDIO

Welcome to the design studio.

While you are in here today, you will be recorded by cameras mounted to the ceiling and your voices will be recorded using these voice recorders. Each of you will have one. Please attach these voice recorders to your clothes. If you need to leave the room, please leave the voice recorder turned on, but detach it and reattach it when you return. Toilets are by the lifts and there is a fire exit in the corner opposite the female toilet and a door out at the end of the corridor. The emergency meeting place is located on the oval behind the building. If you all need to leave the room, please ensure that the door is closed and the room is locked. To get back into the room, please visit 237 and someone will come and unlock. If you have any questions, we can be reached by phoning 16289 on the phone over there. Water is provided. The Interactive Table is not working yet, so please refrain from using it. There are a number of tools in this room.

- The SmartBoard over here is controlled using this keyboard and mouse labeled SmartBoard. It has a two-point-touch system. You can scroll with two fingers and zoom by pinching. SmartBoard pens are here and you can choose a colour, the advanced tools are on this Smart Tools Palette. Smart Notebook software is available down here.

- Two other computers are displayed at the other end of the room. One we call Elephant, the other Frog. Elephant and Frog are controlled using these labeled keyboards and trackpads. If you haven’t used a trackpad before, it clicks like a mouse with a single finger press. A ‘right’ click is a two finger press. Files can be saved either on the Desktop or in the Documents folder. All the computers have been set to record data, therefore, please leave QuickTime Player and Charles running. If any of the computers go to sleep, they can be woken up by pressing their
spacebar. At the end, please leave all the computers turned on. Please use Safari for web browsing.

• Stationery is available on the main table in the middle of the room. These include postits, whiteboard pens, pencils, regular pens, and paper. If you need more supplies, please call us. The phone number is written over there.

• There are two ‘white walls’. These can be used for writing on with whiteboard markers. Two erasers are here. Feel free to rearrange the furniture as you wish.

INTRODUCTION: PARTICIPATION IN THIS PROJECT

Welcome, and thank you for coming today. In a minute (technical support assistants) will explain the tools available for your use in this room. First, we just wanted to give you a brief overview of the study that you are participating in. We have invited three groups of people to participate, each will be given the same task, which is this sheet here, but each group is given a slightly different version of a scaffold that we think will help you through the design process. The idea is that you will spend about 90 minutes producing a design concept for an educational blog about the Murray Darling Basin, as well as a sketch or outline. You will present this to Researcher 2 and I, for 10-15 minutes at the end. Included here (and available online as well) is:

- information for you about the tools in the room
- information for you about the Murray Darling Basin
- the task
- the scaffold for your group (more detailed information about the design process)
- a copy of what I’m saying now
- a consent form and participant information sheet

We will ask you to take a moment to read the participant information sheet provided (this is the same as the one you were emailed) and if you agree to participate in the project, then sign the consent form and return to us. Please note that you are being recorded – video and audio, and we will collect any artefacts that you create, these are listed separately on the consent form for you to agree to.
Do you have any questions?

Thanks again, we will see you at 1:45pm and we will now hand over to (technical support assistants) to talk about the tools in the room.

**TASK FOR ALL PARTICIPANTS**

Imagine that you have been contacted by a person from the Department of Sustainability, Environment, Water, Population and Communities in Australia. You are asked to design an educational blog about the Murray Darling Basin. The aim of the educational blog is to teach the members of the community about issues related to the basin.

In order to complete this task you may access multiple websites as you explore important issues connected to the waterways of the basin, this may include for example, its importance for different communities, ways of educating the public about this topic, or how to best convey the information that you gathered.

The focus of the blog may be to encourage a target group to save water, to address the large number of stakeholder groups, or to make sense of the complex relationships between these.

You will have 90 minutes to discuss the general design problem, and come up with a design brief. You brief should contain the goal, purpose and methods of your design.

**DESIGN BRIEF – (to be completed by the participants):**

Your design brief should consider the goal, purpose and methods for addressing your design problem.

Goal (specify what your blog will be about): An educational blog about….

Purpose (state why it will be about that): because ….

Methods (tell how your blog will address the problem): The blog will include….
SKETCH - Following your design brief your group will have 30 minutes to produce a sketch or an outline of their design solution.

SCAFFOLDING PROVIDED TO GROUP 1 ONLY

Scaffolding Roles in a multidisciplinary design team

Design often involves working in a multidisciplinary team and that means working collaboratively with people from a range of backgrounds and experiences. For the design of this blog the team consists of three members: an adviser on the Murray Darling Basin, an educational designer and a member of the target audience. Here we would like you to assume one of these three roles, and from then on participate in the design of your blog from your assigned perspective.

Please choose whether you will be a:
1) Murray Darling Basin Adviser
2) Educational Designer
3) Member of the Target Audience

When planning your time for this task, remember to factor in time for individual research and planning.

Then open the assigned resource. **Don’t show this to the other members of your team.**

Role 1 – Murray Darling Basin Adviser

You are an environmental specialist. Your role is to learn and become knowledgable about the role of water flows in the river in the rehabilitation of the Murray Darling Basin, as well as the sustainability of agriculture and the communities that are part of the environmental system.

Your task is to ensure that this blog explains scientific data so that the target audience can make sense of the complex relationships between the various components of the ecological system and the varied perspectives of each stakeholder groups that are connected to the Basin. Included below is some background information on the Murray Darling Basin, and further resources you can use to research the issues.

**The Murray Darling Basin**

- The Murray Darling Basin covers 14% of Australia’s land mass. Including over 77,000km of rivers, and more than 25,000 wetlands.
- The three longest rivers in Australia run through the Murray Darling Basin: the Darling, the Murray and the Murrumbidgee Rivers. NSW (56.65%), Victoria (12.32%), Queensland (24.55%), ACT (0.22%) and SA (6.49%) all contain part of the Basin.
- Water storage dams and river regulations provide secure water supplies to cities, towns and industry in the basin. The Basin is home to more than 2 million people, and about 30 Aboriginal nations. The majority of the Basin’s largest dams are located in the Southern Basin.
- The Basin is split into the Northern and Southern Basin. The high profile Cubby Station is located in the Northern Basin on the Condamine/Balonne River system. Water in the northern basin is managed via Government dams, floodplain harvesting diverted to large on farm storages and/or direct river pumping.
- The Southern basin contains Australia’s most valuable food producing areas. Agriculture, and associated processing employs tens of thousands of people. It generates 39% of the national income derived from agricultural production.
- Water in the southern basin is highly regulated. Protection of human supplies and environmental needs are prioritized for Victoria, SA, and NSW before the extraction of water for irrigation. This needs cooperation between Federal and State governments.
- The Basin Plan was introduced in November 2012 by the Murray-Darling Basin Authority. The Plan aims to restore flows to key areas, and to set new limits for existing users.
- The Basin Plan must prioritise the environment over social and economic considerations. It was not developed on a consultative basis with State governments or regional communities. It prioritises ‘end of system’ flows.
- There are six icon sites – mostly listed under the Convention on Wetlands of International Importance (the Ramsar Convention). These are environmental assets that support native fish, iconic vegetation such as river red gums and many species of water-birds.
- The basin has been under stress because of over-allocation, prolonged drought, natural climate variability and climate change.
- Environmental issues include loss of species’, salinity in the Coorong, acid-sulfate soils.

Sources

http://www.abc.net.au/catalyst/murraydarling/
http://www.savethemurray.com/
Role 2 – Educational Designer

You are an educational designer. Your role is to learn about how to design an effective educational blog. This involves learning about the technical aspects, and also about the collaborative design processes leading to an effective educational blog.

Design is about transforming ideas to create an object that aims to have a positive impact for some people, community or group. Design thinking usually involves going through an intentional process in order to come up with innovative ways of addressing a particular problem. There are many different ways of thinking about design. Some designers prefer a design process that is more methodical, scientific and conventional and others may be more prone to embrace feelings, sensations or intuition as part of their processes. There is not one single way that is right or wrong, so you may lean towards being more methodical or more intuitive, or both. Similarly, there is not just one single achievable solution that fully addresses a particular problem; instead, for any design problem there are many different possible creative solutions.

Another important factor to note is that design is not a linear process and one may need to go through a design cycle many times in order to achieve the final design of the object.

You will need to complete two main tasks:
1) to write one or two short paragraphs about your design concept. This paragraph will contain the goal, purpose and methods for the design of your blog.
2) to produce a initial sketch of your blog.

At the end of this session you and your group will be presenting your concept and a sketch of your blog to the researchers in this project.

A Design Process

The D-School in Stanford suggests a design process with the following design phases: Discovery, Interpretation, Ideation, Experimentation and Evolution.

Links to blog applications:
https://www.blogger.com/tour_start - for a tour of Blogger and how to create a blog
http://blogsofnote.blogspot.com.au - search for examples of interesting blogs
https://www.tumblr.com - use the search engine to view some examples of blogs
You are a learner. You can choose to be whatever you want to be: a child, a teenager, an adult learner, an academic, a farmer or just yourself. Whichever identity you assume, your perspective is that of a learner.

Your role is to argue for what YOU would like to learn about the Murray Darling Basin. You know how you learn best, and you need to argue for that.

You might like to write some notes about your learning preferences; this will be your perspective before you start for you to refer back to.

Scaffolding Provided to Group 2 Only

Scaffolding the Design Process

Design is about transforming ideas to create an object that aims to have a positive impact for some people, community or group. Design thinking usually involves going through an intentional process in order to come up with innovative ways of addressing a particular problem. There are many different ways of thinking about design. Some designers prefer a design process that is more methodical, scientific and conventional and others may be more prone to embrace feelings, sensations or intuition as part of their processes. There is not one single way that is right or wrong, so you and your group may lean towards being more methodical or more intuitive, or both. Similarly, there is not just one single achievable solution that fully addresses a particular problem; instead, for any design problem there are many different possible creative solutions.

Another important factor to note is that design is not a linear process and one may need to go through a design cycle many times in order to achieve the final design of the object.

Here, we will guide your group through some of the phases of a design process, as you complete two main tasks:

3) to write one or two short paragraphs about your design concept. This paragraph will contain the goal, purpose and methods for the design of your blog.

4) to produce a initial sketch of your blog.

At the end of this session you and your group will be presenting your concept and a sketch of your blog to the researchers in this project.

A Design Process

The D-School in Stanford suggests a design process with the following design phases: Discovery, Interpretation, Ideation, Experimentation and Evolution.
The design process you will undertake is inspired by the D-School model. The design tasks proposed will guide you through Interpretation (you will complete two sub-tasks - understanding the design problem and coming up with a plan), Ideation (you will develop your design concept) and Experimentation (you will produce a preliminary design for your blog).

**INTERPRETATION**

**Design Process Task 1 – Understanding the Design Problem**

Why is "Understanding the design problem" an important part of the design process?

In this stage of the design process designers consider different aspects and aim to narrow the “design problem”. By exploring ideas of what is involved in a particular design problem, designers start specifying what exactly they will work on, and the characteristics that will be present in the object they are designing.

This phase is about developing ideas of what your design will look like, how it will be made and how it will work. You will do this by considering different aspects of the product (the blog), and by making choices.

**TASK 1**

*Outcome: at the end of the "Understanding the design problem" task you will have produced a list of questions that relate to the design of your blog.

*Time: 30 minutes

What is the “Understanding the design problem” task all about?

There are a number of factors designers take into account when considering an object that they are going to design. As a designer you must consider who will be using your product, how it might be used, what might affect the product, objectives or characteristics of the object that you can change, and what could be affected by these changes.

You have seen the initial brief to design an educational blog about the Murray Darling Basin. This is a very open brief and so you need to narrow down your views in relation to your design of the blog, that is, you need to consider:

1) *Who will be using this blog?* Is this for adults or students? If this is a blog for students, how old would they be?

2) *How is the blog going to be used?* Is this for communicating a single idea or raising awareness about several problems in relation to the basin? Do you envisage
the blog as a school resource? Would you see the blog as contributing to some specific action?

3) What do you see as important in an educational blog? What would your learning outcomes be? Would that mean you ought to include learning tasks?

4) What platform will you use? What are the limitations or advantages of different platforms?

5) How many pages will you use to display your information? Would that be too many, or not enough considering your target age?

6) What visual elements will you consider? What colours, font, pictures would help your learners understand the information?

In this phase of the process we ask you to compose a list with the questions you will pose in relation to your design. Do not answer the questions yet. This will be done at a later stage in the process. At this point we just want you to pose questions related to the design of your blog.

The questions above are some examples of factors that may affect the design of a blog. There is not a right answer to these questions, but by posing them, you are considering aspects of the design problem that will help you to make choices about the purpose of your blog, the reasons for this, and the elements you will add to achieve this purpose.

So open your mind and think about the blog you are designing and the broader goals of your blog. Then, pose questions that would be relevant for its design.

How to do the "Understanding the design problem" task?

Designers must always be aware of standard practices in their field. They need to keep up to date with what is going on and they often do that by reading and researching the topic, and exchanging ideas with their peers. Designers also often need to imagine how people would experience the object they are designing. It is important that designers think about what feelings such an object would evoke. It is also relevant to consider that different people like different things and have different ideas. By talking to others and researching the topic you can be reminded of things you didn’t think of. You might consider some of the strategies below helpful.

1) Ideas to DISCUSS with others:
   Take a few minutes to individually consider your previous experiences with other blogs. You may wish to consider: What might affect the design of the educational blog? What can be changed in the design of a blog? What would your ideal blog look like?

   Talk about the style of blogs you liked and what was good about them. Exchange ideas about what you feel is important when designing a blog? What do you and the other members of your group like the most about other blogs they have come across?

2) Ideas to RESEARCH the topic:
   Research what other designers have considered when designing a blog like yours. Search for tips from other designers about their design or their preferences for different elements. All blogs are unusual in some way and it is important to research and see a few before you decide about the design of yours. Here are some links to examples of blogs:

   https://www.blogger.com/tour_start - for a tour of Blogger and how to create a blog
   http://blogsofnote.blogspot.com.au - to search for examples of interesting blogs
   https://www.tumblr.com - use the search space at the top to view some examples of blogs
   http://aussieblogs.com.au - click on ‘random blog’ on the top left corner to see examples of blogs.

   Search for other blogs in the same or related topic as yours, and for example, look for the different layouts, fonts, colours, content presentation, what they say and how they display their information, etc. Record the elements you like in each blog and why you like a particular element.
There is a lot of information out there about points to consider in the design of a blog. It is important to research what is out there, what other designers of blogs find useful. Here are some links with information about important points to consider in the design of a blog:

http://weblogs.about.com/od/startingablog/u/StartingABlog.htm#s5
http://scalabilityproject.com/options-designing-a-blog-that-is-easy/

Sometimes designers may find interesting to add a picture, image or an audio file as part of their blog design. Here are some links to digital images and audio resources:

http://www.freedigitalphotos.net
http://www.shutterstock.com

**INTERPRETATION**

**Design Process Task 2 – Coming up with a plan**

*Why is “Coming up with a plan” an important part of the design process?*

In "coming up with a plan" designers define the characteristics that are going to be present in the product and describe why they are there.

In this task you will make choices and consider the reasons for your incorporation of these characteristics in your design. These decisions will help you to develop your design concept.

**TASK 2**

*Outcome: at the end of the "Coming up with a plan" task you will have chosen a few items from your list of questions that you want to work with. You will also have provided answers to these questions and organized these questions under three headings.*

*Time: 30 minutes*

*What is the “coming up with a plan” task?*

In this task you will select questions/answers from your list that really matter and consider why is that. You will select the questions you will be working with and think about the answers to these questions. In this way you are "coming up with a plan" for the design of your blog. You are formulating what will be important to consider and why it is important.

In this phase you are also thinking of ways you could actually represent your ideas (and solve the problem) in your design of the educational blog about the Murray Darling Basin. This task will help you to think about:

(a) the goal (i.e. the "what" of your design problem)
(b) the purpose (i.e. the "why" of your design problem)
(c) the methods you will use or how you will represent your ideas (i.e. the "how" of your design problem)

At the end of this task you will need to sort your questions/answers under three main headings "what", "why" and "how". Don’t worry if you have more than one question/answer under each of the headings. At this point, just think about under which heading you would place each of your thoughts or ideas, whether a specific question/answer is related to the goal of your blog, the purpose of your blog or the methods you could use in the design of your blog.

For example: Imagine you are designing a house. Your essential initial questions were:

<table>
<thead>
<tr>
<th>Goal (what)</th>
<th>Purpose (why)</th>
<th>Method (how)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who will be using this house?</td>
<td>Is it a house for everyday living or for holidays?</td>
<td>What materials can be used?</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>When will this house be used?</td>
<td>What are the main activities people will do in this house?</td>
<td></td>
</tr>
</tbody>
</table>

Then you start to choose how you will answer these questions and assign the answers to categories:

<table>
<thead>
<tr>
<th>Goal (what)</th>
<th>Purpose (why)</th>
<th>Method (how)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- to design a holiday beach house for a family of four</td>
<td>- the house will be used by people who are on holidays to spend time together</td>
<td>- to incorporate open spaces where family can get together</td>
</tr>
<tr>
<td>- the house will be well ventilated and show the beautiful ocean views</td>
<td>- the house will be used for leisure and relaxation</td>
<td>- to have glass windows and walls that can be retracted</td>
</tr>
</tbody>
</table>

**How to do the "Coming up with a plan" task?**

This task is about deciding on the characteristics of the blog. Use headings and consider whether each of your items relate to the goal, purpose or method: WHAT, WHY and HOW. You might consider some of these strategies to be helpful:

1) Ideas to **DISCUSS** with others:
   - Examine the list of questions you produced as a result of Task 1 and consider which of your questions are more or less important?
   - Consider your preferences when you are looking for an educational blog, what would you like to see there, and how you would like the blog to convey the information.

2) Ideas to **RESEARCH** the topic:
   - Have a look at the results of your research of other, similar blogs. Consider your preferences for specific layouts, fonts, colours, content presentation, what they say etc.
   - Consider the elements you liked in the blogs and why. Note how information is displayed, how it is communicated, what sort of elements are there, and how they relate to its content.
   - Take notes of the characteristics you find interesting and why they are interesting and how you would use or adapt those ideas to the design of your blog

**IDEATION**

**Design Process Task 3 – Developing the concept**

**Why is “Developing the concept” an important part of the design process?**

"Developing the concept" is about formulating how your design will meet your objectives. Your design concept should ensure that important characteristics are considered
and questioned before the development of your object takes place. As you develop your concept you will need to: 1) have made choices about the characteristics that are going to be present on your design, 2) specify why they are there, and 3) say how you are going to represent them.

Your design concept will express the choices you have made and show your reasons for incorporating certain characteristics in your design. At the end of this task you will have produced one or two paragraphs in which you define the ways you will represent these characteristics in your design. This written piece will be a more elaborated version of the initial brief you were given by the researchers.

TASK 3

**Outcome:** at the end of the "Developing the concept" task you will have written one or two paragraphs about your design concept for the educational blog about the Murray Darling Basin.

**Time:** 30 minutes

**What is the "developing the concept" task?**

To produce one paragraph or two about your design of the blog you should break down concepts, assigning ways you could use these to represent some important aspect in your design. In your brief you will need to address:

(a) the specifications of your design (what are the objectives you selected to work with e.g. use your answers from the Goal, Purpose and/or Method headings, completed in the previous task)

(b) prioritize the objectives (select which objectives need to be worked on first or which ones seem to be the most important ones)

(c) define ways you could represent the objectives (state how you are applying your ideas to meet the objectives)

The objective of this task is to break the concepts down and assign ways of representing each aspect into your design. So in this task you will reflect on your ideas and elaborate further on them, transforming the headings and items you listed in Task 1 and Task 2 into a short passage. At the end of this task you will have written a short paragraph or two about your design concept.

Your paragraph will describe your design specifications, what you are prioritizing and how you will address this in your design.

Start your first sentence with your Specifications (use your objectives – in sentence format of what was under the three headings - Goal/Purpose/Method in the previous task).

Then discuss what you are prioritizing in your design (use the specifications above, and select one or two characteristics, features or factors in your design that you consider as essential in your blog).

Your third point will be about Representation (elaborate what in your design is representing the important characteristics/features/factors you chose in Prioritizing. State how your design will express your objectives and its implications).

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**Our design concept:**

Our group is designing an educational blog about the Murray Darling Basin. The goal of our blog is ____________________________________________________________.
The most important aspect of our blog is that ______________________________. We will address this factor in our design by______________________________.

For example:

An example of a summary of a design concept:

Our group is designing a house, which will be set in a beach location and used by a family of four, with two children under the age of five. The goal of our design is to create a building where the family can enjoy each other’s companies and being together. Our design will focus on open common areas for leisure.

The most important aspect of our design is that family members have opportunities to interact and spend time together. We will address this factor in our design by including a large open lounge area with glass walls so that the family can enjoy the ocean views while interacting with each other.

How to do the “Developing the concept” task?

You may find the following strategies useful:
1) Ideas to DISCUSS with others:
   Make links between the characteristics of the object you are designing and the reasons that these characteristic are there (e.g. a spiral picture of a design process will represent the continuity of the process).
   Brainstorm ideas in which to represent the characteristics you described for your blog.
   To brainstorm ideas, follow these steps:
   a) Record as many ideas as you can, and no matter how crazy they seem.
   b) It is ok to come up with as many ideas as possible, from solidly practical ones to wildly impractical ones.
   Reflect on your brainstormed ideas of ways of representing the goals and purpose of your design. Refine your concept by selecting a few ideas that you want to work with and the ones that you will dispose of.
2) Ideas to RESEARCH the topic:
   Again use the results of your research of other similar blogs. Check that some of your preferences for a specific layout, fonts, colours, content presentation, ways of saying something appear in the blog.
   Use your notes of the characteristics you find interesting and why they are interesting and how you would use or adapt those ideas on the design of your blog, as you consider your goals, purpose and methods.

EXPERIMENTATION

Design Process Task 4 – Producing a preliminary design
TASK 4

Outcome: at the end of the "Producing a preliminary design" task you will have sketched the design of your educational blog about the Murray Darling Basin.

Time: 30 minutes

Using the paragraphs you wrote for your conceptual design, consider ways of representing your concepts in a sketch. Record your ideas with a sketch of your design. Experiment with what will go where, how your ideas will be represented, what elements of your blog can be added or eliminated as they contribute or conflict with your goals.

Find ways of visualizing your design. You may, for example, have different elements represented separately and experiment in arranging the elements at different positions or you may choose to produce more than one sketch in order to experiment with your concepts.

SCAFFOLDING PROVIDED TO GROUP 3 ONLY

Scaffolding the Tools Used in Collaborative Design

Design usually involves working in a collaborative setting. Designers (such as architects, engineers, or fashion designers) will often work in a dedicated design studio, with specialized tools. Here we will help you to make good use of the space and resources available in the Educational Design Research Studio that may help you as your group design your educational blog.

Physical Space

You should arrange the furniture in the room to suit your needs. The way in which the physical space is arranged can be useful for different types of activities. Use the objects and digital tools to access resources that will help you design your blog. Some of the items in the room are fixed (such as the whiteboard walls (white-walls)), and others are movable (such as the chairs).

Movable objects:

Furniture

You can move the sofa, chairs, and tables as you engage in different tasks during your design work. You can move around the room to perform different tasks.

Arranging the sofas and chairs to form a semi-circle may suit a group discussion that has a focus on a tool such as an iPad or draft ideas in notebook paper.
Arranging the sofas and chairs in a straight line may be useful for example if your group is looking and discussing at something that is projected on the wall.

Chairs forming a circle at a table tend to be good for an open discussion between group members.

Fixed tools

The fixed tools include: two whiteboard walls (white-walls), two sections of which can be projected onto from computers, discussed below; and one electronic whiteboard.

You can project computer screens, laptops, or the iPads onto the white-walls. By projecting the screen of your digital device, annotations can be made on the white-wall around it. You can also use the white-wall for brainstorming, planning, or sketching. Everyone can visualize and contribute to the discussion as your group works towards a shared understanding of your design solution.

Projecting the results of research into other blogs onto the white-wall also allows multiple streams of information to be available to all team members during the collaborative design process.

Mobile tools and resources

Computers hidden in the ceiling are connected to wireless keyboards and mouses and two iPads are available. Other resources include post-its, butchers paper, whiteboard markers, pens, blutak, notepads, pens and pencils.

Feel free to use any of these during your design work. You may wish to brainstorm using post-its that you stick to the white-wall. A collaborative sketch on butchers paper could also be blu-take’d to the wall or white-wall. Access to brainstorming or iterations of design work can help a design team to remember the initial design brief.

Digital Space

Searching efficiently for digital resources, and using the digital tools available to you for collaborative writing of a design concept are important in a collaborative design process. Your design should reflect a careful integration of tools fit for the intended design feature.
Software applications for design:

Links to blogs applications:
https://www.blogger.com/tour_start.g - for a tour of Blogger and how to create a blog
http://blogsofnote.blogspot.com.au - search for examples of interesting blogs
https://www.tumblr.com - use the search engine to view some examples of blogs
http://aussieblogs.com.au - click on ‘random blog’ on the top left corner to see examples of blogs.

Links to resources about designing a blog:
http://weblogs.about.com/od/startingablog/u/StartingABlog.htm#s5
http://scalabilityproject.com/options-designing-a-blog-that-is-easy/

Links to digital images and audio resources:
http://www.freedigitalphotos.net
http://www.shutterstock.com

Software applications for collaborative writing:
- Google drive
- Microsoft Word

Links to information about the Murray Darling Basin:
http://www.abc.net.au/catalyst/murraydarling/
http://www.savethemurray.com/
www.muddiedwaters.com
http://www.abc.net.au/rural/murraydarling/
Appendix Four: Study - A Thinking Marks

DARREN’S THINKING MARKS

TASK FOR ALL PARTICIPANTS

Imagine that a person from the Department of Sustainability, Environment, Water, Population and Communities in Australia has contacted you to ask you to design an educational blog about the Murray Darling Basin. The aim of the educational blog is to teach the members of the community about issues related to the Basin.

In order to complete this task you may access multiple websites as you explore important issues connected to the waterways of the basin, this may include for example, its importance for different communities, ways of educating the public about this topic, or how to best convey the information that you gathered. You have been give some information about the Murray Darling Basin to get you started.

The focus of the blog may be to encourage a target group to save water, to address the large number of stakeholder groups, or to make sense of the complex relationships between these. You have been given some information about how to design for learning.

You are in the Educational Design Research Studio (EDRS). You can use all the resources provided in the room. You can use the following usernames for collaboration via google drive (all documentation presented is also available here):

Username and password: user1edrs
Username and password: user2edrs
Username and password: user3edrs

You will have 90 minutes to discuss the general design problem, and come up with a design concept for your blog. You will write one or two paragraphs about your concept, which should contain the goal, purpose and methods of your design.

Preparation - INTRODUCTION (about 15 minutes)

Before you start the design tasks, please use a couple of minutes for a short introduction of yourself to your group. Tell members of your group:

- Your name
- The area that you work and/or study in
- Whether you have ever designed a blog
- Whether you subscribe to any blogs

Read through any notes that you have been given.

Familiarize yourself with the facilities in the room, log into the nominated google account.

Task 1 - DESIGN CONCEPT (about 1 hour)

In your design concept you should consider the goal, purpose and methods for addressing your design problem.

Goal (specify what your blog will be about): An educational blog about...

Purpose (state why this is the goal of the blog): because...

Methods (explain how your blog will address the problem): The blog will include....

Task 2 - SKETCH (about 20 minutes)

After you have produced your design concept your group should produce a sketch or an outline of your design solution.

Task 3 - PRESENTATION (about 10 minutes)

Your group will present and explain your design concept to the Department of Sustainability, Environment, Water, Population and Communities representative who first contacted you (the researchers).
Software applications for collaborative writing:

Google drive

Microsoft Word

- Each person has access to a different user (see task information).
- Each group member could use a different device. Alternatively, each group member could take responsibility for one tool.
- Google drive could be used to annotate existing notes.

A look at sample blogs — what’s in it (list down

- relate to learning
- how to motivate people to visit/join/participate in the blog
What is the “Understanding the design problem” task all about?

There are a number of factors designers take into account when considering an object that they are going to design. As a designer you must consider who will be using your product, how it might be used, what might affect the product, objectives or characteristics of the object that you can change, and what could be affected by these changes.

You have seen the initial brief to design an educational blog about the Murray Darling Basin. This is a very open brief and so you need to narrow down your views in relation to your design of the blog, that is, you need to consider:

1) Who will be using this blog? Is this for adults or students? If this is a blog for students, how old would they be?
2) How is the blog going to be used? Is this for communicating a single idea or raising awareness about several problems in relation to the basin? Do you envisage the blog as a school resource? Would you see the blog as contributing to some specific action?
3) What do you see as important in an educational blog? What would your learning outcomes be? Would that mean you ought to include learning tasks?
4) What platform will you use? What are the limitations or advantages of different platforms?
5) How many pages will you use to display your information? Would that be too many, or not enough considering your target age?
6) What visual elements will you consider? What colours, font, pictures would help your learners understand the information?

In this phase of the process we ask you to compose a list with the questions you will pose in relation to your design. Do not answer the questions yet. This will be done at a later stage in the process. At this point we just want you to pose questions related to the design of your blog.

The questions above are some examples of factors that may affect the design of a blog. There is not a right answer to these questions, but by posing them, you are considering aspects of the design problem that will help you to make choices about the purpose of your blog, the reasons for this, and the elements you will add to achieve this purpose.

So open your mind and think about the blog you are designing and the broader goals of your blog. Then, pose questions that would be relevant for its design.
JUDY’S THINKING MARKS

TASK FOR ALL PARTICIPANTS

Imagine that a person from the Department of Sustainability, Environment, Water, Population and Communities in Australia has contacted you to ask you to design an educational blog about the Murray-Darling Basin. The aim of the educational blog is to teach the members of the community about issues related to the Basin.

In order to complete this task you may access multiple websites as you explore important issues connected to the waterways of the basin, this may include for example, its importance for different communities, ways of educating the public about this topic, or how to best convey the information that you gathered. You have been given some information about the Murray-Darling Basin to get you started.

The focus of the blog may be to encourage a target group to save water, to address the large number of stakeholder groups, or to make sense of the complex relationships between these. You have been given some information about how to design for learning.

You are in the Educational Design Research Studio (EDRS). You can use all the resources provided in the room. You can use the following usernames for collaboration via google drive (all documentation presented is also available here):

Username and password: user1edrs
Username and password: user2edrs
Username and password: user3edrs

You will have 90 minutes to discuss the general design problem, and come up with a design concept for your blog. You will write one or two paragraphs about your concept, which should contain the goal, purpose and methods of your design.

Preparation – INTRODUCTION (about 15 minutes)

Before you start the design tasks, please use a couple of minutes for a short introduction of yourself to your group. Tell members of your group:

- Your name
- The area that you work and/or study in
- Whether you have ever designed a blog
- Whether you subscribe to any blogs

Read through any notes that you have been given.

Familiarize yourself with the facilities in the room, log into the nominated google account.

Task 1 – DESIGN CONCEPT (about 1 hour)

In your design concept, you should consider the goal, purpose and methods for addressing your design problem.

Goal (specify what your blog will be about): An educational blog about...

Purpose (state why this is the goal of the blog): because...

Methods (explain how your blog will address the problem): The blog will include....

Task 2 – SKETCH (about 20 minutes)

After you have produced your design concept your group should produce a sketch or an outline of your design solution.

Task 3 – PRESENTATION (about 10 minutes)

Your group will present and explain your design concept to the Department of Sustainability, Environment, Water, Population and Communities representative who first contacted you (the researchers).
Appendix Five: Copies of Participant Information Sheets and Consent Forms

STUDY-A

EMAIL INVITATION TO PARTICIPANTS

Dear Postgraduate Research Students

We would like to invite you to participate in a study investigating ways of supporting learners in their understanding of complex environmental problems through participation in a collaborative design task. The study would take about two hours of your time. This study is being conducted as part of Peter Goodyear’s Laureate Research Program at CoCo (Centre for Research on Computer Supported Learning and Cognition) in the Faculty of Education and Social Work, University of Sydney. For more information about the project please visit:

http://sydney.edu.au/education_social_work/coco/research/projects/design/

If you would like to hear more about this study and what is required please contact Dr Kate Thompson (kate.thompson@sydney.edu.au) or Dr Lucila Carvalho (Lucila.carvalho@sydney.edu.au), who will discuss further details with you.

Best regards,
PARTICIPANT INFORMATION STATEMENT

(1) What is the study about?
You are invited to participate in a study to further the understanding of how we can support learners to understand complex environmental problems through participation in a design task.

(2) Who is carrying out the study?
The study is being conducted by Peter Goodyear (Professor of Education), Dr Kate Thompson (Postdoctoral Research Associate), Dr Lucila Carvalho (Postdoctoral Research Associate), Dr Beat Schwendimann (Postdoctoral Research Associate), David Ashe (Postgraduate Fellow), Ana Pinto (PhD Student), Dewa Wardak (PhD student) and Dr Nick Kelly (Research Associate) at The University of Sydney

(3) What does the study involve?
You will be asked to participate in a collaborative design task for two hours. During this time you will design an educational blog about the Murray Darling Basin, and produce a prototype and design brief in a group, which you will present to members of the project team. Your design work will take place in the Design Studio, room 221 in the Faculty of Education and Social Work Building, and will be recorded. These recordings will be both audio and video so we can look back and see how you worked with other members of the team. If a computer is used, we may also keep log files and record how you used computer tools. We may keep a record of any writing and drawings that are made to help us understand how you are working as part of the team. As part of this task we may ask you to use a particular design tool, follow a particular process of design, adopt a role within the group, focus on the representations you create, or use the Design Studio in a particular way.

(4) How much time will the study take?
This study will take 2 hours of your time.

(5) Can I withdraw from the study?
Being in this study is completely voluntary - you are not under any obligation to consent and - if you do consent - you can withdraw at any time without affecting your relationship with The University of Sydney.

(6) Will anyone else know the results?
All aspects of the study, including results, will be strictly confidential and only the researchers will have access to information on participants. A report of the study may be submitted for publication or presentation. Video, photo, artefacts, and audio recordings will only be used for presentations or publications with your explicit consent. Versions of the data might be shared with external collaborators.

(7) **Will the study benefit me?**

There are no direct benefits to you.

(8) **Can I tell other people about the study?**

Yes

(9) **What if I require further information about the study or my involvement in it?**

When you have read this information, Dr Kate Thompson and/or Dr Lucila Carvalho are available to discuss it with you further and answer any questions you may have. If you would like to know more at any stage, please feel free to contact Dr Kate Thompson (Postdoctoral Research Associate) kate.thompson@sydney.edu.au and Dr Lucila Carvalho (Postdoctoral Research Associate) lucila.carvalho@sydney.edu.au

(10) **What if I have a complaint or any concerns?**

Any person with concerns or complaints about the conduct of a research study can contact The Manager, Human Ethics Administration, University of Sydney on +61 2 8627 8176 (Telephone); +61 2 8627 8177 (Facsimile) or ro.humanethics@sydney.edu.au (Email).

*This information sheet is for you to keep*
PARTICIPANT CONSENT FORM

I, ........................................................................................................................[PRINT NAME], give consent to my participation in the research project

TITLE: Scaffolds for learning by design

In giving my consent I acknowledge that:

1. The procedures required for the project and the time involved have been explained to me, and any questions I have about the project have been answered to my satisfaction.

2. I have read the Participant Information Statement and have been given the opportunity to discuss the information and my involvement in the project with the researcher/s.

3. I understand that being in this study is completely voluntary – I am not under any obligation to consent.

4. I understand that my involvement is strictly confidential. I understand that any research data gathered from the results of the study may be published however no information about me will be used in any way that is identifiable.

5. I understand that I can withdraw from the study at any time, without affecting my relationship with the researcher/s or the University of Sydney now or in the future.

6. I understand that the observations can be stopped at any time if I do not wish them to continue, the audio and video recording will be erased and the information provided will not be included in the study.

7. I consent to:

   • Audio-recording   YES□ NO□
   • Video-recording   YES□ NO□
   • Receiving Feedback YES□ NO□
   • Researcher’s use of artefacts I produce YES□ NO□
If you answered YES to the “Receiving Feedback” question, please provide your details i.e. mailing address, email address.

**Feedback Option**

Email: ____________________________________________

Signature ...................................................

Please PRINT name............................................

Date.................................................................
PARTICIPANT INFORMATION STATEMENT

Title: Studies of design for learning: Self-directed studies

(1) What is the study about?
You are invited to participate in a study of collaborative design for learning. This project aims to gain a deeper understanding of the processes of collaborative design for learning involving a mix of people, tools and tasks.

(2) Who is carrying out the study?
The study is being conducted by Professor Peter Goodyear, his postdoctoral researchers Beat Schwendimann, Kate Thompson, Lucila Carvalho, and his doctoral students David Ashe, Martin Parisio, Pippa Yeoman, Ana Pinto, Paul Parker, and Dewa Wardak.

(3) What does the study involve?
You will be invited to conduct part of your usual design work, as part of a multidisciplinary team, in the Educational Design Research Studio (EDRS), room 221, Building A35, at the University of Sydney. You will be asked to complete a questionnaire asking you about your experience with collaborative design projects. You will then begin your design work. The EDRS is equipped with video, photo, and audio recording devices, and so aspects of your collaboration such as your speech, gestures, use of the tools provided will be recorded. In addition, any artefacts that you produce (e.g. sketches, etc), will be either collected, or if you would prefer, a copy made. After the activity in the EDRS, we will conduct a debriefing interview for about 20-60 minutes to ask you about your experience. If your project continues over several days, we may ask you to take part in additional interviews. The debriefing interviews may be conducted with the group or with you individually. In either case, the questions will be the same. Interviews will take place at the University of Sydney in the EDRS.

(4) How much time will the study take?
The questionnaire will approximately 10-20 minutes. The design activity will vary in length depending on the project. The post-task interview will approximately take 20-40 minutes.

(5) Can I withdraw from the study?
Being in this study is completely voluntary - you are not under any obligation to consent and - if you do consent - you can withdraw at any time without affecting your relationship with The University of Sydney. You may withdraw from the project at any time if you do not wish to continue, the recordings will be erased and the information provided will not be included in the study.

If you take part in a group activity and wish to withdraw, as this is a group activity it will not be possible to exclude individual data once the session has commenced. Participants will only be allowed to use the EDRS if all members agree to participate in the study. If full agreement is not achieved, we will direct groups to alternative spaces in the university.

(6) Will anyone else know the results?
All aspects of the study, including results, will be strictly confidential and only the researchers will have access to information on participants. The data will be securely stored and archived in filing cabinets to which only researchers have access. A report of the study may be submitted for publication or presentation. Video, photo, artefacts, and audio recordings will only be used for presentations or publications with your explicit consent. Versions of the data might be shared with external collaborators.

(7) Will the study benefit me?
You may benefit from having an opportunity to reflect on issues associated with your educational design processes, collaborations and interactions with others within these environments.

(8) Can I tell other people about the study?
Yes

(9) What if I require further information about the study or my involvement in it?
When you have read this information, Beat Schwendimann or other members of the research team will discuss it with you further and answer any questions you may
have. If you would like to know more at any stage, please feel free to contact Beat Schwendimann, Postdoctoral Research Associate, University of Sydney, beat.schwendimann@sydney.edu.au, or Peter Goodyear, Professor of Education & Australian Laureate Fellow, University of Sydney, peter.goodyear@sydney.edu.au

(10) **What if I have a complaint or any concerns?**

Any person with concerns or complaints about the conduct of a research study can contact The Manager, Human Ethics Administration, University of Sydney on +61 2 8627 8176 (Telephone); +61 2 8627 8177 (Facsimile) or ro.humanethics@sydney.edu.au (Email).

*This information sheet is for you to keep*
PARTICIPANT CONSENT FORM

I, ..........................................................[PRINT NAME], give consent to my participation in the research project

TITLE: Studies of design for learning

In giving my consent I acknowledge that:

1. The procedures required for the project and the time involved have been explained to me, and any questions I have about the project have been answered to my satisfaction.

2. I have read the Participant Information Statement and have been given the opportunity to discuss the information and my involvement in the project with the researcher/s.

3. I understand that being in this study is completely voluntary – I am not under any obligation to consent.

4. I understand that my involvement is strictly confidential. I understand that any research data gathered from the results of the study may be published. I understand that any research data gathered from this study may be shared with external collaborators.

5. I understand that I can withdraw from the study at any time, without affecting my relationship with the researcher(s) or the University of Sydney now or in the future.

6. I understand that I can stop the interview at any time if I do not wish to continue, the audio and video recording will be erased and the information provided will not be included in the study.

I consent to:

• Audio-recording    YES □ NO □
• Photo-recording    YES □ NO □
• Video-recording    YES □ NO □
• Collection of any artefacts created YES □ NO □
• Use of audio, photo, artefacts, and/or video in presentations and/or publications YES □ NO □
• Receiving Feedback YES □ NO □

If you answered YES to the “Receiving Feedback” question, please provide your details i.e. mailing address, email address.
Feedback Option

Email: _______________________________________________________

Signature.................................................................

Please PRINT name............................................................

Date.................................................................................