Transference of Dance Knowledge through Interface Design

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Abstract

This thesis is concerned with the careful arrangement and organization of technical content. I argue that subject matter in the context of observation or ideation acts in concert with the abilities of the designer and available materials to shape the form of a product with its functional purpose and relevance. To assist the inquiry into the treatment of form and matter, a poetic strategy has been adopted which includes elements of dialectic, rhetoric, and grammar to better understand the requirements of design and to formulate a solution. Within this framework, a prototype application, "LabanAssist," has been designed to provide dancers, choreographers, artistic directors, choreologists, students, and educators with a tool designed to enhance dance literacy through greater provision and accessibility of the dance notation system "Labanotation."

The ephemeral nature of dance and the absence of a widely acknowledged system to provide an objective record of dance movement have contributed to the scarce historical references to dance material (Calvert, Coyle, and Maranan, 2002). An increasing awareness of the drivers surrounding the preservation of movement highlights the necessity to effectively preserve dance works that risk being contaminated or lost (Wang, 2004).

The integration of technology into the arts motivated the development of complex computer applications that supply artists with a greater means of creative expression (Assey, 2005). Movement can be effectively documented by the use of dance notation. Languages such as Labanotation provide a precise system of recording movement; analogous to the techniques musicians employ to notate music (Calvert et al., 2002). Current literature emphasises that existing dance notation applications are not equipped to detect or prevent errors made during the composition of Labanotation scores. These dance notation applications require an expert knowledge of Labanotation to operate effectively (T. Calvert, I. Fox, R. Ryman, and L. Wilke, 2005), fuelling the risk of further contamination as dance knowledge is transferred to a digital environment.

This research proceeds on the basis that the integration of an operational structure for the documentation of movement within the prototype application LabanAssist can ensure that the correct syntax of dance notation is established. Coupled with the visual

interpretation of notated movement in an immediate environment, LabanAssist functions as a diagnostic tool in which novice users of Labanotation may evaluate their notation and more easily interpret errors in their notation. LabanAssist has been tested in the dance community to assess levels of user response, understanding, accessibility, and capability.

Acknowledgements

I am deeply thankful to Dr. Deirdre Barron, my principal research supervisor at Swinburne University of Technology (SUT), for her untiring support, encouragement, and contact throughout the various locations in which this thesis was developed. By acknowledging my abilities and passion for my area of research, Dr. Barron has given me the freedom to explore the full potential of this research. This in turn allowed me to move far beyond my own expectations, and to achieve my research aspirations; many that I would not have thought possible. I also would like to thank Dr. Margaret Zeegers and Ms. Anita Kocsis for supporting this research.

Fundamental to the design of the LabanAssist prototype has been the participation of Labanotation experts and students at Ohio State University's (OSU) Dance Department. In particular, I would like to thank Associate Professor Sheila Marion (my research supervisor while at OSU), Professor Emerita Lucy Venable, Professor Emerita Odette Blum, Professor John Giffin, and Mr. David Ralley (programmer of "LabanWriter") for their invaluable support, expertise, and contribution to the development of this research, which was made possible by a 2006 Fulbright Postgraduate Award in Visual Performing Arts, sponsored by Anthony Joseph Pratt; and I would like to express my thanks to the Australian American Fulbright Commission.

The knowledge and exposure to design literature, philosophy, and the work of noble laureates that have come to influence my thinking about design draws on Professor Richard Buchanan's lectures at Carnegie Mellon University's (CMU) School of Design. For the final year in writing this thesis, I had the pleasure of accepting an invitation from Professor Dan Boyarski, head of CMU's School of Design, to participate in design lectures at the school as a visiting research scholar under a Fulbright Academic Training Agreement. The impact of this year has played a significant part in shaping the experience, which has led to the completion of this thesis.

Furthermore, I would like to thank both Dr. Paul Pangaro and Dr. Ranulph Glanville for their invaluable comments and expert advice in reference to my work and subsequent publication regarding cybernetics and design.

Finally, it is with my greatest admiration that I thank Ms. Dianne Summons (aka “the moots”), who has been an inspiration throughout the thesis writing and prototype development phases; particularly for her ongoing support in everything I do; for the constant revisions of my work; and for being such a wonderful motivator from start to finish.

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Declarations

I certify that the thesis entitled "Transference of Dance Knowledge through Interface Design," submitted for the degree of Doctor of Philosophy, is the result of my own research, except where otherwise acknowledged; and that this thesis in whole or in part has not been accepted for an award, including a higher degree, by any other university or institution. Furthermore, I acknowledge that this thesis has been professionally edited. This has been done on the provision that only the style and/or grammar of the examinable outcome, and not its substantive content, have been addressed to maintain the consistency of the work.

Full Name: Natalie Erika Ebenreuter

Signed Natalie Ebenreuter Date 11th December 2008

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Introduction

An Interactive Dance of Communication

From an early age, I have been actively involved in visual and performing arts. My first career as a classical ballet dancer enabled me to dance internationally with companies in Australia, New Zealand, and Germany. Upon my return to Australia, a career change turned my focus to design. My research developed out of a combination of my experience as a dancer and a desire, through my newfound knowledge, to develop a tool that would offer the dance community the potential to preserve and foster its cultural heritage.

It was during the final year of my undergraduate degree in design that I was fortunate enough to stumble across an old series of interviews on computers in the arts. One interview in particular featured the work of Eddie Dombrower (KCSM-TV, 1989) in which he gave a working demonstration of a computer application capable of representing movement by an animated human figure. This required a programmer to specify each individual frame of movement in order to create a sequence of movements. In this interview, Dombrower refers to the method of recording the language of dance on paper as being too cumbersome to view. Therefore, he designed a system to visually replicate the information of dance movement on a screen. This method of representing movement is analogous to the way movement is visually communicated and then learned through imitation during dance rehearsals. Such an exchange of dance information can be from a choreographer, a notator, or from one dancer to another. The computer system Dombrower designed back in the late 1980s offered choreographers a powerful tool with which to create movement, and was considered an animation tool. On reflection, it was apparent to me that this manner of representation was without reference to its written form. Such limitation meant that it did not offer a means to develop the language of dance, its literacy, or scholarship. I wanted to find a way to integrate the missing elements that Dombrower referred to as being too cumbersome.

For those with an understanding of established notation systems, the documentation of dance enables the critical analysis of movement concepts to be communicated. It also allows for the interpretation of movement to be verbalised, and enables intellectual

discussion to develop in the discipline of dance (as I will discuss further in Chapter Two). From my past experience as a student at the Australian Ballet School, I am well aware of the attitude and general resistance towards learning to read, write, and interpret dance notation systems. For the most part, this was because of the necessary complexity of a notation system to capture a detailed account of movement, which adds to the time-consuming tasks of using such systems. Yet, at the same time, I also had experienced the pleasure of learning to decode a notation score; to embody, experience, and perform great classical works such as *Giselle* and *Cinderella* from my interpretation of the score. There is a sense of elegance and simplicity about a language that captures an infinite variety of cultural works; especially one in which such diversity can be expressed through the visual representation of movement. This is achieved in a manner that facilitates the ephemeral transformation and expression of creative thought and movement as tangible records, and by this means exemplifies a rich source of cultural heritage. I use the word "rich" in the sense that participating in its reading, understanding, interpretation, and performance contributes to the use and enjoyment of its art in a wider social and cultural context.

When I compared the experience of interpreting movement from a score against the experience of learning choreography by imitating another performer's interpretation of the same movement, I came to appreciate the necessity and value of enhancing dance literacy. At its core, the process of creating and interpreting dance notation scores enables a choreographer's intent of movement to be expressed (Hutchinson Guest, 1984). This is separate from a record of movement that captures the physical and stylistic capability of another dancer's performance; most commonly found in video and motion-capture data. For this reason, the symbolic notation of movement, as it is expressed in dance notation scores, provides its reader or interpreter, and ultimately its performer, with a greater sense of artistic interpretation in the recreation and performance of movement. Yet surprisingly enough, most dancers are unable to make use of the information contained within dance notation scores without the assistance of a professional notator or the use of computer support tools that facilitate its translation (R. J. Neagle, Ng, and Ruddle, 2004).

It has long been understood that literacy contributes to the development of modern society and civilisation. As such, members of the dance community have the resources

to develop dance scholarship and to create, share, and communicate dance knowledge through the use of dance notation scores. Hutchinson Guest (1984), a leading world expert on dance notation looks to the role of music notation in the cultural development of Western music as a promising indication of the potential for the development of dance literacy. Selma Jeanne Cohen, an instrumental figure in the development of dance criticism and scholarship, looks at the practical application of dance literacy in the wider community:

> Scholarship, however, is not just for the library shelf, but for use—by the scholar, by the critic, and by the young person just developing an interest in dance (G D, 1995, p. 150).

This suggests that greater accessibility to the practical use of dance notation scores is vital to the preservation and cultural heritage of dance. I have taken the position that this information should encompass both established and new dance works for widespread use by the general public. However, much work needs to be done to foster the development of dance literacy at a fundamental level.

With the advantages of a further sixteen years of development in computer technology in the arts that was unavailable to Dombrower in the late 1980s, I set out to research the design of a system to facilitate the documentation and interpretation of dance knowledge. I quickly discovered, however, that previous and existing attempts to do this via the translation of dance notation to animation brought with it a new set of technical difficulties that, to date, impede its technical development. As a response to these difficulties, I wrote an article suggesting that the combination of Labanotation and animation were proficient and accessible uses of technology to record, edit, and visualise a wide range of human movement (Ebenreuter, 2005). I suggested that the design of an interface could further support the visual representation and interpretation of this information (as outlined in Chapter Three). I argued that not only would this enhance the usability and usefulness of these systems from a cultural perspective and assist members of the dance community, but it also has the potential to provide a structure that could be leveraged to assist modern developments in the computational translation of Labanotation. Because of the broad use of Labanotation in the United States and the Dance Notation Bureau’s sixty-six-year history in maintaining and

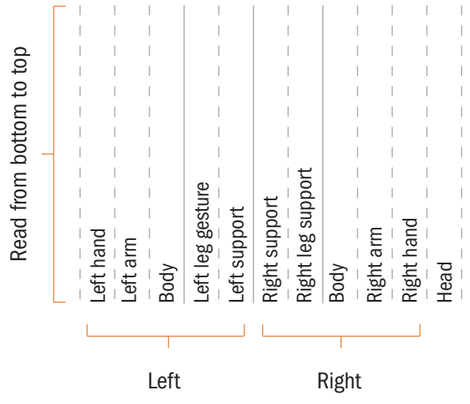
disseminating Labanotation scores, I applied for a Fulbright Award in visual and performing arts to work with leading world experts in Labanotation at the Dance Notation Bureau Extension for Education and Research located at Ohio State University.

After nearly eight years outside the theatre and the dance world, I suddenly found myself in foreign, yet familiar territory. The shift from dancer to designer, and a return to the former, provided me with a unique opportunity to combine the knowledge of these disciplines in a new environment. In September 2006, I spent six months learning the practise of Labanotation in the studios of the Ohio State University's Dance Department together with dancers, like myself, who were new to the language, and with the assistance of experts in the field.

Rudolph Laban, the creator of Labanotation in the early twentieth century, was a teacher and a shaper of attitudes towards dance and movement. He believed that through actively experiencing movement, a better understanding of theatre dance could develop among the wider community (Wilk, 2006). Laban (in Wilk, 2006) regarded dance as a social and communal activity, and was a pioneer in the early development of dance education. In 1928, he published his system of notating movement, called "Labanotation," which was the result of his studies in architecture, the moving body, and space (Wilk, 2006).

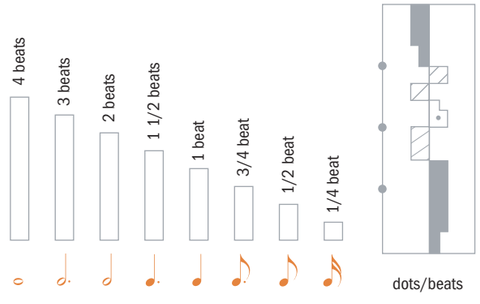
Today, members of the dance community use Labanotation to describe a wide range of human movement (see Figure 1. Laban Primer). It provides a system of recording movement that is similar to the techniques musicians use to notate music. Labanotation is a symbolic language designed to record the nuances and intricacies of all forms of human movement. As you might imagine, the range of human movement is vast. With this in mind, Labanotation offers an extensive symbolic vocabulary to describe a wide variety of human movement.

In comparison to the English language alphabet, which consists of twenty-six letters, Labanotation is a complex language made up of more than seven hundred symbols. The process of describing or notating movement involves the careful composition of these symbols on a score. This is where an understanding of the staff and specific columns of



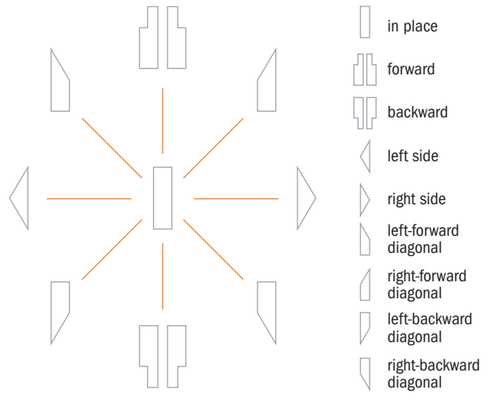
The Staff

The Labanotation Staff is made up of three vertical lines, that is read from bottom to top. The center line of the staff represents the center of the body that is divided in to the left and right sides. The diagram above indicates which coloum each body part is assigned to.



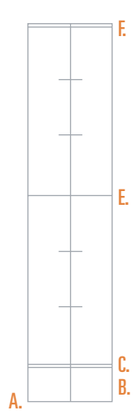
Time

The length of a symbol indicates how long a movement lasts and can be seen in the diagram above indicated by the length of a musical note. Simple beats marked by dots on one of the three lines of the staff can also be used as a musical aid to indicate rhythm.



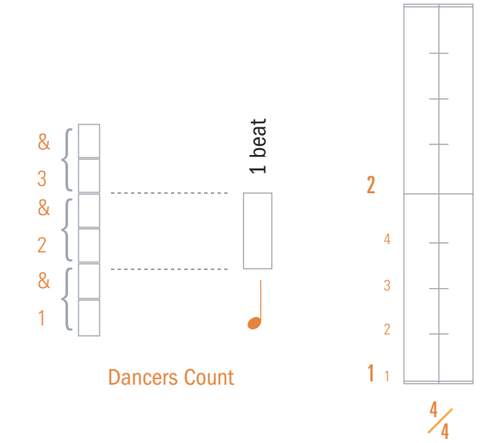
Direction Symbols

Direction symbols are made up of three basic shapes. The first indicates forward and backward directions, the second sideways direction and the third diagonal direction. A rectangle is used to indicate no direction when a movement is in place.



The Score

A. & F. A single line begins and ends a movement sequence. **B.** Indicates the starting position. **C.** The start of a movement is marked with a double bar. **E.** The marking of bars along the staff are relative to the length of the symbols to indicate a set time structure.



Indicating Time

The method of using a "dancers count" becomes apparent when the length of a beat and a Laban symbol can be subdivided and visually indicated. Large numbers indicate each bar and small numbers represent counts or beats that are also marked on the center line by a short stroke.

Level of Movement

The level of movement is indicated by the shading of the symbol. These levels can be upward, downward or horizintal movements in any direction.

Reference: Knust, A., "Dictionary of Kinetography Laban (Labanotation)", Macdonald and Evans LTD, Plymouth, UK, 1979.

Figure 1. Labanotation Primer

Laban scores are crucial to its description. While Labanotation is effective in supplying the dance community with a powerful language to describe movement, the visual representation of its symbolic language is difficult to interpret. Labanotation poses a problem for novice users of the system, because the notation itself does not transparently represent the movement it describes.

Through the experience of learning Labanotation from an introductory to an intermediate level, I soon discovered through trial and error the difficulties students encounter in gaining an understanding of the language. At OSU, students learn to read, write, and interpret Labanotation in two, distinct ways. At first, they learn to read and interpret its symbolic language, in a dance studio, by physically embodying and performing the movement they read from Labanotation scores. Once a basis for this understanding has developed, students learn to notate scores of movement in a computer lab with the use of a dance notation editor called “LabanWriter” (Ohio State Department of Dance, 2008).

Dance notation editors are very similar to text editors such as “Microsoft Word.” They make the creation and preservation of digital artifacts possible. However, instead of using the letters of the alphabet to write words, sentences, and paragraphs; dance notation editors use symbols to construct beats, bars, and scores of movement. LabanWriter is a dance notation application, created as a result of the foresight of Lucy Venable (I. Fox, Marion, and Venable, 2004; Venable, 1999), who saw a need to enable Labanotation scores to be created, copied, edited, and saved on a computer. As the former head of the Dance Notation Bureau and both founder and Director of the Extension for Education and Research, Venable’s extraordinary commitment to dance literacy continues today in the ongoing development of LabanWriter with programmer David Ralley at OSU.

Eager to learn at a time when Labanotation was very new to me, I downloaded the freely available program LabanWriter from the Web, and began exploring the functionality of the system. In my explorations, I came to realise that the system was designed for expert use, and relied on a proficient knowledge of Labanotation to use it effectively. While I found the accessibility of the product to be encouraging, the system functioned more as drawing tool, which permitted the random placement of symbols on

a score. In order to describe and document movement, I was required to identify and select individual symbols from a wide range of unfamiliar libraries. Furthermore, the system's interface provided me with little clue as to what course of action I could take or how I should proceed in a given context.

As a novice and interested learner of Labanotation, the application LabanWriter offered me little assistance in the correct composition of Labanotation scores or the identification of Laban symbols. From this perspective, the experience left me with a deep concern for the practise and ease of use of Labanotation. The experience also emphasised the significance of the implications surrounding the accurate preservation of dance records created in a digital environment, because even the foremost expert in Labanotation is subject to human error. In the eyes of a designer and novice user of Labanotation, this highlighted the potential for developing a notation application that facilitates the correct grammatical composition of Labanotation, and assists the identification of Laban symbols and scores for those with little knowledge of the language. To a certain extent, the development of the "LabanDancer" project (Tom Calvert, Ilene Fox, Rhonda Ryman, and Lars Wilke, 2005a), designed to translate Labanotation scores to computer-generated animation, assists the visual interpretation of Laban symbols and scores. This translation is clearly illustrated when a Labanotation score is placed in close proximity to the movement it represents for comparison. Yet, LabanDancer (Tom Calvert et al., 2005b) makes use of existing notation scores, and does not enable the creation, manipulation, and interpretation of scores within a single application.

As an alternative to existing dance notation applications, I set out to design a prototype application for novice users of Labanotation, called "LabanAssist" (see Appendix A1: LabanAssist). More important, this was in collaboration with Labanotation professors, who are experts in their field; and students learning Labanotation, who represent the potential users of this system. By involving members of the dance community in the development of this research, I have been able to create an application that has complemented and built upon the existing suite of Labanotation tools created at the OSU. LabanAssist makes use of broad terms of movement descriptions common to members of the dance community and those who deal with movement in general to facilitate the documentation of Labanotation scores. It supplies users with a visual

representation of the movement selections they make by associating a Laban symbol and a corresponding human figure illustration to the movement they specify. By integrating a structured process to the composition of Labanotation that provides user feedback and preventative measures during the selection of movement descriptions, the correct syntax of a score is maintained. This is achieved through a function of the system which positions Laban symbols on a score, once a basic description of movement has been specified. Coupled with the visual interpretation of notated movement in an immediate environment, LabanAssist proposes to function as a diagnostic tool in which novice users of Labanotation may evaluate their notation and more easily identify errors in their scores.

A fundamental aspect of design is the act of bringing differences together to create a product or service that enhances the human experience. This is achieved through the creation of a framework or plan for productive outcomes that facilitates a particular goal or need. In effect, design can be understood as a strategic instrument used to augment communication and the exchange of diverse ideas in a global society (Liedtka, 2004). As we communicate on a daily basis through various modes of interaction; be it verbal or nonverbal; we are creating, designing, choreographing, and reshaping elements of our public and personal lives (Glanville, 1988). To a certain extent, we are all designers (Simon, 1996). Whether it is in the conception and generation of ideas; the exploration of unknown possibilities; the consideration of potential alternatives; or negotiating differences to reach a desirable outcome; we have a basic understanding of the components that make up design (Petroski, 2003).

In a similar way that a choreographer forms an understanding of the physical capabilities of a dancer (or muse); and uses them to his or her advantage in consideration of its appeal to a prospective audience; a designer seeks to understand a user's needs and requirements to create and design products or services that are useful, usable, and desirable (Buchanan, 2001b; Sanders, 1992, 2006). In recognition of such needs, designers create specific criteria to direct the focus of a design purpose or goal; while choreographers may be guided by the cultural sensitivity, emotion, or structure of music as a framework for the development of dance. The composition of movement differs from the process of choreographing movement in that, once a sequence of movement has been established conceptually, its documentation, if described using a

dance notation system, must follow specific rules and conventions to capture the intent of a choreographer's work.

It is in the description of movement that specific and general aspects of style and motion are communicated. Once documented, the symbolic representation of movement can be read and interpreted in parts as distinct components of movement or in its entirety, as a broad description of movement. The combinations of compatible elements of movement as distinct parts and as a unified whole are continually examined for their ability to work in concert or conflict with one another. The iterative examination of the relationship between the parts of a design situation and a unifying whole echo the balancing act a designer performs in understanding, negotiating, and determining the requirements necessary to meet a distinct design objective. I see this process as an interactive dance of communication that, when successful, reflects the cultural foundation of a community and assists the development of an appropriate solution to a particular need.

In the course of interaction, designers deal with various levels of bias and ambiguity in the exchange of ideas and information. Design is one such discipline that serves to enrich cultural life and its heritage. While perhaps this is not a generally accepted view, Margolin (1995, p. 354) argues: "Design in a deeper sense is a service. It generates the products that we require to live our lives." In dealing with the complexities of society, Nelson (1957) sees the role of a designer as a provider of service that can be rendered at a variety of levels, and is crucial to the type and quality of products produced. Rittel (in Cross, 1984, p. 305) refers to the provision of a designer as: "That of a midwife or teacher rather than the role of one who plans for others." This is achieved through the reexamination and negotiation of practise and purpose; by looking at how designers do things and developing a rationale for the grounds upon which new courses of action are taken. This requires collaboration, learning, and mutual understanding between various stakeholders in the design process. This is important because in the act of designing, there is a distinct possibility to induce cooperation between members of a community, and to facilitate change through effective modes of communication. In doing so, design becomes a powerful approach to shaping cultural practises that encourage and motivate people to take action. This thesis and the design of the prototype LabanAssist are examples of the application of design to a problematic situation.

LabanAssist is the culmination of nine months of working in close association with Shelia Marion, who graciously agreed to supervise this research. Sheila is an Associate Professor and Director of the Dance Notation Bureau Extension for Education and Research at OSU's Department of Dance. Her involvement in this research has been instrumental in the pedagogical development of this prototype. She also is the creator of the online Labanotation tutorial site, "LabanLab" (Sheila Marion, 2001b), which is an educational resource within LabanAssist. By enabling novice users of Labanotation to progressively master the creation of Labanotation scores with the utility of LabanAssist, it is envisaged that LabanWriter may ultimately facilitate the expert use of the language. My aim in designing the interface for LabanAssist is to facilitate a creative approach to an otherwise technical procedure of notating movement. By emphasising the visual relationships between words, images, and symbols; it is envisaged that learners of Labanotation may interpret the movement it signifies. Moreover, as a means to reduce the ambiguity surrounding the meaning of specific Laban symbols, and enhancing the creative composition of scores, students may take a hands-on approach to notating movement and, in doing so, subtly learn the conventions of the language. The experience of actively engaging in the process of documenting movement through the utility of LabanAssist works to establish a basic understanding of Labanotation for dancers undertaking additional instruction in an introductory Labanotation course.

The effect of creating a prototype application that offers members of the dance community a valuable tool in relation to facilitating the art of composing Labanotation scores as grammatically precise and significant long-lasting cultural records and their interpretation was made clear to me during a presentation of LabanAssist. On its formal presentation to the staff and students at OSU, there was a sudden gasp of excitement from students in the auditorium as I demonstrated the facility of the tool. While such a reaction was unexpected, an element of surprise can be attributed to the emotional impact of a work that is simultaneously believable, necessary, and yet unanticipated. Aristotle (2005, p. 29) captures the notion of the art of design when he tells us:

> Tragedy is an imitation not only of a complete action, but of events inspiring fear or pity. Such an effect is best produced when the events come on us by surprise; and the effect is heightened when, at the same time, they follow as cause and effect. The tragic

> wonder will then be greater than if they happened of themselves or by accident; for even coincidences are most striking when they have an air of design.

Summary of Thesis

This thesis is presented in five parts. The chapters in Part I focus on the purpose for design in the context of this research and establish a foundation for the creation of the prototype application LabanAssist. Part I is comprised of two chapters. Chapter One locates this research project in the field of design as a vehicle for cultural expression. Chapter Two establishes the basis for which the communication of symbolic information can be understood. I discuss the premise of this thesis, and provide an explanation of how the inquiry is organised. I propose a principle for design that is explored further in application to the research project LabanAssist.

The chapters in Part II focus on research for design. Part II consists of two chapters. In Chapter Three, I concentrate on the nature of movement and discuss how it can be perceived, interpreted, and described. I examine the strengths and weakness of three leading movement notation systems in order to determine how the description, documentation, and interpretation of movement are considered in this thesis. In Chapter Four, I address the types of technology used to record, edit, interpret, and visualise movement. I give focus to the strengths and limitations of modern technologies to capture an appropriate account of movement for its preservation and reconstruction.

The chapters in Part III focus on research about design. Part III is comprised of two chapters. In Chapter Five, I address the complexities and pluralism in design with regard to its practices and theoretical foundations. I provide an overview of design methods, with a specific focus on the treatment of analysis and synthesis in the design process. I do this in order illustrate how design processes can take shape and determine a method of approach for the development of the research project LabanAssist. In Chapter Six, I focus on a strategy for design that simultaneously captures knowledge from the arts and sciences in the realisation of design products. I offer a strategy for design that guides discovery, invention, and production that also leverages practical and theoretical knowledge.

The chapters in Part IV focus on research through design. They provide a working example of the application of design to the prototype application LabanAssist. Part IV consists of two chapters. Chapter Seven concentrates on the early conceptual development and functional requirements of the design situation for LabanAssist. It also concerns the communication and visual modelling of participatory design practices that seek to enhance mutual design decisions and capture diverse user interactions in task analysis schematics. Chapter Eight illustrates the problems of composing movement as Labanotation scores for novice users of the language. Drawing on my knowledge of these problems, I develop a rationale for the definition of system requirements that better address their needs. I also discuss how knowledge captured in the formative stages of design research can be incorporated in the design of a product and an interface that communicates its utility to a specific community of users.

The chapters in Part V focus on the outcomes of design research. Part V is comprised of two chapters. In Chapter Nine, I discuss the evaluative process for the prototype application LabanAssist. I illustrate the various methods employed to test and develop the prototype application, and discuss the subsequent results of the different evaluations. Finally, in Chapter Ten, I discuss the overall outcomes of this research. I return to the significance of the research premise and the principle employed in the development of the prototype application LabanAssist.

Part I: Design Purpose

1 A Vehicle for Cultural Expression

> All communication is like art. It may fairly be said, therefore, that any social arrangement that remains vitally social, or vitally shared, is educative to those who participate in it (Dewey, 1967, p. 7).

Problem Statement

Designers and developers of current dance notation applications have not addressed the necessity for tools that accurately facilitate the process of score composition. According to the literature in this field, there presently are no dance notation applications that permit the accurate notation of dance movements. Calvert et al. (2005) argue that contemporary notation editors overlook the need to provide a structure for the correct notation of symbols, and ideally are only suitable for use by professional notators. I argue throughout this thesis that the co-creation of a prototype application capable of communicating knowledge of its utility through an interface can be designed to enhance the experience of composing abstract symbolic information. Effective methods of communication that make a shared process of learning, understanding, and negotiation possible can contribute to the framing of a design situation that considers user diversity. I further argue that this provides greater accessibility of dance notation systems to members of the dance community, and offers the potential to enhance dance literacy. Literature that points to a growing awareness surrounding the importance of dance literacy and the reliance on alternate methods to read, write, and interpret dance notation scores provides an understanding of the potential significance of this research. Similarities found in the established heritage of music literacy also can be drawn upon to illustrate this potential.

Music notation is an essential aspect of music education. It provides a cultural and historical record of music literature and a practical understanding of music composition. Furthermore, it facilitates the ability to read, write, and perform music (Hutchinson Guest, 1984; Wang, 2004). Because of this, it is generally accepted that musicians and composers need to study music notation (Hutchinson Guest, 1984; Thomas, 2003). A

plethora of music literature enables the teaching, rehearsing, study, performance, and composition of music through the analysis of this notation (Hutchinson Guest, 1970). A parallel can be drawn between the techniques musicians use to notate musical scores and the systems that enable the creation of dance scores. Dance notation systems offer a framework by which members of the dance community may learn to read, write, and analyse movement (T. Calvert et al., 2002, 2005; Hutchinson Guest, 1970, 1984; Thomas, 2003; Wang, 2004). This provides a language in which movement can be visualised in a symbolic form, and offers a method to preserve an objective record of movement (Calvert et al., 2002).

Dance notation systems assist the communication of movement between choreologists, dancers, and choreographers during the creation, rehearsal, and reconstruction of dance works. The documentation of dance notation scores allows for the analysis and interpretation of movement to be verbalised, and enables intellectual discussion to develop in the discipline of dance (Hutchinson Guest, 1984; Knust, 1979; Wang, 2004). Buck (2003) tells us that there exists specific uses of dance terms and vocabularies to describe and analyse a broad range of dance genres and styles. Knowledge of these terms is a necessary component to dance literacy, and establishes a method of expression that constructs a dialogue in which dance is universally understood (Buck, 2003). With this in mind, it is reasonable to suggest that dance notation systems support the development of dance literacy, and provide the dance community with an essential means of communicating, analysing, and interpreting movement.

In music, notation is an essential study component of music education (Thomas, 2003). The foundation notation provides as a means to reference and develop musical heritage leads one to question why existing notation systems have not been successfully employed in the study of dance. Hutchinson Guest (1984) tells us that the application of dance notation systems among the educated classes flourished during the eighteenth century. However, after the French Revolution, the cultural status and development of dance went into decline upon its departure from the royal courts and its move to the theatre (Hutchinson Guest, 1984). This, in turn, prompted the attitudes among the educated classes to discourage the education of dance literacy during the Victorian and Edwardian eras that had a significant effect on the application and development of dance notation systems (Hutchinson Guest, 1984).

If we accept the notion put forward by Hutchinson Guest, then we can understand why few dancers and choreographers have been exposed to dance notation systems, or understand their usefulness (T. Calvert et al., 2002, 2005; Thomas in Carter, 2004; Knust, 1979; Lake, 1990; Lansdown, 1995; Neagle, Ng, and Ruddle, 2004; Wang, 2004; Wilmer and Resende, 1998). As a consequence, choreographers are unable to notate individual works as fluently as musicians are able to notate their own musical scores during the process of composition. Furthermore, dancers are unable to read, interpret, or translate dance notation scores to movement as easily as musicians are able to sight-read musical scores when studying and performing musical works.

The ability to enhance dance literacy requires the preservation of a cultural, historical, theoretical, and practical record of dance via the recording and comprehension of dance notation scores (Mlakar in Knust, 1979; Wang, 2004). Yasuda (2001) equates the need for a choreographer's record or notation of movement to that of musical and dramatic performances, for which texts in the form of a score or a script are made available prior to and after a performance. An absence of these records makes the act of dance criticism increasingly difficult, and has subsequently reduced it to a level of superficiality that perpetuates an insignificance of the value of dance theory and criticism (Yasuda, 2001). The history of Western dance has been referred to as a history of "lost" dances: this has been attributed to the ephemeral nature of dance (Thomas, 2003; Wang, 2004). The challenge of the momentary realisation of a dance work becomes difficult to encapsulate since it is performed without a tangible or enduring record of its existence (Thomas, 2003; Wang, 2004). Hutchinson (1984) argues that movement is just as intangible as thought. In spite of this, Carter (2004) acknowledges the difficulties associated with materialising the ephemerality of dance, and maintains that the past exists only in the record of events—not in the events themselves—because the past is just as momentary as the performance of dance. Drawing on the notions put forward by Carter (2004), then it is reasonable to suggest that a tangible record of dance is both possible and essential to providing a historical record of dance. This is significant in two, overarching respects. First, that movement is recorded for its preservation and use by third parties; and, second, that it is recorded without personal interpretation, while minimising personal bias. Mlakar (in Knust, 1979) advocates the use of notation as a scientific approach for documenting the ephemeral art of movement to be analysed in the structure of dance notation scores in support of this argument. Hutchinson Guest

(1984) strengthens this view by arguing that the science of dance, as a scientific study of movement, can only be appropriately developed, examined, and explored through scientific methods of representation in symbols, numbers, or notation.

The documentation of movement is important in providing a tangible and continuous record of dance that would otherwise see the historical record of movement limited to a dancer's or choreographer's memory (Hutchinson Guest, 1984; R. J. Neagle and Ng, 2003; Singh, Beatty, and Ryman, 1983). As indicated by Hodes (1992), dance is bound to a paradigm of oral history in which memory and emulation are not seen to be sufficient archiving tools. The absence of a widely applied documentation system has seen the handing down of dance works by modes of imitative demonstration directly from the choreographer, or from dancer to dancer (Thomas in Carter, 2004; Hodes, 1992; Hutchinson Guest, 1984; Lake, 1990; Singh et al., 1983; Wang, 2004). Traditionally, dancers have learned choreography by emulation (Hutchinson Guest, 1984; R. J. Neagle and Ng, 2003). Practical experience and the literature available (János Fügedi, 2001; Hutchinson Guest, 1984; R. J. Neagle and Ng, 2003) inform us that the process of restaging dance works involves the demonstration of movements during an extensive rehearsal period from one dancer to another. This imitative mode of demonstration is facilitated by dancers with prior knowledge of the work, either from the experience of working with a choreographer during the creation of a ballet or from performing the piece in question. At present, smaller dance companies predominantly rely on those with firsthand knowledge and performing experience of dance works, as invaluable sources of reference material (Fee, 2005; Greig, 2005). Hutchinson Guest (1984) tells us that the speed of handing over roles in rehearsal commonly leaves dancers with an incomplete concept of the entire movement sequences, in which the finer nuances of movement are left unobserved. The implication of this has seen the gradual reinvention or complete loss of productions from the repertoire of dance works (Lake, 1990; R. J. Neagle, and Ng, 2003). Mlakar (in Knust, 1979, p. xx) explains this:

> The lack of notation scores prevents the art of ballet from rising to its appropriate place within the work of culture. This lack is alleviated by the fact that a few ballet works have been handed down from one generation to the next by practical demonstration. This way of keeping the choreographies alive, though not quite

> authentic, is to a certain degree a substitute for dance notation scores.

In an effort to preserve a record of choreographic material, the method of practical demonstration, while somewhat unpredictable as a reliable source of reference material, proffers the argument that dance notation scores possess the ability to offer dance a richer cultural heritage in providing a necessary historical description of movement.

Apart from the lack of a widely applied system to document movement, Hutchinson Guest (1984) describes the act of choreography as “the throwaway art.” This is because of the numerous dance works left undocumented. The preference of contemporary choreographers to create new dance works as opposed to adapting and ensuring the preservation of previous creations has contributed to the loss of this material (Thomas in Carter, 2004; Hutchinson Guest, 1984; Mlakar in Knust, 1979; Thomas, 2003). Wang (2004) supports the idea of the nature of this loss by acknowledging that dance notation is not a necessity in the creation or performance of dance. As a consequence, the present application of dance notation systems find greater use as a means to archive movement (Calvert, Bruderlin, Mah, Schiphorst, and Welman, 1993; Singh et al., 1983; Wang, 2004). Further to this, choreographers are more inclined to use notation as a means to record or amend complete dance works as opposed to employing the use of notation systems during the creation of new compositions (Lansdown, 1995).

The creation of contemporary dance works has impacted the development of existing notation systems, which have evolved simultaneously with modern forms of movement (Hutchinson Guest, 1984). This signifies a balance between the influence abstract movement exploration and expression has in developing a greater need of movement description and dance literacy. Furthermore, it underpins the relationship between movement exploration, performance, and analysis in the process of creating contemporary dance forms. This suggests that notation systems have developed as a consequence of complex forms of modern movement and a growing awareness of dance literacy. However, Thomas (2003) argues that the complexity involved in archiving a complete record of dance works has contributed to the loss of historical dance references. In contrast to this Mlakar (in Knust, 1979) discusses an additional concern regarding a perception that the simplicity of preserving dance works by film provides an

adequate reference to enhance dance culture. In general, a lack of dance literacy and the use of notation systems stimulate the debate surrounding the documentation of dance, its lack of cultural standing, and the need to define a universally accepted method of recording movement.

In comparison to music and theatre, in which symbolic notation and the written word provide a literary reference to performance material, dance relies on the ability of professionally trained choreologists or notators to document and interpret movement (Thomas, 2003; Wang, 2004). Traditionally, the role of a choreologist trained in the use of dance notation systems is to describe and translate the meaning contained within the symbolic representation of movement on a dance score. The translation of movement from one symbolic language to another assists dancers to interpret and perform these movements (Hutchinson Guest, 1984). A reliance on trained choreologists to perform these tasks becomes a problem in the limited resource they offer, and in light of few alternative methods to assist the interpretation of dance notation (R. J. Neagle, 2003). As a response to this, Schallmann (1999) emphasises a much-needed awareness and responsibility for addressing the wider issues on a global scale concerning the accessibility, preservation, and safety of the information contained within dance notation scores. However, much work needs to be done at a practical level to reduce the complexity involved in the creation of long-lasting useful and usable cultural archives.

An explanation for the absence of alternative modes to interpret dance notation scores can be provided when considering a broader definition of the term “choreology.” Rudolf Laban (in Knust, 1979) coined the term to define a study of dance to be understood from a scientific approach to the analysis of movement; equivalent to that of musicology. The practise of choreology examines systems of composition (dance notation systems) and types of choreography that consider external artistic influences on the creation and development of dance. This methodology relies on a system of dance notation, which facilitates these practises and is essential to the practise of choreology (Knust, 1979). At present, the absence of an adequate and reliable source of notated dance material, and a lack of dance literacy among dancers and choreographers, has contributed to the indispensable role choreologists play in facilitating the comprehension of notation scores (Hutchinson Guest, 1984; Mlakar in Knust, 1979; Thomas, 2003; Wang, 2004). As a result, choreologists remain a necessary component

in the creation and translation of dance notation for the written, verbal, and physical interpretation of movement (Thomas, 2003).

Necessity of Research Proposal

The development of sophisticated computer applications that support the comprehension and interpretation of dance notation have the greatest potential for offering the dance community greater accessibility to the understanding and creation of dance notation scores (Buck, 2003; Wang, 2004). The initial development of dance notation applications during the mid-1960s saw the choreographic process and the exploration of movement concepts as the primary focus for their development. Today, this is apparent in the development of software applications such as "DanceForms" (Credo Interactive Inc., 2005a) that provide choreographers with an interactive tool to facilitate the composition of movement through key-frame animation techniques. This means that contemporary choreographers are accessing emerging technologies to develop and conceptualise innovative forms of visualising and expressing movement (Neville, 2003). This is demonstrated by the assistance DanceForms offered choreographer Merce Cunningham in the creation of "Trackers," which enhanced his ability to develop new forms of movement (Herbison-Evans, 2003). However, the necessity to develop tools that read and interpret dance notation scores prevails (Calvert et al., 2002). This suggests that, in order to provide reliable sources of reference material that cultivate our dance heritage, it is necessary to develop measures of assistance to ensure that the correct documentation of dance notation scores is possible. Leveraging existing modes of notation applications may serve to prevent further fracturing of dance knowledge, and focus on the enhancement of existing notation tools.

Dance suffers from the absence of a solid cultural foundation from which theoretical and historical analysis can be practised to enhance its cultural standing (Mlakar in Knust, 1979). Devoid of a rich cultural heritage to draw on, Mlakar (in Knust, 1979) advocates the wealth of knowledge disseminated through scores of notated works to offer future generations a culture worthy of critical examination. In support of this, Hutchinson Guest (1984) draws on music notation's role in the cultural development of Western music as a promising indication of the future potential for dance literature to develop. If the potential in this comparison can be realised, then it is reasonable to

surmise that the cultivation of dance literature provides the dance community with the opportunity to establish and contribute valuable reference material to libraries (The Benesh Institute, 2007; The Dance Notation Bureau, 2008; International Council of Kinetography Laban/Labanotation, 2008; Language of Dance® Centre, 2007).

Herein lies the potential to provide a foundation or a "useable past" upon which, both Thomas (in Carter, 2004) and Mlakar (in Knust, 1979) speak of: to generate a legacy of dance culture for future generations. Thomas (2003) tells us that advances in the use of film, video, and dance notation to document movement have motivated an increasing interest in the reproduction of earlier dance works to provide a permanency to the heritage of dance. Reference to these materials provides a vital element of cultural reproduction that conveys a sense of tradition for the literary prosperity of dance. Thomas (2003) and Carter (2004) identify the intrinsic worth of a rich dance heritage that can be recognised in the study of dance history; to provide valuable insights into the past and impart a wealth and maturity in the present. A growing awareness surrounding these benefits is evident in the offering of dance-related studies, the practise of dance reconstruction, and dance notation throughout the United States education system (Carter, 2004; Pernod in Thomas, 2003). For a limited overview of various educational institutions that offer dance notation in "Motif Description," Labanotation, and "Benesh Movement Notation" (Benesh), see Figure 2. Dance Notation Educators and Institutions. This suggests that the implications of recording movement become culturally significant to the preservation of dance works in establishing an historical and scholarly archive of dance material to support and enhance dance literacy (Wang, 2004).

Knust (1979) tells us that the cultural importance of dance lies in its preservation and the cultivation of contemporary choreographic works. He (Knust, 1979) advocates the use of dance notation as a necessary tool to record and foster their development. In support of this, Hutchinson Guest (1984) insists on the practicality of notation as a means to develop contemporary dance works during their creation and rehearsal; akin to the role notation provides in music and drama. This argument is further strengthened by, Lansdown (1995) who envisages a potential in which advances in computer technology may permit the use of notation systems in a rehearsal environment. With

Key

Educational — Program
Delivery Methods — Web Resources
Delivery Methods — Correspondence
Delivery Methods — Software
Writing Skills — Theoretical Application
Performance & Choreographic Skills — Practical Application
Notation Skill Level — Introduction
Notation Skill Level — Elementary
Notation Skill Level — Intermediate
Notation Skill Level — Advanced

Labanotation

Institute

- Dance Notation Bureau
- Laban
- Integrated Movement Studies
- Laban International Courses
- Laban Guild for Movement & Dance

University & Schools

- Ohio State University
- The University of Surrey
- The University of New South Wales
- The University of Mississippi
- Bowie High School
- Colorado College
- The University of Georgia
- Wesleyan University
- University of Regina in Canada
- University of Illinois at Urbana-Champaign
- Hong Kong Academy for performing Arts
- Tainan Womens College of Arts & Tech
- University of Hawai'i at Manoa
- Arizona State University
- Mills College
- University of Hartford
- Goucher College
- Florida State University
- Northwestern University
- Montclair State University
- Texas Woman's University
- Marygrove College
- Western Oregon University
- University of North Texas
- Sam Houston State University
- Scottsdale Community College
- New York University
- Michigan State University
- University of Arkansas Little Rock
- George Mason University
- SUNY Brockport
- The University of Southern Mississippi
- Western Oregon University
- Virginia Polytechnic Institute & State University
- The University of Iowa
- Roehampton University

Benesh Notation

Institute

- The Benesh Institute
- The Royal Academy of dance UK
- The Royal Academy of Dance Canada
- The Royal Academy of Dance NZ
- The Royal Academy of Dance Australia
- Notation Du Mouvement
- Parrs Wood Sixth Form Centre, Dance

University & Schools

- University of Cape Town
- University of Waterloo
- Theatre School of Dance
- Elmhurst
- The National Ballet School
- Kate Simmons Dance
- The English National Ballet School
- Ball State University
- Northern Illinois University
- San Francisco State University

Motif Description/Writing

Institute

- Language of Dance
- LIMS

University & Schools

- Western Michigan University
- University of Idaho
- Alliance of Dance Notation Educators
- Eastern New Mexico University

Figure 2. Dance Notation Educators and Institutions

this in mind, it is reasonable to suggest that availability and access to dance notation material is vital to the preservation and analysis of our dance heritage and culture. Dance notation systems provide the capacity to archive and preserve historical dance works; to foster the development of contemporary works; and to contribute to a richer dance heritage. Therefore, the importance of facilitating the use and understanding of literary materials plays an important role in the cultivation of our dance heritage. The inadequate documentation of a majority of past notation scores (Hutchinson Guest, 1984) and a lack of education surrounding the knowledge of dance notation systems has restricted the development of dance literacy (Hutchinson Guest, 1984; Mlakar in Knust, 1979; Thomas, 2003; Wang, 2004). For these reasons, it is essential to ensure a foundation of material that can be appropriately accessed, analysed, and understood by future generations. As early as 1984, notation was recognised as a necessary tool worthy of considerable study; however, because of its limited use within a specific field of experts, there remains a need to gain greater acceptance and application of dance notation throughout the dance community (Hutchinson Guest, 1984).

Buck (2003) and Wang (2004) argue that increasing access to information will ensure a faster progression of dance literacy through the use of technology. They (Buck, 2003; Wang, 2004) envisage that this, in turn, will provide improved dance educational opportunities that will rapidly develop the awareness of movement notation systems and movement analysis disciplines:

> The concepts, skills and processes bound up in developing dance literacy are the very literacy skills that I believe will inform the way forward in education, they are the literacy skills that will make connections with technology and with people (Buck, 2003, p. 20).

While there have been significant advances in the use of technology to develop tools that simplify the notation process, Wang (2004) maintains that further development of the processes involved in the notation, verification, and interpretation of dance notation are required. This means that it is necessary to ensure the accuracy of dance notation scores, and to analyse various measures of assistance that can be developed to create greater accessibility to the composition and interpretation of dance notation.

In view of the present arguments, it is reasonable to propose that alternative approaches to the composition of dance notation scores are required to reduce the margin of possible errors for notators and interpreters of these scores. The development of tools that facilitate the process and correct grammatical composition of dance notation scores have the potential to gain greater acceptance within an educational setting, and thus encourage dancers and choreographers to integrate the use of dance notation systems in their daily practises. Hutchinson Guest (1984) foresees a future in which choreographers may have the capacity to notate their own work as a result of an accessibility, acceptance, and understanding of the advantages in the practical application of dance notation in the creation of new dance works.

Design Purpose

The combination of artistic creativity and computer technology is not a new concept. Computer-aided design (CAD) systems are well established as tools of trade in many fields. Dance notation applications that facilitate the documentation and interpretation of movement notation scores are examples of this. Yet, in the process of documenting movement, existing dance notation applications are unable to detect or prevent user error. A possible explanation for this may be found in the original intent and design of these applications. Typically, dance notation applications such as “MacBenesh” (R. Ryman, 1999), “Labanatory” (Gábor Misi, 2005), and LabanWriter have been designed by and for expert use. This has involved collaboration between researchers with expert knowledge in computer science, dance notation languages, movement analysis, and associated interdisciplinary fields. Developments resulting from these collaborations primarily have concerned the technical development of computer software applications targeting particular dance notation languages. The consequences of which have had a direct impact on the broad use of these software applications. These applications function more as drawing tools than notation editors, and require an expert knowledge of them to be used effectively. Because of the above limitations, a design approach was adopted for the creation of the prototype application LabanAssist. This became necessary when the conventions of other established disciplines, such as engineering and computer science practises, no longer were considered effective alone in facilitating the production of well-designed cultural artifacts (T. Calvert et al., 2005; Ebenreuter, 2005).

I argue that a preoccupation with the software engineering of dance notation applications has left little room for concern regarding the significance of enabling members of the dance community to communicate knowledge of their art effectively. It is, therefore, necessary to look toward facilitating communication that exists between members of a specific community and their subject matter or field of knowledge production through the utility of technology. The facilitation of the artistic expression of movement within an environment using computer technology is one objective of this research. The research also seeks to overcome the issues concerning the internal mechanisms and processing capabilities of computer technology, which currently limit the translation of dance information. Finally, through an understanding of the requirements of the end-user, it seeks to provide products that work in concert with technology to achieve these outcomes.

The theory of communication known to engineers and computer scientists is important to the technological development of dance notation systems. However, as Weaver (1979) maintains, it has little to do with the meaning of a message. Signal processing theories of communication primarily are concerned with the efficient transfer of statistical data between two sources. Just as the Internet is increasing the ability of people to communicate with each other via video conferencing technology, the concern in doing so focuses on how data sources are transferred proportionally from sender to receiver; rather than the content of the messages themselves. Nonetheless, technology provides a fundamental basis for the development of dance notations systems and software that are central to design in a technological society.

The unsuccessful application of notation systems to a technological environment suggests that a human-centred design approach that carefully considers the sensibilities surrounding the art of knowledge creation by a specific community is an alternative worth exploring— one in which the medium for its communication is considered as a dynamic environment for interaction. This is the case in which the design of products enables knowledge of a culture to be communicated successfully as a result of the capacity in which a product is effectively embodied in its functionality or purpose. The focus of this research lies in facilitating the accessibility of Labanotation to members of the dance community; the cultivation of dance works; and the development of literacy in the arts. Fundamentally, it is to encourage members of the dance community to take

action through the facility of LabanAssist to move beyond the arbitrary use of symbolic information, and provide them with the freedom to create and express movement. Moreover, this must be done intelligently so that the Labanotation scores are produced in such a form that others can understand. LabanAssist seeks to make the transference of dance knowledge possible by establishing relationships and associations between the use and understanding of Labanotation through the effective design of an interface. The term “accessibility” in this sense refers to assisting the practical use of symbolic writing systems by members of the dance community. This is not to be confused with the notion of “easy to use”; or the design of “user-friendly” tools that remove intellectual complexity to the detriment of user understanding, creativity, and learning through practical use.

Central to the design of the prototype application LabanAssist is the way in which tools designed for the documentation of movement represent the information contained within Laban symbols. It seeks to guide user actions, figuratively and symbolically, as opposed to literally; and supply those who interact with the tool the possibility of utilising the dance notation symbols that Labanotation scores represent. The intent, therefore, is to motivate thoughtful and engaging interaction between novice students of Labanotation and the symbolic vocabulary of the language, via the medium of technology, to enhance dance scholarship. The manner in which movement is conceived, as the result of imaginative ideas and creativity, then becomes a motivation for action in a dramatic sense rather than being dependent on a user’s knowledge of the conventional or semantic construction of a symbolic language as the context for its use (Burke, 1969a). This is pertinent where semiotic or semantic principles, external to the actual context of use, present little relevance to the operative procedures of composing Labanotation scores. Instead, the correct grammatical and syntactic composition of movement becomes a function of the prototype, guided by user interactions. In the design of an interface, the manipulation of a general set of terms representing a broad description of movement creates the possibility for an artistic and creative documentation of movement. This interaction stems from a figurative interpretation of literal terms, and transforms these ideas through the active participation of user interactions within the prototype application to give form to the composition of Labanotation scores. As a result, the underlying structure for the composition of movement is facilitated by the prototype application.

A Final Note

In this chapter, I have argued that the correct grammatical and syntactical composition of movement as dance notation scores is vital to the preservation of dance culture. Drawing on literature in the fields of movement, dance notation, and technology; I establish that current dance notation applications are unable to detect or prevent errors made during the composition of movement. I argue that the potential to enhance dance literacy begins by providing members of the dance community with greater access to the use of dance notation systems. In light of this, I propose the design of a prototype application to facilitate the composition of Labanotation scores for those with little knowledge of the language. A design approach is adopted as a way to overcome the limitations imposed by the conventions of other established disciplines.

However, before a design approach can be developed, it is necessary to understand the function of symbolic writing systems and how we can understand the concept of communication to allow for experience, interpretation, and interaction. In the next chapter, I turn my attention to the problem of facilitating the use of arbitrary symbolic information. This has particular significance in capturing the ephemeral art of dance, and in enabling the composition of experimental ideas. I proceed by exploring a broader notion of communication, and discuss how this can provide a foundation for the treatment of information in design products.

2 A Basis for Design

> Once you have a distinction so clear as that between image and idea at the extremes, you can expect to find some vocabularies treating them as almost diametrical opposites (Burke, 1969b, p. 87).

Introduction

Symbolic writing systems offer an effective means of communication for the expression and preservation of knowledge in all manner of theoretical and practical disciplines. In general, such systems facilitate the broad dissemination and exchange of ideas. However, the conventions surrounding the use and application of symbolic writing systems also can limit the knowledge they represent to those without a basic understanding of the language. This, in turn, prevents the active participation of symbolic forms of communication. In Chapter One, I argued that the significance of this for members of the dance community is critical to the preservation and cultivation of contemporary art forms, dance scholarship, and dance literacy.

In this chapter, I explore the basis for designing a creative computational tool that seeks to enhance the symbolic communication of arbitrary information. This involves the creation and communication of fundamentally a system for recording dance knowledge on a score as identifiable and replicable signs and symbols. In this research, I depart from a conventional understanding of grammar, or more particularly, the rules of a language to assist the practical use and application of movement in a symbolic form. This application is one in which a literal understanding of grammar is no longer seen as an adequate basis for the generation of dance knowledge expressed via symbolic writing systems. Instead, this research focuses on the way in which the figurative aspects of language can be represented in the design of an interface to orient user thinking and facilitate the generation of diverse movement compositions.

Symbolic Communication

Contemporary society relies on many forms of conventional practises, strategies, customs, and social behaviours to operate effectively. Typically, we recognise these as terms of reference for agreement in areas such as international policy, law, and industrial negotiations established to bring about cooperation between organizations, institutions, and communities of different countries. More commonly, these conventions can be understood as a language or a means of communication that facilitate the active exchange and recording of ideas. This communication or interaction provides the means for systematically preserving and fostering the knowledge of our cultural identity, customs, and traditions; that includes intellectual and technological advances. To facilitate this symbolic writing, systems offer a way to share and disseminate knowledge to a wider community for the possible participation by literary or scholarly practitioners.

The consequences of symbolic communication as a medium for explicit and sometimes harmful expression; and the unsolicited representation of cultural values as statements of religious prejudice or fact; are at the centre of many contentious societal and political issues. While these modes of symbolic expression are all weighted with a certain responsibility of the society and individuals that employ such methods of communication, this research looks to the practical problem of their use and operation for the cultural expression of dance. Symbolic languages employed by members of the dance community are understood as a means of communicating performative knowledge for the mutual pleasure and enjoyment of performers and audiences alike. Rather than take issue with the contentious beliefs symbols may represent, the languages discussed in this research are widely accepted among the communities that participate in the cultural development of movement, and are employed to further the cultural heritage of dance.

This cultural heritage is important. However, without a specific subject matter for design, the resulting pluralism of methods and the adoption of interdisciplinary practises has seen the gradual extension of design to new and previously unexplored areas of application (Boland and Collopy, 2004). A shift to the intangible design of systems and actions is an example of this development (Lyytinen, 2004), as is the creation of the

prototype application LabanAssist, designed to facilitate the documentation of the ephemeral art of dance. In more general terms, movement is described in a symbolic language called Labanotation for the preservation and visualisation of dance scholarship. In the same way that musicians notate the tone, pitch, and duration of sound as scores of musical notes; members of the dance community document movement as dance notation scores using the symbolic vocabulary of Labanotation.

The skill required to document movement as symbolic scores is well known at the professional level by choreologists. However, for the purposes of this research, the intended end-users are members of the dance community who have little knowledge of Labanotation. This means that the systematic rules of a language do not offer explicit information about the use of a symbolic writing system, and do not provide a defining structure for the interactive design of a prototype application. This is important because the lack of a sign system in which it is possible to derive distinct or inherent meaning from the reading of a symbolic message underpins the paradox Barthes (1977) describes of a message without a code: a situation where prior knowledge of a sign or lack thereof is tied to our ability to successfully read and identify symbolic messages. The irony of a message without a code becomes particularly apparent when members of a specific community are faced with the task of facilitating the use of arbitrary symbols to illustrate imaginative ideas in unanticipated situations of use. This is relevant because, when symbols are used to represent the knowledge or the conventions of a specific group, they become the objects or the tools for the documentation, preservation, and dissemination of ideas. Of particular import are situations in which the context for gaining an understanding of a symbol is not known from prior experience, because the knowledge of a symbol is bound in the perspective we bring to bear upon the image for its interpretation.

For Saussure (1983), the linguistic sign or the signs of a language have little value in isolation. It is not until the relationship of two or more signs may be compared with one another that their character is revealed (Saussure, 1983). If we accept that a symbol works to distinguish one person, object, or thing from another; then we can begin to understand the utility of a symbol as the confirmation of action and cooperation between at least two members of a like-minded community (Z. K. McKeon and Swenson, 1998). The use of symbolic writing systems for the communication of

information or knowledge regarding the practises and traditions of a specific community provide powerful tools for the presentation of thoughts and ideas that prompt actionable outcomes.

With this in mind, communication in this sense is not universal in its ability to communicate: rather it is circumstantial and open to interpretation by the members of the community for which it holds significance (Aristotle, 350 B.C.). A good example of this idea lies in the understanding of poetry. If a poem is understood as it actually exists in its material form, it represents an object or thing as lines, marks, or symbols. However, when read poetically, it produces a series of experiences. Communicated as thought, action, images, sound, quality, and intensity; the experience is unique in comparison to the variety of ways in which poetry can be sensed and felt by an individual. Moreover, such an experience is separate from one's prior knowledge or familiarity with the subject matter being explored (Dewey, 1980). This is based on the understanding that the relationships we develop with symbols, regardless of their intended use, may be as diverse as the uses we have for them.

For Mead (1934), the meaning of an object is established by an individual or community for which it is an object. Individual meanings arise as the result of a willingness to actively engage with an object, as opposed to the notion that an object is the embodiment of an uncontested and discernable meaning (Mead, 1934). A disposition toward the reading of a newspaper as a source of information could provide the newspaper with a meaningful connection to newsworthy events. However, without the experience of treating a newspaper in this manner, it may find greater use as packing material for the storage of precious items. This suggests that objects do not embody an inherent meaning with a certainty shared by all. As Mead (1934) maintains, the relationship between an individual and an object represents a range of possible meanings which bring forth a variety of different human responses.

I argue that, as human beings, we are not merely the passive receptors of information. We think, feel, and act intelligently during the course of interacting with one another and the immediate elements or things that constitute our surrounding environment (Dewey, 1980). This notion of humans as active receptors impacts on the relationships we form for the use of Labanotation symbols. There are movements that still have not

found expression within a distinct set of rules and symbolic conventions. Because of the dynamic nature of language, Labanotation is under continual development, as is all language at the level of communication. This highlights the problem of naming abstract ideas as expressed by symbolic language systems. These remain arbitrary until they are made known through their personal and public use by means of documentation, and physical and verbal expression. Facilitating the use of symbolic information, or transforming it into useful objects of knowledge for the description of movement, can be said to depend largely upon the approach one takes to gain an understanding of its vocabulary. This is where a description of movement stems from its conceptual understanding to its material composition in reference to its physical performance.

> For Aristotle the objects of true knowledge are not absolute and suprasensible entities, but rather the formative aspects of things as these aspects are abstracted by the activity of the intellect. To have true knowledge of a thing, therefore is to have knowledge of its inherent form (Ruben, 1989, p. 34).

The meaning we attribute to symbols can, therefore, be the result of the relations we develop in the act of constructing form (Turner, 1991). The distinction between "doing," that is the ability to take action; as opposed to "undergoing" an enforced course of action; is significant to the experience of forming matter (Dewey, 1980, p.137). The notion of "doing" can be understood as an interactive process that contributes to the unity, quality, understanding, and experience of form (Dewey, 1980). Language, such as Labanotation, can be understood as symbolic action (Blumer, 1969; Burke, 1969a) in the composition of movement as dance notation scores, rather than as a mode of knowledge. For the purpose of this research, I consider Laban symbols as matter, and their expression is in the creation of form. This form is a description of movement embodied and represented by a Labanotation score. I argue that the organization and arrangement of Labanotation symbols on a score is the content of this form (see Figure 3. The Components of Form).

My argument is reinforced by the works of Dewey (1967), who argues that it is not through the transmission or conveyance of knowledge, emotion, or ideas that we gain an understanding of a particular set of circumstances or subject matter. Rather,

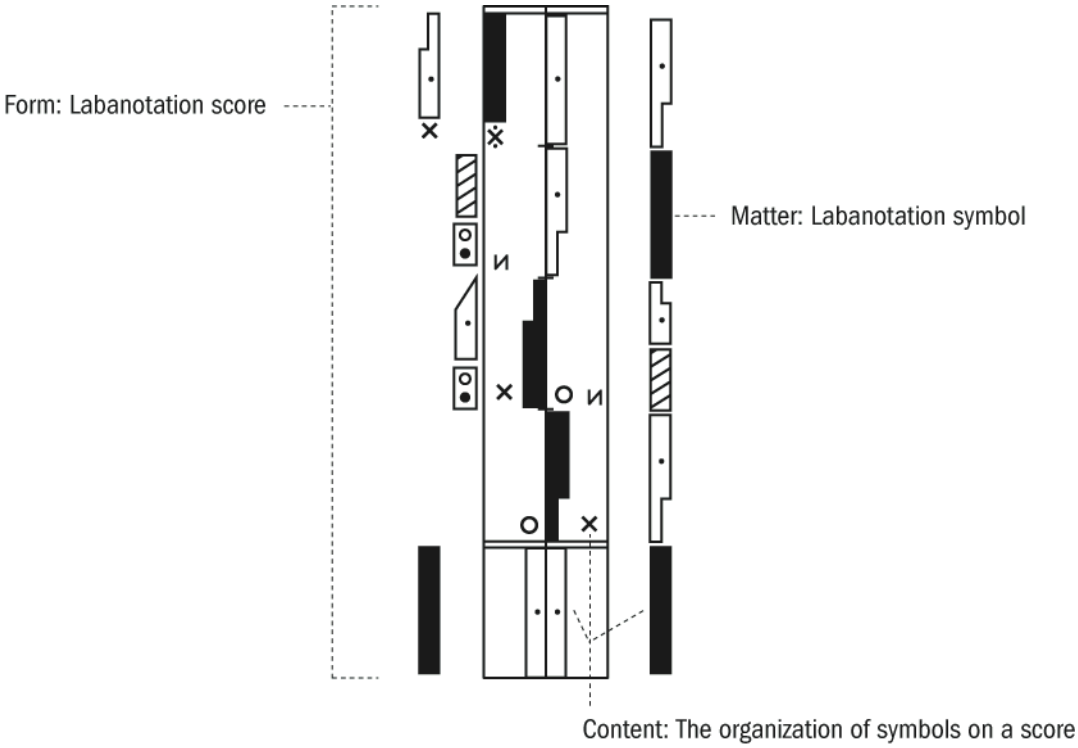


Figure 3. The Components of Form

understanding is as a result of interacting with the elements that constitute a situation or the environment in which an activity is carried out that makes learning possible (Dewey, 1967). Aristotle (2005) expands this view with his notion of tragedy; the natural development of human capabilities, where the acts of producing and experiencing are connected to learning and emotion. However, a tragedy must, by necessity, supply its audience or community of users with an experience that is complete and of a particular magnitude, so that its parts work together to create a composite whole (Aristotle, 1985, 2005).

The ability to experience and learn, however, can become confusing. “Symbol shock,” a term coined by Marion (2006), refers to the inability of novice users of Labanotation to identify with the variety of abstract symbols it encompasses. As a result, this impedes one’s ability to take action or interact with its symbolic language for the description and interpretation of movement. To counteract such shock or failure to take action, Barthes (1977) maintains that the linguistic message, at a literal level, provides a technique in which the identification and understanding of indistinct signs guides the relationship developed for the comprehension of a symbolic message, rather than its connotation.

For Burke (1969b), the connoted or suggestive meaning of an image or idea is confused in the sense that, upon its analysis, a connoted message can never fully divulge the extent of that to which it refers, or be successfully indicative of its corresponding meaning whether it have an intellectual, imaginary, or practical basis. This is where "productive poetic imagery" gains significance (Burke, 1969b, p. 86). An ability to underpin the creation and representation of innovative ideas as imagery that stems from the intangible to a tangible representation is beneficial to members of the dance community in the preservation of movement as dance notation scores (Burke, 1969b). It enables one to create an image of an idea that represents a conceptual understanding of movement, and to make or produce it in a symbolic form. Developed from the imagination, Burke (1969b) tells us that the poetic image can facilitate the creative expression of ideas never before seen or experienced.

I argue that the creation of a conceptual understanding of movement is made possible by the utility of the prototype application LabanAssist. This is achieved via the description of broad terms in the design of the interface that differ in their representation by functioning as poetic constructs. In this way, poetic constructs, which are illustrated by text or words and expressed in broad terms that depict movement, provide a point of reference that contribute in part to a complete description and representation of movement. Through an interactive process of identification, association, selection, and modification; the discovery of such terms to describe and represent movement underpin their conceptual formation. In the act of manipulating a malleable display of terms that illustrate the verbal vocabulary of Labanotation, users become familiar with a flexible use and applications of language that enables associative means of thinking and working to develop in the concrete documentation of movement. This is opposed to using the names of Labanotation's symbolic vocabulary to describe movement. Indicative of Burke's (1969b, p. 84) "poetic image," this process enables the manipulation of verbal terms as conceptual ideas and images to extend beyond the practical or positivistic qualities of movement.

For Barthes (1977), a written symbolic message as descriptive text or words works to orient one's thinking by giving focus to a message or ideology. However, I argue that this is not necessarily literal in the sense that Barthes suggests. As Turner (1991, p. 151) maintains, precise meanings diverge from a fixed or literal point of reference in a "play

of tropes." Tropes are constructs that enable insight to be gained into different perspectives and understandings as a result of conceptual repositioning (Burke, 1969a; Turner, 1991). Through the overlapping and merging of a variety of meanings derived from literal terms, they give shape to an idea or image (Burke, 1969a; Turner, 1991). In doing so, they allow the transformation of the literal to the figurative, and thus open up a wide range of possibilities associated with a specific subject matter or theme, which then can be explored (Burke, 1969a; Turner, 1991). Tropes provide a starting point in which to begin and develop individual interpretations and meaning. The function of tropes could just as easily be substituted by the notion of terms previously described. While not the same in their role and mode of operation, McKeon et al. (1998) refer to a similar notion of tropes as "places" or a "commonplace" for invention and creativity. This is in close association with Burke's (1969a; 1969b) "titles" (and "tropes"), Aristotle (1997) and Cicero's (1949) "topics," and Buchanan's (1992) doctrine of "placements." The significance of these types of constructs enables an individual to work within a set of circumstances, which are not determinate or absolute. Rather, they offer a conceptual place in which to interpret and then shape the necessary elements of a given situation. For Turner (1991, p. 150):

> … both tropes and cultural structures are constructed through a "play of tropes," a dialectical process in which meaningful wholes are simultaneously integrated as parts of larger wholes and differentiated into new patterns of relations among their own parts.

Labanotation offers the means to facilitate a dialectical progression of diverse and innovative ideas to the logical composition of movement. This is made possible through the rhetorical design of an interface for the prototype application LabanAssist. As Burke (1969a) argues, the association between perception—how we view a situation—and what is actually perceived are equally representative of one another. This suggests that symbols; whether written as text, numerals, or glyphs; can encourage interaction not because they represent a clear literal understanding of terms, but because of the broad nature in which they provide a basis for meaning and action, which underpins their effectiveness and subsequent use (R. P. McKeon, 1987). This interaction is not based on reasoning alone, but the combination of emotion and reason which, for the purposes of this research, are taken as being essential to the artistic conception of movement, its

composition or choreography, and symbolic description (R. P. McKeon, 1987). In this way, thought is transformed from the figurative formation of ideas to a symbolic description of movement via its conceptual creation; its description in broad terms; and subsequent tangible or concrete representation as dance notation scores.

In light of this, Burke's (1969a) method of dramatism can be adopted to develop an approach that encourages and motivates the use of thought and language as modes of action to facilitate the symbolic creation of dance notation scores. In treating the concerns of the symbolic, or the formulation of conceptual ideas, Burke (1969a) turns to rhetoric, the art of delivery, as that which enhances symbolic communication through ordering, arrangement, and display. This is in combination with the art of making or design, also referred to as poetics or productive science (Aristotle, 2005; Buchanan, 2006), as a means to create and represent the figurative aspects of thought and language which are the result of the dialectic formation of ideas and interactive perspectives (Burke, 1969a). In this way, the representation of symbolic communication is hortatory in its capacity to put into practical terms a way of interacting with the unfamiliar. These terms are represented in the design of an interface as words, labels, or images; and can be used to accommodate the ephemeral nature of movement without distinct reference to its precise or probable description; illustrative of the notion of tropic interplay (Turner, 1991). Since no two movements are identical in performance, identification, or description; a synecdochic relation between what is understood in relation to a symbol or label that represents this in the interface will assist interaction. This interaction occurs through the provision of an implicit representation of possibilities that enables the transformation of ideas to move from the figurative to the symbolic in the course of notating movement as dance notation scores. This means that the manipulation of arbitrary symbols through the broad selection of labels makes possible greater interpretation and understanding of their meaning. It leads to the progressive development of an idea through the changed conditions of an interactive situation. This is where interaction or communication is in a symbolic sense in the representation of the interface, and in an individual's conceptual understanding of their actions through experiential learning. It is communicative in the sense that the participating elements of the situation are equally transformed and effected by the experience (Dewey, 1967).

The development of the prototype LabanAssist offers a working example in which the central theme and treatment of grammar departs from the conventions of formal language structures, and focuses on the figurative aspects of thought and its documentation which deals with the interaction between the conception, description, and representation of the symbolic. This is where the reduction of ideas to physical things is not considered in their lesser parts or in an objective, deterministic view. It is synoptic in its method of reduction, and offers a system of placement for the representation of observations as an integrated and organised idea, resulting in a unified composition (Burke, 1969a). More of a summation than a reduction, this system of placement embodies the complexity and extent of its constitute parts in a symbolic form. As with a mapping function, Labanotation scores systematically illustrate the relationships between the nuances of movement and its interconnecting parts. The significance of this lies in the overall composition of movement. This can be more fully appreciated and provide a deeper understanding of the motivation or impetus behind the actions it represents and its reenactment from symbol to action. This reenactment gains momentum through the design of the interface for LabanAssist. An interface is one such facilitator of the symbolic composition of ideas in action.

The significance of this provides a plausible foundation for the conceptual development of the prototype application LabanAssist. It takes the imagination of those interacting with the functionality of LabanAssist as a primary factor that will shape the creative process of composing and documenting movement. How this can be understood and integrated into the design of a product that is useful, usable, and desirable brings us to the premise of this research, discussed further below.

Thesis Premise

The premise of this thesis, in relation to Labanotation, is that the treatment of matter (Labanotation symbols) and form (the composition of Labanotation scores) as an integrated, organised whole is integral to the formation of design products that can effectively enhance the experience of others. The relationship of part-to-part, part-to-whole, and whole-to-part between the elements of the design situation and dynamic circumstances must be considered. A designer’s knowledge and practical understanding of the way the members of a specific community of practise think, act, and accomplish

their goals is instrumental to the agency in which design products are created to function. In the context of this research, design is understood as a dynamic and complex process made up of diverse people, methods, perspectives, and values. I argue that, through effective methods of communication and mutual understandings as espoused in dialectics, knowledge can be developed between designers and various stakeholders in the design process. As a result, this can provide designers with a better understanding of the necessary variables of a design situation, and assist the creation of useful, usable, and desirable products or services. By developing an understanding of the subject matter for design and the diversity of user actions in interactive situations, designers may better accommodate different use situations and enhance the qualitative utility and provision of design outcomes.

In light of this, I propose a principle for design: That the structure of content provides form with a functional purpose and tropes, as poetic constructs work to orient conceptual thought and open up the potential for a variety of concrete possibilities. I argue that the careful arrangement and organisation of content, that is subject matter in the context of observation or ideation, provides the form of a product with a functional purpose. As Watson (1993, p. 95) maintains, “Everywhere the form orders the matter, and the matter gives content to the form.” In the context of this research, it is understood that in dynamic use situations where the composition of Labanotation scores give structure to Laban symbols, the arrangement and ordering of such symbols give content to the form of Labanotation scores. This is significant because symbolic information without a coherent structure or form is meaningless. Just as a sentence composed of a scrambled lettering of words will yield incomprehensible results, an improperly structured dance score will convey an unfeasible sequence of movements to perform.

Dewey’s (1980, p. 136) argument adds to the notion of dynamic form when he tells us: “What is form in one context is matter in another and vice versa. Moreover, they change places in the same work of art with a shift in our interest and attention.” I argue that this shift in emphasis at a level of an individual’s experience supports the potential for an almost infinite range of possibilities in which a variety and range of movements can be described. This is because different types of connections made between the subject matter, content, and form of a product affect the ability to engage with the content of a

product and the quality of the experience. Burke (1975, p. 195) states: “A form is a way of experiencing; and such a form is made available in art when, by the use of specific subject-matter, it enables us to experience in this way.” This suggests that how this experience unfolds is vital to the progressive development of ideas and their connection to the composition of movement. It is not what we do per se, but how it is done. The linkages between various parts of movement descriptions that contribute to a whole and complete representation of an idea may be realised and give significance to our actions. Where problems arise is in the practical use of unfamiliar symbols and their relationship to the expression of movement, as represented by the information contained within Laban symbols and scores. The process is made clearer by doing.

My argument stems from the notion that “form ever follows function” (Sullivan, 1896) to the development of design outcomes that create meaningful relationships between form and content (Buchanan, 2001a). This shift in design thinking marks a distinct difference between designing a product that fulfils a distinct purpose or is determinate in its facility, to one that carefully considers its design and utility for diverse ways of thinking and acting. The purpose of this research involves the design of a product that serves to facilitate the understanding and creative activity of composing movement as Labanotation scores for those with little understanding of the language. This is where Labanotation, as the subject matter for design and the practical use of Laban symbols in the context of describing movement, gives shape to the activity of composing Labanotation scores. It suggests that form is the creation of dance notation scores. As such, form is driven by content, that is, the utility of dance notation languages as found in the application of computer software systems.

A lack of knowledge concerning the conventions of a specific type of symbolic writing system will present distinct challenges for the design of a product that facilitates the understanding and use of arbitrary symbolic information. This tension ultimately concerns the design of a prototype application with an interface that communicates its usefulness for the practical purposes for which it is designed. The specific intent in the design of the prototype LabanAssist is to facilitate the activity of composing movement with greater grammatical and syntactic precision in dynamic use situations. The main premise of this research is explored through a variety of subsidiary hypothesises peculiar to the elements that constitute and guide its development. For the purpose of

simplicity, the following research is presented in three distinct parts. Each part represents different aspects of a design situation, which are categorised as design for, about, and through design (Downton, 2003).

Research for Design

The chapters in Part II of this thesis focus on the research conducted for design. In Chapters Three and Four, I seek to establish a suitable use of materials to produce a design outcome that will be useful and accessible to members of the dance community. Accordingly, this research is based on the following subsidiary hypotheses particular to this research:

- The structural makeup of Labanotation supports a logical discourse in the composition of movement that can be efficiently and effectively utilised for the computational documentation of movement.

- Notation-based animation derived from Labanotation can provide a suitable use of technology to record, edit, translate, and visualise movement in a digital environment.

In Chapter Three, I investigate the role that specific classes of notation systems serve in the documentation of movement. I seek to identify what form-inducing or structural elements of existing movement notation systems are significant to the representation and description of movement for use within dance notation applications. To achieve this, I examine visual and abstract notation systems for their capacity to provide in-depth descriptions of movement and immediate visual clarity in the symbolic description of that movement. The characterisation of specific criteria was developed to demonstrate each system's ability to meet a set of stated deliverables. These criteria focus on the structural, representational, and temporal aspects of movement; and their ability to sufficiently foster dance education, scholarship, and research. Through an explicit comparative analysis of three notation systems, I argue that Labanotation enables the preservation of a comprehensive range of movement, and has the capacity to foster the development of contemporary dance. Despite the visual aesthetic of Laban symbols, which is not visually suggestive of the movement they describe, the evaluation

maintains that Labanotation's structure offers a framework that may be efficiently and effectively utilised to assist in the documentation of dance notation applications.

In Chapter Four, I explore various types of existing technologies that can provide a suitable level of accuracy and accessibility to members of the dance community in the documentation, translation, and visualisation of movement. I begin by establishing the capacity for which existing technologies provide an appropriate level of functionality, usability, and expediency in the documentation and modification of movement. This is achieved through a method of comparative analysis in which specific criterion are designed to identify the manner and scope by which movement is treated through various technologies. This encompasses the capabilities for different technologies to appropriately assist in the documentation, modification, immediacy, efficiency, and storage of data in a digital realm that is also relatively straightforward to use.

The difficulties associated with translating a description of movement to an animated form are also discussed. This is in relation to the types of motion data that provide a basis for the interpretation of movement to a digital representation for its eventual visualisation. An additional set of criteria is designed to evaluate the levels of precision, aesthetic value, visual perspective, immediacy, and accessibility that are possible within the interpretation and visualisation of movement. The comparative analyses of technologies utilised in both the documentation of movement and those in its translation and representation demonstrate that the notation-based animation, derived from Labanotation, is a suitable use of technology for recording, editing, translating, and visualising movement in a digital environment.

Research about Design

The chapters in Part III of this thesis focus on research about design. A review of the literature on research about design provides a foundation for the design perspective in which this research is conducted. I consider the influence this perspective has on the approach taken to develop the design outcome of this research, and the various techniques employed in the design process. This research is further based on the following subsidiary hypotheses:

- An operational method for the planning and production of design artefacts offers a way in which the design process can be shaped to simplify complex information, relevant to the diverse practises of movement composition as Labanotation scores.

- A systematic design strategy characterized as a productive science or poetics can facilitate the design of a product that embodies the necessary structure to support the interaction of complex information as an integrated and organised whole.

In Chapter Five, I consider the complexities of design, its attendant practises, and theoretical foundations. Here, I seek to better understand the pluralism of perspectives in design, and ways in which designers may leverage interdisciplinary knowledge from the arts and sciences in the creation of new products and services. This is because the nature of understanding a problem is related to the approach taken to solve it, and where the definition of a problem develops into a method of approach that will impact upon the direction from which the solution is derived (Rittel and Webber, 1973).

For the purposes of this research, I characterise the design process as a conversation. This is suggested as a way to enhance a designer's ability to interact with stakeholders involved in the co-creation of a design solution, and conceptually develop novel design solutions in participative situations (N. Ebenreuter, 2007). The examination of design strategies offers a foundation for understanding the use and appropriateness of design methods for a variety of issues and problems in the act of designing. To facilitate a designerly understanding of thinking, doing, and acting in the design process; I take a philosophical approach to the analysis and subsequent interpretation of design literature from the late nineteenth to early twenty-first centuries.

The intimate relationship between the analysis and synthesis of form with regard to the variety in which they can be treated suggests that an operational method for the act of designing is central to shaping the process carried out in this research. This is one in which a designer's perspective, experience, and judgements made during the design process are central to the actions taken to guide its development. However, I also argue that a method of approach alone is not sufficient to guide the act of designing (Alexander, 1964). I argue, rather, that when design is considered an art, it is a way of

working and thinking that seeks to bring differences together for the embodiment of a design outcome that will enrich the human experience (Buchanan, 1995; Gropius, 1955).

In Chapter Six, I discuss the dynamic nature of the design process. I offer a second-order cybernetics structure, based on a constructivist perspective, as a way to enhance design thinking by providing greater insight into the actions and consequences of designing, and the designer's role in the design process. In support of this, I argue that conversation theory can provide designers with a practical method by means of which the components of a design situation; through discussion, negotiation, and mutual understanding; can be formulated. To incorporate these ways of thinking and working, I suggest a poetic strategy, the art of making, for the creation of design products in which scientific and common sense approaches may be equally considered and argued as being necessary. I provide a strategy for the discovery, invention, production, and formation of connections between various elements of a design situation that encompass elements of dialectic, rhetoric, and grammar.

Research through Design

The chapters in Part IV of this thesis focus on research through design. In Chapters Seven and Eight, I discuss by way of example the reformulation of a design outcome that seeks to establish a unity of form between the structure, materials, and the manner in which design products are created to function. Chapters Nine and Ten in Part V of this research serve to contribute new knowledge to the field of design through the process of actually designing and evaluating the usability of the prototype application LabanAssist. This research follows a process of inquiry, analysis, synthesis, and evaluation; and is further based on the following subsidiary hypotheses:

- A number of interactive functions within existing or similar applications designed to capture movement can be utilised to enhance the composition and interpretation of movement and, in doing so, support a variety of user interactions.

- Designers can develop an understanding of the diversity of users' needs and actions in interactive situations through collaboration, negotiation, and learning during participatory modelling activities.

- Interaction and interface artefacts can be appropriately designed to structure complex information and allow for diverse use situations through a play of tropes represented as broad associations of terms in the design of an interface.

- The integration of an operational structure within the prototype application LabanAssist can facilitate the composition of notation, and provide the dance community with greater accessibility to the use of Labanotation.

In Chapter Seven, I focus on the early conceptual development of the prototype application LabanAssist. I use system capabilities that draw on the outcome of an evaluation of functional requirements for LabanAssist to define a provisional set of high-level system features and functionality. This is in combination with high-level usability goals and user functions for the prototype's development. In this way, the key elements of existing dance notation applications' functionality, usability, and visibility can be ascertained and leveraged accordingly to develop suitable design alternatives. Furthermore, it provides a basis to establish the evaluation criteria required to assess the effectiveness of the proposed system's form and function.

I also discuss the difficulties associated with modelling and visualising an appropriate system of interaction that facilitates the composition of Labanotation scores. I consider an approach that enables the knowledge of mutual design decisions to be made explicit. This is based on the collaboration and agreement between the potential users of the system and the designer during task analysis workshops. I suggest that a combination of visual tools can be utilised to facilitate the representation of user tasks as a way to frame the functionality of the proposed system and the boundaries of the design inquiry. In doing so, the communication of new knowledge to be created will be assisted, and will provide the underlying rationale for the design of products that value diverse-use situations. I argue that effective modes of interaction, conversation, and understanding will enhance the framing of a design situation that will appropriately consider the diversity of user needs.

In Chapter Eight, I illustrate the fundamental problems novice users of Labanotation encounter when learning its symbolic language. This knowledge is developed collaboratively with Labanotation students and experts as a means to better understand the necessary requirements of a system for novice use. It provides a rationale for the type of artefacts that should work to assist in the design of interactive features and an interface that communicates a structured process to the composition of Labanotation scores. I discuss the process of transforming this information into a visual interface in relation to various design techniques and principles used to structure and simplify complex information.

In Chapter Nine of Part V, I examine the outcomes of an iterative design process that aims to enhance the usability of the designed prototype application LabanAssist. I discuss the continual reformulation of the design situation, and the various types of prototyping utilised in the design of an outcome that has capacity to accommodate diverse user interactions. To support this, OSU dance students have evaluated the usability of the system. Product evaluation results suggest that the introduction of an operational structure for the composition of Labanotation scores can facilitate the correct syntactic and grammatical composition of notation. This has the potential to provide the dance community with greater accessibility to the use of Labanotation. Sheila Marion, Associate Professor and Director of the Dance Notation Bureau Extension, has critically examined and approved the prototype application for its pedagogy and suitability for learners of Labanotation.

Finally, in Chapter Ten, I summarise the findings of this research and suggest the possibilities for future development. I suggest that taking a design approach to the creation of the prototype LabanAssist has resulted in the formulation of a prototype application that has the potential to enhance dance literacy. More important, I argue that the utility of LabanAssist achieves this in a manner that captures the creativity of an artist by alleviating the complexity of the technical composition of Labanotation scores. Through the design of an interface that facilitates the communication of complex symbolic information, novice students of Labanotation are able to create Labanotation scores by visually associating Labanotation symbols with the movements they describe. This, in turn, offers greater provision and accessibility of dance notation systems to

members of the dance community, and serves as a vehicle for the ongoing cultural expression of dance knowledge.

Part II: Research for Design

necessary to acknowledge this complexity and to identify the challenges it presents for the documentation and interpretation of movement (Hutchinson Guest, 1984). Badler and Smoliar (1979) tell us that there have been many approaches for representing human motion within a digital context. A lack of consensus regarding the manner in which movement should be described creates distinct challenges to researchers in identifying a framework for its consideration (N. I. Badler and Smoliar, 1979). Taking this view into account, it is necessary to acknowledge these difficulties, and to supply a basis upon which movement is perceived, described, and understood throughout this thesis.

Movement is a result of internal or external muscular responses that motivate the physical shape of the human body (Hutchinson Guest, 1977). Laurel (1993) discusses the explicit and implicit characteristics of human movement, and the challenges involved in reiterating its description by way of the written word or speech, because of its inherent ambiguity. The intricacies involved in providing a sufficient reference to a continuous flow of movement and rhythm in a three-dimensional space become challenging when the numerous movements the body can perform simultaneously are considered (Barbacci, 2002). While the muscular impetus of the body is not vital to the documentation of movement, the result of its force allows for a visual form that may be recorded successfully (Hutchinson Guest, 1977). Typically, a record of movement involves the translation of space, time, energy, and body into a symbolic structure that can be interpreted and converted to a physical form (Hutchinson Guest, 1977). This method of translation requires an explicit description of movement that can appropriately convey the nuances of movement in a tangible record that is universally understood.

Perceiving and Interpreting Movement

Tangible records of movement provide an historic account of human motion that enables the interpretation, analysis, and reconstruction of movement for its performance. As dance creation and composition finds greater application in a digital environment, the perception of the body and its disembodiment with a physical presence has become an emergent topic (Behm, 2004; Bench, 2004; Fernandes, 2002; Kroker, 1995; Neville, 2003; Sharir, 2007; Stelarc, 2005). Foster (1986) investigates the

Hutchinson Guest, 1977, 1984; Sheets, 1966). While this approach does not attempt to link the fields of dance and science, it serves to juxtapose elements of their use in the exploration and analysis of movement to establish a basis upon which I consider movement throughout this thesis.

Hutchinson Guest (1984) argues that dance is primarily a scientific endeavour that can only be described, interpreted, documented, and developed through symbolic languages. Her view is premised on an understanding that elements of artistic qualities attributed to the art of dance are perceived as creative human developments that contribute to a fundamentally scientific discipline (Hutchinson Guest, 1984). For Hutchinson Guest (1977), symbolic languages provide an objective record of movement that enable methods of innovative research to be performed through the comparative analysis and identification of movement structures and patterns. This is significant to this research because it enables me to attach structures to movement. Chatfield (in Fraleigh and Hanstein, 1999) argues that there is a necessity for a scientific framework in which the collection of data applicable to dance research can be objectively observed and analysed. He (Chatfield in Fraleigh and Hanstein, 1999) challenges the notion that scientific practise is fundamentally formulaic, and maintains that creative aspects of scientific experimentation comparable to the choreographic process can be used to augment discovery and innovation. While there is a perception that creative methods of exploration result in the exclusion of effective forms of analysis or logic (Laurel, 1993), creative experimentation can be leveraged for methods of investigation and innovation. Sheets (1966), however, takes into account the perspective of the performance and the experience of movement, in relation to its actuality and observation, as significant to the uniqueness and quality of dance. This suggests that the phenomenology of dance is one that places value on the meaning found in the immediate experience of dance, rather than on the result of objective reflection (Sheets, 1966). A canvassing of the varying contexts in which movement is perceived provides insights that are significant to the description and context of the analysis of dance.

Describing Movement

If we accept the notion put forward by Hutchinson Guest (1984) that dance is primarily a scientific activity that makes use of symbolic writing systems, it is necessary to

consider symbolic languages that have the capacity to describe movement for its documentation, analysis, and reconstruction. One symbolic language in particular that is readily available and broad in its field of communication is natural language. It is generally accepted that the use of words, or natural language, can be utilised to facilitate a description of movement that is commonly understood (N. I. Badler and Smoliar, 1979; Hall and Herbison-Evans, 1990; Hutchinson Guest, 1984, 1989). However, difficulties associated with the complex nature of movement and the capacity to provide an adequate portrayal of its occurrence (Sheets-Johnstone, Hutchinson Guest, 1984, 1989; Jensen, 2005) generally result in convoluted descriptions of movement that offer little assistance in the clarification or concept of motion. In support of this argument Badler and Smoliar (1979), tell us that natural language descriptions are more susceptible to imprecision and ambiguity when attempting to specify complex aspects of movement such as dynamics and style. Nevertheless, occasions in which natural language are employed as a method to describe movement can be found in "Danscore" – *The Easy Way to Write a Dance* (in Hutchinson Guest, 1984) and the proposed application "Ballet Animation Language Linked over Nudes Ellipsoid System" or "BALLONES" (Hall-Marriott and Herbison-Evans, 2007).

Danscore offers its users predefined word descriptions. These descriptions are designed to facilitate the documentation of movement by encompassing a range of actions achievable within a particular dance genre (Hutchinson Guest, 1984). Elaborate combinations of word descriptions form the foundation of movements available for selection. This requires a user to circle key words from each group of text descriptions to indicate a record of the desired movement that aligns itself with accompanying musical scores and stage plans.

The computer application BALLONES eliminates the use of dance notation systems, and interprets natural language in the context of classical ballet terminology to facilitate a representation of movement (Hall-Marriott and Herbison-Evans, 2007). This is achieved by documenting a concise description of movement using classical ballet terminology that BALLONES then translates to an animated form (Hall-Marriott and Herbison-Evans, 2007). Communicating a description of dance through written words appears to be ideally suited to members of the dance community, because classically trained dancers are customarily educated in the terminology of classical ballet.

Within the context of specific dance genres, however, there exist distinct techniques and styles of dance that require subtle variations in their description of movement, to differentiate one style from another. For example, the Russian Vaganova method of classical ballet and the English style of the Royal Academy of Dance are examples in which the variations between these two techniques could not be easily identified using a generic form of ballet terminology. A consequence of the inability to accurately describe these differences could produce undesirable results in their interpretation. This is because classical ballet terminology does not consider those movements outside the context of the language to which it subscribes. As Hutchinson Guest (1984) tells us, dance terminology is not universal in its application or interpretation. Systems that employ words to document movement limit the extent to which they find application in a wide range of fields (Hutchinson Guest, 1984). This suggests that the use of natural language in the context of a specific dance genre is limited in its capacity to account for the explicit representation of a complex range of movements.

To overcome such a limitation, Laurel (1993) argues that the requirements of objectivity and accuracy eliminate the role of natural language in favour of unambiguous numerical forms of symbolic representation. In contrast to this Badler and Smoliar (1979) recognise the advantages of symbolic languages in the expressive facility they offer in computer animation over the use of artificial or man-made languages such as computer programming languages. This becomes significant for the use of language and its potential for computation into movement descriptions and animated forms, because the practicalities of symbolic languages provide a concise and objective description of movement in a visual system that can be easily identified and referenced (Hutchinson Guest, 1984).

The literature (Mlakar in Buck, 2003; Hutchinson Guest, 1984; Knust, 1979; Wang, 2004) emphasises the use of movement notation systems as a symbolic form of communication. The above-mentioned authors provide methods of analysis to further enhance dance literacy, and warrant the preservation of movement to cultivate a richer dance heritage. Singh et al. (1983) call attention to the use of notation systems as a means for encapsulating and translating a choreographer's abstract movement concepts to those who execute their performance. It is the ability for notated choreography to be communicated and danced. The communication of movement, therefore, becomes

significant in this research; not only in its representation, but also by what it is, that is communicated, and how the exchange of ideas is made possible.

Authenticity of Movement

Techniques utilised to document and interpret movement serve to inform the authenticity and aesthetic qualities of movement reconstructed for performance. The term "reconstructor" in this instance refers to an individual; other than the original choreographer of a specific work; who utilises notation scores to reconstruct a dance work as closely as possible to its original state (Thomas in Carter, 2004). The analysis and interpretation of dance notation scores enable a choreologist to recreate dance works in their entirety.

The authenticity of movement provided by notation scores is a highly contentious area among academics (Hutchinson Guest, 1984; Jeschke, 1999; Thomas, 2003; Van Zile, 1985). A parallel can be drawn between the fields of dance and music that have endured similar theoretical and practical debates concerning the authenticity, recreation, and preservation of music (Hutchinson Guest, 1984; Thomas, 2003). However, a key distinction must be made between the preservation of dance and music. While musicians have the training and capacity to document and preserve the original intent of their work in established conventions and protocols for writing music; choreographers must rely on a notator's ability to communicate this appropriately in a dance notation score. Concerns surrounding the information notation scores embody perpetuate speculation as to whether these scores illustrate a choreographer's intent; a notator's interpretation of a choreographer's intent; or captures a performer's interpretation of movement (Thomas, 2003). Discussions concerning these topics are by no means an attempt to resolve these issues. Rather, they offer an overview of the complexities associated with the authenticity of movement to determine the way in which movement can be considered in the process of its translation and visualisation.

The authenticity of movement can be evaluated, to a certain extent, for its faithfulness to the original intent of the choreographer; the degree of autonomy permitted to its performers; or the level of precision in its documentation and interpretation. Dance notation languages provide choreologists with the tools to encapsulate the impetus and

concepts behind a broad range of movements (Hutchinson Guest, 1984). Significant to the art of dance is not only the physical knowledge of its performance, but the expression of its aesthetic (Fraleigh in Neville, 2003). Trained choreologists learn to observe and notate various aspects of movement that are central to the objective of its documentation. However, these descriptions can vary considerably with respect to the manner in which movement is understood and subsequently documented (Hutchinson Guest, 1984). Variances in the description and documentation of movement challenge the authenticity of these scores. Choreologists act as translators in communicating the structure and meaning of a choreographer's work in a symbolic form (Hutchinson Guest, 1984). It is through an indirect interpretation of movement that the authenticity of notation scores are queried (Thomas, 2003). Main (in Thomas, 2003) argues that notation scores documented by dancers of a specific work adequately encapsulate the sense and meaning of the choreography. As a result, interpretations of movement by those with direct experience of its performance provide these scores with a greater sense of aesthetics and authenticity (Main in Thomas, 2003). This notion is reflected to a degree within the practise of professional dance companies. The role of a choreographer, ballet master, rehearsal director, and dancer become vital resources in supplying firsthand knowledge of a specific dance work. Through the experiential knowledge of movement, they enable the exchange of detailed information to be communicated in the reconstruction of dance works.

Descriptions of movement are central to shaping the type and style of information a choreographer or choreologist wishes to capture (Hutchinson Guest, 1977, 1984). The nature of these descriptions supplies choreologists with descriptive and prescriptive representations of movement. A descriptive representation of movement illustrates movement in the style it was originally performed, while a prescriptive representation refers to the manner in which it should be performed (Hutchinson Guest, 1984). These descriptions propound choreologists with distinct knowledge of the information they elucidate for the reconstruction of movement.

During the process of reconstructing movement, notation systems make visible performative knowledge, that is, the symbolic communication of physical experiences (Jeschke, 1999). This knowledge is representative of an implicit description of movement that negotiates the ideal skills and capabilities of the body and movement

(Jeschke, 1999). From this perspective, performative knowledge enables the individual interpretation of movement, and provides a framework for its application to dance (Jeschke, 1999). Implicit or general descriptions of movement enable performers greater autonomy in the expression and interpretation of movement (Hutchinson Guest, 1977). Their reconstruction and resulting performances generate new perspectives of dance knowledge (Jeschke, 1999). The notation of an explicit description of movement, however, will impart a distinct record of movement, regardless of a performer's individual capability, interpretation, or talent. Explicit descriptions of movement enable the intent of a choreographer's style and context of movement to be effectively preserved (Hutchinson Guest, 1984; Wang, 2004). For that reason, implicit and explicit descriptions of movement are fundamental to the record and interpretation of movement.

The interrelationship of the comprehension, description, and interpretation of movement are complex. An appropriate record of movement is not the only characteristic required for the dedicated reconstruction of movement to effectively communicate the style, context, and motivation of a dance work. Choreologists interpret notation scores based on individual understanding, experience, dance training, technique, and artistic judgement (Harrington, Delaney and Fox, 2001; Hutchinson Guest, 1984; R. J. Neagle, 2003). In this research, I focus on developing an appreciation and understanding of the diversity in which movement can be described, documented, and interpreted; rather than on the nature of its authenticity.

Understanding Movement

In view of the arguments outlined above, the debate continues in relation to whether notated movement should depict the practicalities of movement or encompass the concept and motivation underpinning it (Hutchinson Guest, 1984). Similar difficulties surrounding the representation of movement and its intention of providing a reference to the manner in which movement is, or should be, performed have yet to be determined (Hutchinson Guest, 1984). Divergent perceptions and analyses of movement provide a foundation upon which distinct aspects of motion can be scrutinised for their authenticity and aesthetic value.

This research sits within distinct parameters. It does not attempt to provide a solution to the authenticity of documenting movement. Rather, it takes into consideration that no two individuals will interpret, describe, or record movement in the same way. In assisting the precise grammatical record of movement, it is not the intent of this research to modify the symbolic language of dance notation. As an alternative, technology will be used to facilitate the accurate placement and construction of notation symbols on a score, so that movement may be preserved, documented, and interpreted with greater syntactic and grammatical precision. In allowing for greater precision in the authorship and interpretation of dance notation systems, in this sense, there is the potential to enhance dance literacy in the dance community, and safeguard the accurate preservation of valuable cultural archives. For the purpose of this research, the method of scientific movement observation and analysis provided by Hutchinson Guest (1984) is adopted as a framework in which the documentation and interpretation of movement is understood. This involves the use of movement notation systems to facilitate a symbolic description of movement.

Movement Notation Systems

Hutchinson Guest (1984) tells us that dance notation systems enable a symbolic representation of movement to be documented. This is achieved by providing recognisable signs on paper for individual analysis and interpretation. The signs are comparable to the use of music notation for musicians and the written word for drama (Hutchinson Guest, 1984). If we accept Hutchinson Guest's (1984) definition of notation systems, then we can acknowledge the range of benefits in writing, recording, and viewing movement; particularly in the description and preservation of dance. An in-depth study of these languages is provided by Hutchinson Guest (1984, p. 203).

Notation systems permit varying degrees of detail to be captured in the documentation of movement (Hutchinson Guest, 1984). This is achieved by recognising the vital aspects of motion, and evaluating their role in the preservation of movement to facilitate its reconstruction (Hutchinson Guest, 1984). It relies upon elements of body part, location, direction, weight transference, style, duration, and dynamics to be recorded accurately (Hutchinson Guest, 1977, 1984; Knust, 1979). A comparison can be drawn between the technique notators use to identify and record key elements of action, and

the key poses of action traditional animators record as "key-frames" to generate animated movement (Calvert et al., 2002; Hutchinson Guest, 1984; Lasseter, 1994). A general description of implicit movement allows for the reconstruction of dance works from notation scores, giving a performer greater autonomy in the interpretation and expression of their performance (Hutchinson Guest, 1977). For a choreographer's intent to be explicitly represented and communicated, a precise record of movement is required for the study of movement analysis (Hutchinson Guest, 1984).

Difficulties associated with the complexity of movement and the practical use of notation systems are further complicated by these systems' capacity to accommodate a comprehensive range of human movement that extends from simple to complex symbolic representations of movement (Calvert and Chapman, 1978; Calvert et al., 1980; Lansdown, 1995; Singh et al., 1983). Generally, each system consists of a rigorous lexicon of symbols. These lexicons require a thorough understanding of each system's detailed orthography to ensure that a precise account of movement is documented correctly (Herbison-Evans, 2003). Similarities can be drawn between the correct use of grammar and linguistics in verbal communication, and the arrangement of symbolic movement (Brown & Smoliar, 1976; Calvert et al., 2002; Hutchinson Guest, 1977, 1984). Hutchinson Guest (1977, p. 19) illustrates the correspondence of movement to a linguistic form in a *Movement Family Tree* (see also Chapter Seven, "Mapping Interface Objects and Actions"). The structure and visual representation of notation systems becomes significant in maintaining a logical discourse in the comprehension and composition of movement. Hutchinson Guest (1984) claims that an effective use of semiotic and linguistic communication simplifies the interpretation of notation. This means that the proficiency of a system to symbolically represent a structured account of movement contributes to the capacity in which it successfully communicates and translates knowledge or meaning. Whether this can be attributed to the semiotic value of a system is considered further in Chapter One, "Symbolic Communication" and Chapter Two, "Visual Representation." A method of description comparable to the grammatical structure of words and sentences allows for a sufficient level of expression with regard to the characteristics of movement description. Such a method allows for an association between the object of movement and its action to form a logical relationship with each other, and in the context of a complete sequence of movements (Hutchinson Guest, 1977, 1984). A solution to this based on the linguistic

structure of notation systems may also be used within dance notation applications to support efficient methods of assistance in the documentation of movement.

A broad range of symbolic notation systems has been developed for the analysis of, or description of, movement in a number of disciplines such as personal assessment, interpersonal communication, dance, clinical medicine, animation, anthropology, physiotherapy, psychotherapy, athletics, movement-centred interactivity, and industrial time and motion study (N. Badler, Chi, Costa, and Zhao, 2000; The Benesh Institute, 2007; Bishko, 2005; Calvert and Chapman, 1978; Calvert et al., 1980; The Dance Notation Bureau, 2008; Jensen, 2005; The Labanotation Institute, 2007; Loke, Larssen, and Robertson, 2005). An overview of various notation systems and their association to specific areas of application are illustrated in Figure 4. Notation Systems in Fields of Application.

A Comprehensive System

Notation systems are designed in relation to the needs and requirements of a particular field. These target a distinct function, as defined by the designers of such systems, that interpret and understand movement in a specific context (Hutchinson Guest, 1984, 1989). This is exemplified by the characteristics of the "Beauchamps-Feuillet" notation system that was designed specifically to record the ornate style of baroque dancing (Barbacci, 2002; Pierce, 1998; Wilson, 2003). With such a definite purpose for its creation, the exclusive nature of this highly stylised form of notation renders itself useful only to its own precise context.

Notation systems have now developed beyond the original intent of their design functions (Hutchinson Guest, 1989). This is because of an increasing awareness surrounding the need for alternative descriptions of movement (Hutchinson Guest, 1989). Research that investigates a range of movement notation languages is illustrated in Figure 4. Notation Systems in Fields of Application. This data demonstrates that each language is beneficial to an extensive range of disciplines. The ability of notation languages to be used either generally or specifically further highlights the capacity of a language to encompass a comprehensive description of movement or remain specific to

Key

Languages
Notation Systems

Areas of Use
- Fields of Application

Defined Areas of Use
Relevant Disciplines

Notation Systems

1980
Eshkol - Wachman Movement Notation

1997
Morris Dance Notation

1955
Benesh Notation

1979
Kestenberg Movement Profile

1973
Sutton Sign Writing

1980's
FASR-System

1967
Motif Description (LOD)

1989
HamNoSys

1974
Sutton Dance Writing

1983, 1998
The Absolute Kinegraphic Notation System (AKNS)

1928
Laban Notation

- Animation
- Expressive Character Acting

- Computation
- Robotics
- CAD/CAM
- Virtual Reality

- Human Modeling & Simulation
- Training
- Engineering Evaluations
- Ergonomic Evaluations
- Performance Analysis
- Human Factors

- Linguistic Analysis
- Sign Language Machine Gesture
- Sign Language Dictionaries
- Sign Writing
- Sign Synthesis/Animation
- Sign Language Recognition

- Psychobiology
- Animal Behavior
- Animal Movement
- Brain Research
- Animal Morphology

- Sport
- Tennis
- Karate
- Ice Skating
- Football
- Basketball
- Baseball
- Volleyball
- Gymnastics
- Players & Coaches
- Fitness Instructors

- Physical Therapy
- Diagnosis
- Assessment
- Reassessment
- Body Language
- Human Movement
- Injury Rehabilitation
- Teachers of the Disabled
- Treat Autistic Children & Cerebral Palsy Patients

- Movement Analysis
- Movement Research
- Gestural Interpretation
- Body Language
- Animal Movement
- Stylistic Analysis
- Cultural Movement
- Movement Pattern Analysis
- International Cultural Exchange
- Memory Aid for Mechanical Drawing

- Dance Research
- Theory
- Aesthetics
- Early Dance
- Critique of Dance

- Dance Technology
- Record & View Choreography
- Computer Assisted Instruction
- Computer Applications
- Performance Art Installations

- Dance & Movement Education
- Performance
- Production
- Composition
- Choreography
- Dance Technology
- Somatic Techniques
- Notation
- Dance History
- Technique
- Teaching

- Design
- Tangible Interfaces
- Interactivity
- Interface Design

- Dance Therapy
- Trauma
- Developmental Difficulties
- Movement Behavior

- Dance Creation & Documentation
- Notation
- Directing
- Rehearsing
- Choreology
- Choreography
- Performance
- Dance Writing
- Dance Documentation

- Dance Genre Form/Style
- English Country
- Country Western
- Classical Indian
- Folk Square Dancing
- Scottish
- Contemporary
- Hip Hop
- Latin
- Barn
- Mime
- Jazz
- Square
- Ballroom
- Swing
- Baroque
- Classical Ballet

Figure 4. Notation Systems in Fields of Application

a single purpose. This is an example of the restrictions on the use and actual capacity of notation languages, especially when compared to the ability of the Beauchamps-Feuillet notation system to effectively describe a range of movement beyond the capacity of its original intent. Laurel (1993, pp. 156–157) informs us that:

> The nature of the task and the form of the representation presented to people can serve to constrain the intentionality and physical characteristics of the gestures that they are likely to employ.

The range of movement possible within a particular dance form, then, becomes stereotypical to its context. This is because of a rigid offering of symbolic description. While systems of this nature appear beneficial for maintaining high levels of accuracy, they neglect the capacity to foster the development of contemporary movement appropriately. Once we begin to consider the function of notation languages outside of the context of the specific field they were designed to facilitate; as a foreign instrument, their ability to communicate to a wider audience is challenged (Buxton in Laurel, 1993). This demonstrates a necessity for notation systems to encompass a broad perspective of movement in their symbolic description. For that reason, notation systems need to be far-reaching in their capacity to communicate.

The design of a universal vocabulary to record implicit and explicit movement is necessitated by the potential benefits in which a system of communication may facilitate a direct representation of the form and quality of movement outside the confines of context- specific motion (Laurel, 1993). Similarities can be made between the development of sign notation systems and movement notation systems. Miller (2002b) tells us that derivatives of various sign notation languages have resulted in the prevalent use of the “HamNoSys” (Bentele, 2007) and “Stokoe Notation” (J. Martin, 2007) systems. Lack of a universal language, which would be necessary to assist the explicit representation of gestural movement, predicates the call for a standardised sign notation system (Miller, 2002b). An attempt to provide the deaf community with a universal form of notation was made by Delsarte (Laurel, 1993) in the nineteenth century, which also was the original intent behind the design of the HamNoSys (Miller, 2002a) system. Analogous with the design of dance notation, sign languages are

developed exclusively for specific use within communities, and are not universal in their application (Nakamura, 1995).

Dance is inherently stylised and requires a system of documentation that allows for the analysis of movement within a specific field. The absence of a universally applied system to document movement necessitates the investigation of symbolic languages that cater to a comprehensive representation of movement (Hutchinson Guest, 1977; Singh et al., 1983; Thomas, 2003; Wang, 2004). The derivation of sign notation systems, as stated above, illustrates the consequential use of two central notation systems within the deaf community. Uncertainty remains as to the success that a synthesis of existing dance notation languages may have to be utilised to create a universal dance notation system. Hutchinson Guest (1984) maintains that through the practical application of notation systems the capacity for use will be revealed. Practicalities surrounding the exclusive use of notation systems to a specific need or group of individuals may perpetuate a situation in which a universal language is less desirable (Hutchinson Guest, 1984). The purpose of this investigation does not attempt to lay claim to a notation system for universal application. Rather, the evaluation of existing notation systems works to identify the most appropriate system to meet the purposes of this research. The evaluation of existing notation systems is the basis for identifying a system capable of encompassing a broad range of movement disciplines that enables a level of precision in its vocabulary; equivalent to a system designed for explicit use. This provides the potential for notation applications to employ the use of a comprehensive notation system that facilitates a wide application of movement analysis. It also offers an opportunity in which the findings of this research may be applied beyond that of the dance community. In order to achieve this, it is necessary to investigate a comprehensive range of movement notation languages that extend beyond the confines of dance (Hutchinson Guest, 1984). For the purposes of this research, the capacity in which notation systems enable a critical analysis of movement concepts becomes significant in supplying the dance community with a means to develop dance literacy.

The characteristics of a comprehensive notation language can be recognised in the dominant practise of the Labanotation and “Eshkol-Wachman Movement Notation” (EW) systems, as illustrated earlier in Figure 4. Notation Systems in Fields of Application. These notation languages highlight a generalised structure of their design,

which allows them to sustain various needs across a wide range of disciplines (Calvert and Chapman, 1978; Calvert et al., 1980). Three dance notation systems noted for their ability to encapsulate various styles of dance movement are Benesh, Labanotation, and EW (Lansdown, 1995). Each was created for the notation of dance. Benesh and Labanotation currently enjoy wide use; however, the EW system finds greater application in scientific research (Faulkes, 1998). This is because of its mathematical structure, which offers the user a choice in its unit of measurement. An analysis of these notation systems illustrates their diversity for a distinct use or broad application. Moreover, these languages are the three most commonly used and widely established dance notation systems (Herbison-Evans, 2003; Hutchinson Guest, 1984; Lansdown, 1995; R. J. Neagle and Ng, 2003; R. J. Neagle et al., 2004; Singh et al., 1983).

Visual Representation

Notation languages are symbolic languages. The method in which these symbols represent information visually is relevant to the success in which they communicate. The visual and descriptive capacity of notation systems to provide an unambiguous association to a detailed description of movement that is both visually aesthetic and easily interpreted is difficult. This is because symbols do not explicitly represent the objects they depict. In relation to their semiotic value, Krippendorff (2006b) tells us that signs or symbols are established by the conditions or conventions of their use; rather than a consideration for their ability to be meaningful or useful to users of such systems. I argue that this determines the capacity for which notation systems can provide an understanding of the movement they represent. Dictated by the rules and conventions of a specific language or notation system, the aesthetic value of abstract languages such as Labanotation are regarded as secondary to the concern for their functionality and kinetic content (Barbacci, 2002). This, in turn, affects the accessibility and subsequent usability of such systems by an unassuming community of participants. This is important because it represents a fundamental issue of design which concerns the transfer of semantics to imagery (Barthes, 1977).

The identification and interpretation of symbolic writing systems by a community of participants that engage in the practise of disseminating knowledge via such systems, is central to their use and practical application. This is because without an understanding

of the information various signs and symbols of a system communicate, there is less potential for their use. While technology has removed the necessity to write notation scores (Hutchinson Guest, 1984; Venable, 2005), visual aspects concerning the representation and interpretation of dimension and perspective remain vital to the symbolic efficiency of notation systems (Hutchinson Guest, 1989). Barbacci (2002) tells us that fundamental characteristics of notation systems are designed to provide varying methods of movement analysis, symbolic representation, or levels of description. Depicting movement by distinct forms of visual representation achieves this variance in the function of notation systems. Specific types of notation systems are identified by the manner in which they describe movement. Stick figure (Hutchinson Guest, 1989, p. 35), music note (Hutchinson Guest, 1989, p. 79), or abstract symbols (Hutchinson Guest, 1989, p. 119) are the means through which movement is described and symbolically represented (Hutchinson Guest, 1989). Each type of notation system is acknowledged for its benefits to a specific purpose.

Stick figure systems indicate movement by way of pictorial figure drawings (Hutchinson Guest, 1989). They provide an impression of motion that is immediately understood for their aesthetic resemblance to the human form (Hutchinson Guest, 1989). Through the symbolic use of abstract signs; elements of body, direction, time, and force are arranged to describe and represent movement (Hutchinson Guest, 1989). Generally, systems that make use of abstract symbols allow for a rigorous description of movement (Hutchinson Guest, 1989). However, the ability to discern the movement they represent is a highly ambiguous activity. This is due to their level of abstraction and, because of this, the capacity to describe a comprehensive range of movements at a conceptual level. The apparent contradiction in terms gives emphasis to the difficulties concerning the description and interpretation of movement in a consistent and reproducible form. This is with particular reference to the rigour in which movement is documented and the potential for difference in the individual interpretation of its symbolic representation. By comparison, music notation has been adapted by music note systems to signify the timing and position of movement as opposed to pitch (Hutchinson Guest, 1989; Singh et al., 1983). Because of this, the ability to capture complex variations in time and space means that music note systems are too rigid for the notation of movement (Hutchinson Guest, 2005a).

It is useful to consider the visual characteristics of these languages in relation to their ability to convey movement aesthetically; particularly in practical use situations where it may be possible to gain a basic understanding of the movement a system signifies, without knowledge of its conventions or performing an exhaustive analysis of the language. A specific style of symbolic representation could work as a constructive element that assists the formation of meaningful associations to the movement it represents for users of its language. Hutchinson Guest (1984) tells us that the visual appeal of a system contributes significantly to its ability to communicate with its intended audience. In light of this, it is possible to appreciate the propensity to supply dancers with immediate modes of visual representation through stick figure systems. Examining the propensity in which symbolic notation systems have the capacity to communicate various aspects of dance knowledge becomes significant in this research when facilitating the use of a system that has the potential to offer the dance community an accessible means of reading, writing, and interpreting movement.

Evaluative Method of Notation Systems

In order to conduct a proficient, comparative analysis of notation systems, the degree to which notation systems function to provide an efficient and logical framework to establish an appropriate discourse in the composition of movement needs to be defined. Hutchinson Guest (1984) provides us with an extensive model for the evaluation of notation systems. This establishes a basis upon which each criterion was adapted to stipulate a distinct condition.

Fundamental to the method used in this evaluation is the design of a systematic approach for identifying a notation system that enables an appropriate description and representation of movement suitable for computation. To date, an in-depth comparative analysis of the existing eighty-five or more movement notation systems has not been formally undertaken (Hutchinson Guest, 1984). The nature of this research and its specific focus on notation systems that may be used by the dance community for the purposes of education, scholarship, and research does not attempt to provide a rigorous evaluation of a broad range of systems. As Hutchinson Guest (1984) suggests, the following method of evaluation that I designed offers a comparative evaluation with

other systems that focuses on the strengths and weaknesses found in Benesh, Labanotation, and EW.

In this evaluation, I consider key aspects of the structure, representation, and measure (timing) of movement as fundamental elements in the identification of a comprehensive movement notation system. My definition of these criteria offers a framework for the comparative analysis of each system to be documented. This allows the extent of their value, use, and possible outcomes to be exhibited.

The following criteria illustrate the degree to which each notation system is required to operate to demonstrate capabilities for its use. They are required to:

1. Encompass a comprehensive range of human movement that is both flexible in its application and detailed in its description;
2. Embody a structure suitable for computation;
3. Allow for the analysis of movement concepts to a degree suitable for the education, research, and theory of movement;
4. Provide timely visual communication of movement through symbolic representation;
5. Effectively represent three-dimensional direction within a spatial context; and,
6. Provide a reference for complex rhythm.

Movement notation systems that facilitate a record of movement play a significant role in determining the extent and ease in which an extensive range of movement can be accurately documented. Each system under review provides various strengths and weaknesses in its ability to capture and represent movement concepts. As a result, it is necessary to examine the unique aspects each system offers in the documentation and representation of movement to reach a suitable outcome. The above criteria characterise the visual, symbolic, spatial, and structural aspects of notation systems needed to facilitate the analysis of movement. When these criteria are applied, they provide evidence of a notation system's capacity to meet them.

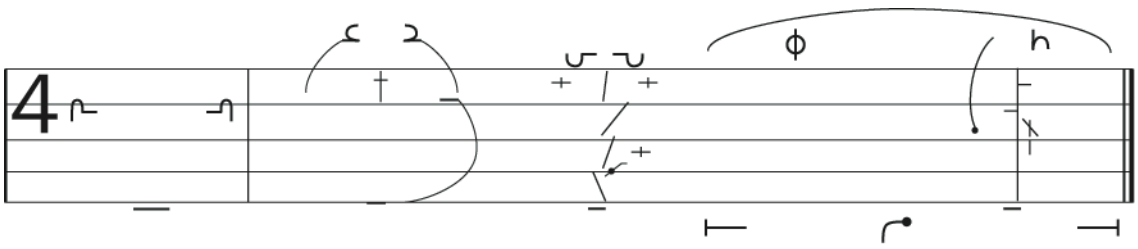
These criteria are applied to the examination of the following movement notation systems:

- Benesh
- Labanotation
- EW.

Mapping notation systems that are extensive when applied in the description of movement against the above criteria establishes a method of analysis that I address in the examination of each notation system.

Benesh Movement Notation

Benesh, devised by Joan and Rudolf Benesh, takes the visual representation of movement as its primary concern (Damle, 2002). (See Figure 5. Benesh Movement Notation Score for a visual representation of Benesh.) A five-line musical staff provides a two-dimensional reference of movement that distinguishes elements of the body through the positioning of pictorial symbols. Three-dimensional spatial coordinates are indicated with the addition of symbolic modifiers (Hutchinson Guest, 1989; Singh et al., 1983). A Benesh score describes movement as it is observed when standing behind a performer. This enables movement to be easily interpreted from the perspective of the reader, and provides a viewer with an immediate representation of movement and time (Hutchinson Guest, 1989). Benesh was specifically designed to indicate rhythm for dancers who react to the pulse of music rather than notes (Damle, 2002). A time signature and tempo are indicated at the beginning of the staff, with additional rhythmic symbols positioned above for the identification of beats (Hutchinson Guest, 1989; R. J. Neagle, Ng, and Ruddle, 2002).



Reference: After The Benesh Institute, viewed March 2005,
http://web.archive.org/web/20070311051028/http://www.benesh.org/frames.html

Figure 5. Benesh Movement Notation Score

Benesh was originally devised to record all forms of movement (Hutchinson Guest, 1984). However, it has identified a greater application in assisting with the description of movement within the rules and structure of classical ballet (Calvert and Chapman, 1978; Calvert et al., 1980; Hutchinson Guest, 1989; R. J. Neagle and Ng, 2003; Wang, 2004). These rules refer to the stylised nuances of movement and precise positioning of limbs necessary to achieve the visual aesthetic classical ballet demands. More recently, Benesh has evolved to accommodate a description of movement outside the stylistic confines of classical ballet (Wang, 2004). Hutchinson Guest (1989) notes the difficulties associated with the use of visual notation systems by telling us that documenting a dancer's key visual positions does not effectively capture a description of movement. Abstract movements then become problematic for a notator to capture in a pictorial form. In so doing, it distorts the original intent of movement (Hutchinson Guest, 1989). This suggests that Benesh remains restrictive in its ability to provide a comprehensive range of movement (Hutchinson Guest, 1989; Lansdown, 1995; Wang, 2004).

The design of Benesh allows for a concise description of movement that works on a principle of redundancy avoidance. This involves the elimination of excess symbolic descriptions beneficial to the timely composition and visual interpretation of Benesh scores. However, the omission of a detailed and precise description of movement opens itself up to ambiguity and becomes a problem in the analysis of movement (Hutchinson Guest, 1989). With an emphasis placed on the simplification of movement descriptions, visual notation systems fail to provide necessary movement concepts such as motivation or dynamics to be successfully recorded for movement analysis (Hutchinson Guest, 1989). Given these shortcomings, current dance notation editors MacBenesh (R. Ryman, 1999) and "Benesh Movement Notation Editor" (R. Ryman, Singh, Beatty, and Booth, 1984; Singh et al., 1983) are still able to demonstrate the successful application of Benesh within a digital environment. Furthermore, Lansdown (1995) and Singh et al. (1983) make reference to collaborative and individual developments made by Politis and Herbison-Evans that endeavour to simplify the translation of computer models for animation through the use of Benesh.

Labanotation

Created by Rudolf Laban in 1928, Labanotation is documented on a vertical staff, and is read from bottom to top (Hutchinson Guest, 1984). In a similar style to that of Benesh, a Labanotation score presents a description of movement from the rear view of a performer. (See Figure 6. Labanotation Score for a visual representation of Labanotation.) A Labanotation staff is made up of three lines that are divided by a centre line to indicate the left and right side of the body (Hutchinson Guest, 1984). This provides a symmetrical representation of the body in which each column of the staff is reserved for a specific body part (Hutchinson Guest, 1984). Information pertaining to time, direction, level, and body part are contained within a single Labanotation symbol (Barbacci, 2002). This is illustrated by the particular shape, shading, and size of each symbol. Hutchinson Guest (1989) tells us that such an economy of information cannot be found in other notation systems. Labanotation represents the duration of movement through the length of its symbols that is proportional to the time it takes to perform (Hutchinson Guest, 1989). The design of a system that embodies elements of time in this manner eliminates the need for a visual reference to a musical score alongside the movement notation (Hutchinson Guest, 1989).

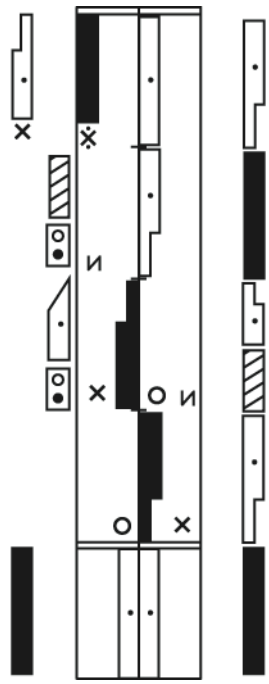


Figure 6. Labanotation Score

Labanotation caters to a broad range of research and analysis across movement-based disciplines (Hutchinson Guest, 1989). It enables a degree of flexibility that accommodates varying levels of description because of the underlying structure, movement principles, and attributes of the system. These attributes provide researchers with the vocabulary and the analytical framework necessary to describe movement (Badler, Chi, Costa, and Zhao, 2000). Dance educationalists (Blum, 1999; Curran, 2001, 2005; Hackeny, 2005; Harrington Delaney, 1999; Hutchinson Guest, 1977, 2005b; Fox in Wang, 2004) tell us that commonalities between Labanotation, "Laban Movement Analysis" (LMA), and Motif Description provide significant benefits for the education and development of dance literacy. I will draw upon these suggested benefits because of the association between the three languages. Literature from the above-mentioned dance educationalists tell us that an understanding of Motif Description provides a foundation for learning Labanotation; while an understanding of LMA principles can enhance the use and application of both systems.

Research that I have undertaken to examine existing notation applications (see Figure 7. Notation Applications) illustrates various types of notation languages that form a direct relationship to the development of computer software and notation applications. It highlights Labanotation as a language that is frequently used to develop existing notation applications. Similarity, Singh et al. (1983) have found that Labanotation has repeatedly been used as a means to interpret movement. However, this comprehensive facility of Labanotation poses distinct challenges in the learning of its extensive range of symbols, when compared to other systems (Yasuda, 2001). This is because of the broad vocabulary and number of symbols that Labanotation uses to define motion (Sternberg and Essa, 2002). Hutchinson Guest (1977) tells us that information portrayed by notation symbols that allow for the research and analysis of movement require abstraction. This means that abstract notation systems, such as Labanotation, are criticised for their ability to perform as a visual language in the immediate documentation and interpretation of movement (Hutchinson Guest, 1984, 1989; Yasuda, 2001).

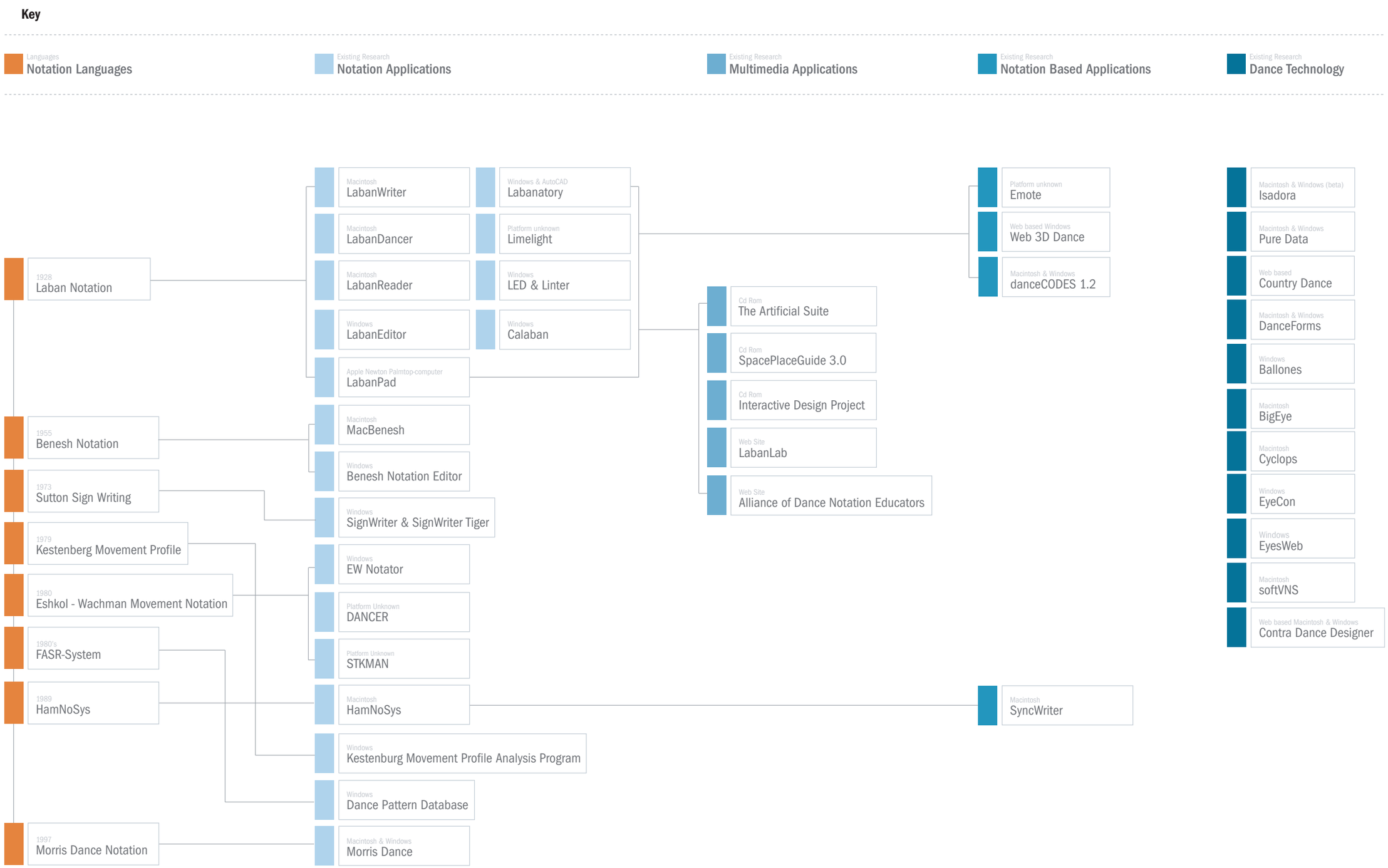
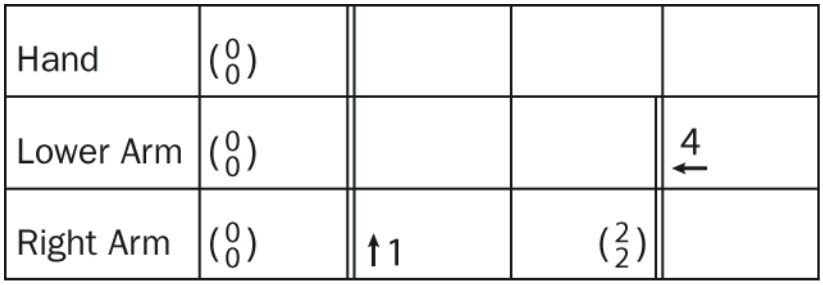


Figure 7. Notation Applications

Eshkol-Wachman Movement Notation

The EW system developed by Noa Eshkol and Abraham Wachmann is based on mathematical logic that brings a scientific approach to the documentation of movement (Hutchinson Guest, 1984). (See Figure 8. Eshkol-Wachman Movement Notation Score for a visual representation of EW.) Designed to encapsulate all forms of movement, it describes movement in anatomical terms (Faulkes, 1998; Hutchinson Guest, 1984, 1989). It takes the circular movement of the joints of the body as fundamental to the description of motion. This allows for movement to be defined by spatial coordinates (see Hutchinson Guest, 1989, p. 189). Movement is then interpreted by reading an initial starting pose, its time structure, the direction and degree of motion, and the final position (Faulkes, 1998). Two numerical coordinates represent the position and destination of movement (Faulkes, 1998; Hutchinson Guest, 1984).



Reference: After Faulkes, Z 1998, Eshkol-Wachman Movement Notation, viewed April 2005, http://web.archive.org/web/20060526155120/http://www.biology.mcgill.ca/perspage/ew_page.htm

Figure 8. Eshkol-Wachman Movement Notation Score

Movements are represented on horizontal staffs that are read from left to right. These staffs are divided into clearly defined segments positioned from the top to the bottom of a score. A written indication of a particular body part provides a context for the description of movement. However, the use of numbers to signify these elements does not allow for a symmetrical representation of the body in its division among the staffs (Hutchinson Guest, 1984). As in music, units of time in EW are indicated by the placement of double vertical lines at set intervals along a score (Faulkes, 1998; Hutchinson Guest, 1984).

EW enables a flexible description of movement. It has the capacity to amend the standard measure of time and movement displacement (Hutchinson Guest, 1984, 1989), which allows it to capture complex variations in space and time. The system offers an extensive range of specialisation and generalisation in its facility to describe all forms of movement (Faulkes, 1998; Hutchinson Guest, 1989). Its primary concern is the shape of movements that illustrate an objective account of motion and its destination from a mathematical perspective (Hutchinson Guest, 1984, 1989). In its description of movement, however, it does not consider the stylistic nuances or dynamics of human movement (Faulkes, 1998; Hutchinson Guest, 1984).

The conceptual shift required to interpret numbers to physical motion is challenging in comparison with visual notation systems. Sternberg and Essa (2002) argue that a minimum of training is required to assist the accurate definition of movement because of its visual simplicity. The contrast between these arguments suggests that, while EW does not provide a qualitative description of movement, it demonstrates a high level of compatibility with the scientific description of movement. In providing a description of movement that defines movement by limb angles and spatial coordinates, it shares commonalities relevant to the method in which computer representations decode spatial coordinates. This highlights the suitability of EW as a language for computation. This is further evidenced by the existing notation application "EW Notator" (Drewes, 2007). Furthermore, EW has been used as a basis to facilitate the control of movement in computer animation because of its high level of representation and compatibility with computation (Sternberg and Essa, 2002).

Research Findings

Researchers with expert knowledge of specific notation systems are equipped to conduct a comparative analysis of these systems (Hutchinson Guest, 1984). Literature (Hutchinson Guest, 1977, 1984, 1989) that provides information specific to the systems under review has made the comparative analysis of Benesh, Labanotation, and EW possible. A comparative analysis of the systems mapped against the criteria I specified in the "Evaluative Method of Notation Systems" above demonstrates that Labanotation is most successful in meeting three of the six criteria (see Table 1. Movement Notation Evaluation). This is further confirmed by its capacity to provide a comprehensive

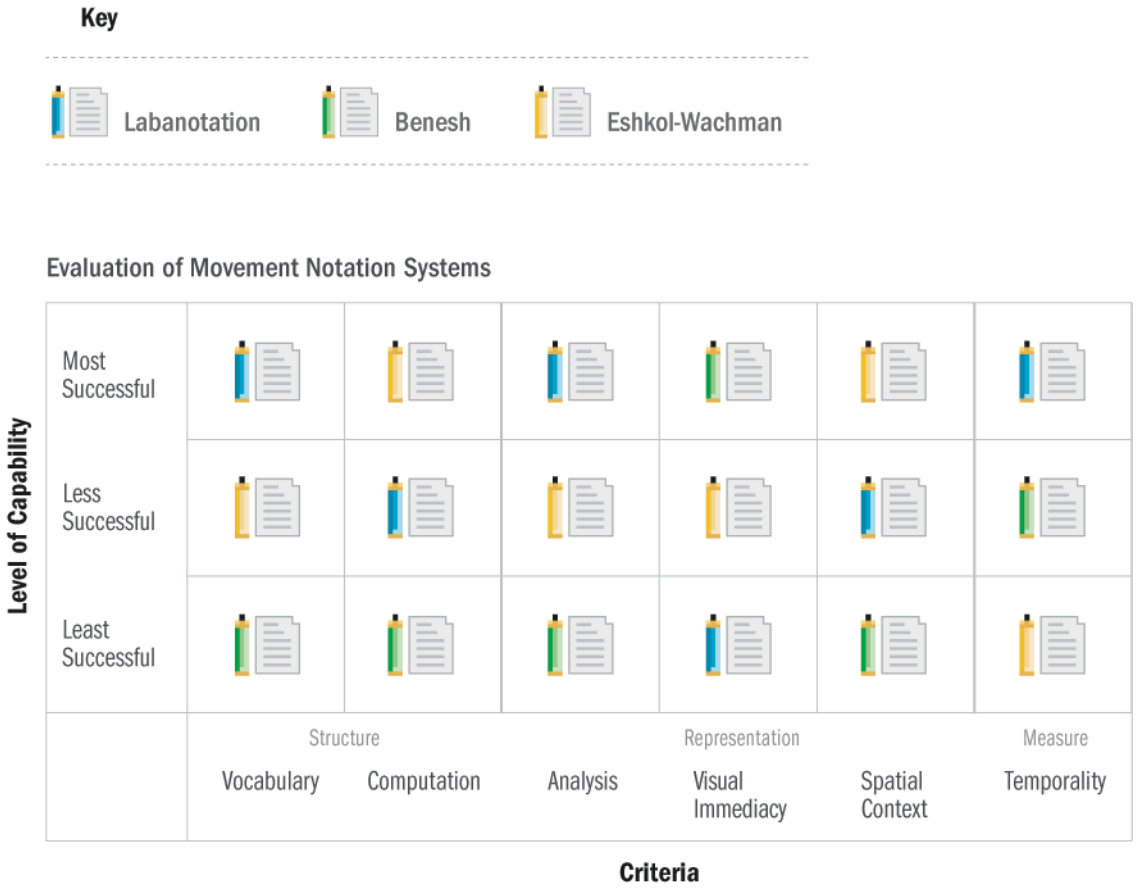


Table 1. Movement Notation Evaluation

account of movement required for analysis, and the ability to reference complex time structures (Hutchinson Guest, 2005a).

One of the evaluation criteria's key objectives listed above in the "Evaluative Method of Notation Systems" was to establish the accuracy in which the systems provide a description of movement, and its suitability for computation. In conjunction with these criteria, the ability of a system to communicate easily through its symbolic representation was essential to the elucidation of information. The extensive application of Benesh to classical ballet means that the dance community has a language in which the visual representation of movement is easily communicated and understood. However, this is achieved at the cost of a detailed record of movement (Barbacci, 2002). Visual notation systems based on an impression of movement do not allow for the analysis of that movement (Hutchinson Guest, 1989). While visual systems appear advantageous to the immediate clarification of movement, knowledge of these systems

and their style of representation remain crucial to their interpretation (Hutchinson Guest, 1984). Abstract notation systems such as EW offer a precise record of movement at the cost of immediate forms of visual interpretation (Barbacci, 2002). The issues concerning the documentation of abstract movement are indeed contentious. This is because notation systems represent movement differently and are bound by the particular rules and conventions of a language. It should therefore be noted that with each notation system there exists a number of trade-offs in which the capacity of a system can capture a comprehensive range of movement in a visually illustrative manner. In light of this, my research proceeds on the basis of a balance needing to be found between the visual representation of movement and the scientific approach to its description; to enable efficient methods of movement analysis.

Goodman (in Damle, 2002) tells us that the challenges associated with a symbolic representation of movement are exemplified in the differences between predominantly descriptive and pictorial notation systems. Interpreting the meaning of symbolic notation systems is fundamental to the outcome. Goodman (in Damle, 2002) argues that the significance of a system lies in the context in which a symbolic account of information is interpreted. This is in relation to the contextual positioning and interpretation of a system's symbolic vocabulary; rather than assessing it at face value (Goodman in Damle, 2002). The relevance of this underpins the notion that a system which embodies higher levels of description within its symbolic structure is necessary for the analysis of movement. Research by Lansdown (1995) has found Benesh limiting in its vocabulary and its ability to successfully capture an expressive range of movement required for choreography, while the anatomical description of movement provided by EW is more suited to the specific focus of scientific analysis and computation (Hutchinson Guest, 1977; Sternberg and Essa, 2002). Comparative analysis of the Benesh, Labanotation, and EW systems by Reynolds (in Hutchinson Guest, 1984) has found that Labanotation provides greater accuracy than Benesh, and is more practical than EW. This provides us with a result that places greater emphasis on the practicable application of Labanotation.

This method of comparative analysis establishes Labanotation as a system that meets the requirements of the criteria stated in the "Evaluative Method of Notation Systems" above as being necessary within a digital environment. I argue that the meeting of these

criteria facilitates modes of assistance in the documentation, interpretation, and understanding of movement. It supplies the dance community with a language that offers a logical discourse in the description of movement, and allows for the analysis of movement across a broad range of disciplines.

Labanotation's symbolic language illustrates the abstract representation of movement and the challenges it presents. Because of this, the identification of movement remains a concern (Hutchinson Guest, 1989; Yasuda, 2001). This creates considerable difficulties for beginners learning this system (Hutchinson Guest 1989; Yasuda 2001) because the notation itself it is not visually suggestive of the movement it describes. Research that has endeavoured to assist novice users in the comprehension of notation symbols has seen the development of ballet illustrations and ciphers as a means to complement the visual communication of this notation (Wilmer and Resende, 1998). As a response to the visual complexity of notation systems, Damle (2002) argues that enhancing the graphic design of these symbolic languages may not improve their ability to communicate visually. Hutchinson Guest (1984) and Damle (2002) advocate the training and education of users of these systems as a means to assist in their interpretation. This is because notation systems that provide a greater abstraction in their symbolic description require a greater depth of study than visual systems (Hutchinson Guest 1989). Therefore, it is necessary to recognise that abstract symbols must be learned in order to associate meaning with their symbolic representation and facilitate their use.

Summary

This research describes the intricacies involved in perceiving, interpreting, and describing movement. It discusses the issues surrounding the capacity in which notation systems can represent an unambiguous description of movement that are easily interpreted and suitable for movement analysis. The underlying structures of notation systems are also considered for their ability to supply a logical discourse in the comprehension and composition of movement. Accordingly, I have adopted a scientific framework for movement observation and analysis for the purposes of this research.

Through an explicit comparative analysis of three notation systems, I have shown that Labanotation enables the preservation of a comprehensive range of movement, and has the capacity to foster the development of contemporary dance. The outcome of the comparative analysis suggests that the structural makeup of Labanotation supports a logical discourse in the composition of movement that can be efficiently and effectively utilised for the computational documentation of movement. However, to extend the use of Labanotation to the wider dance community, concerns surrounding its usability need to be addressed. This indicates a need to facilitate the learning of Labanotation, and to devise an approach that renders the language more accessible to members of the dance community. It is therefore necessary to examine current technologies that enable a suitable level of accuracy in the description and visualisation of movement to assist this development. I turn my attention to this in Chapter Four.

4 The Application of Technology to Movement

> The notation (Labanotation) is based on an agreed-upon form of moving, which I believe is misleading, Mark Morris said after his *All Fours* was staged from a score at Ohio State University last year: "It's nearly impossible to accurately communicate dynamics and phrasing, although I grudgingly admit that it was a far better tool than I had anticipated." (Sulcas, 2007)

Introduction

Significant work regarding the development of notation-based, computer-generated animation (N. I. Badler and Smoliar, 1979; Calvert et al., 1980; Lansdown, 1995) and movement notation systems (Hutchinson Guest, 1984, 1989) provide a number of references to literature that is still cited today. An examination of this early work allows an understanding of the fundamental issues emerging from these fields to be developed, and suggests their continued influence on the technical development of notation applications.

Throughout this chapter I draw on work by developed by Calvert (Calvert, Bruderlin, Mah, Schiphorst, & Welman, 1993; Calvert & Chapman, 1978; Calvert, Chapman, & Patla, 1980; Calvert, Coyle, & Maranan, 2002; Calvert, Fox, & Ryman, 2001; Calvert, Fox, Ryman, & Wilke, 2005; Calvert, Fox, Ryman, & Wilke, 2005a) and his various collaborators, to illustrate how the theoretical basis of existing knowledge supports the further development of dance notation applications. Again, my purpose in this chapter is not to provide a critical assessment of literature in the field or develop a novel evaluative methodology suited to the technology of dance notation applications. I undertake this research in order to develop a rationale that supports the development of the prototype application LabanAssist.

Existing computer applications rely heavily on the successful implementation of practical uses for technology. The level of ease in which technology records movement

to allow choreographers, choreologists, and dancers to capture and preserve the creative process is discussed. In this chapter, my main concern is with the function of technology used to develop dance notation applications. The choice and application of technology for the development of appropriate deliverables is essential. Notation applications must remain accessible to the dance community, while providing a comprehensive description and record of movement. The focus of this chapter is to ascertain if the use of notation-based animation derived from Labanotation is a suitable use of technology to record, edit, translate, and visualise movement in a digital environment.

I begin by investigating current technologies employed to describe and record movement. The functionality they provide in offering a suitable level of accuracy in the description of movement, and their accessibility to the dance community, are also evaluated. This involves the selection and definition of specific criteria to construct a means of evaluation to demonstrate the potential success in which each technology under review has when fulfilling its purpose. I argue that Labanotation is the most effective technology for providing a comprehensive description and record of movement.

This chapter also looks at technology that interprets and visualises movement. I examine methods involving the translation of movement from tangible and virtual records of movement. Records that emulate a representation of movement, and those that encapsulate the fundamental nature of motion, are also examined for their ability to supply a detailed representation of movement for its reconstruction. I design explicit evaluative criteria to provide a framework for this examination, and to demonstrate the capacity of each technology to provide evidence of its use.

In this evaluation, I argue that notation-based animation that utilises a description of movement provided by Labanotation has the potential to successfully facilitate the interpretation for the visualisation of movement. I discuss underlying concerns and the possible benefits associated with the accessibility and current practise of applications that make use of Labanotation.

The Application of Technology to the Documentation of Movement

The effective preservation of dance ensures the safeguarding and development of a culture's heritage and identity. Modern technologies concerned with the computational processing of digital data, from one format to another, provide a means by which the documentation of movement can be captured, translated, and visualised in a digital form. Specifically designed computer systems follow a systematic process in the acceptance, analysis, and demonstration of motion data. This data is supplied by technology used to describe and capture movement. Fundamental to this process is an appropriate description of movement for computation. This is referred to as input data that is directly accepted by a system (Calvert in R. Ryman, 2001). Input data forms the basis upon which movement is then interpreted and translated by a system model to a usable form (Calvert in R. Ryman, 2001). Programmers create this system model or framework to efficiently interpret the input of data for its conversion (Calvert, Fox, and Ryman, 2001). The resulting data represents the initial description of movement once it has been translated. For prototype applications such as LabanDancer (Tom Calvert et al., 2005b) and computer applications such as DanceForms (Credo Interactive Inc, 2005a) , the representation of translated data is demonstrated by means of a visual interface in the form of an animated figure. In this way, the description of movement becomes significant to its interpretation and visualisation in a digital environment.

Drawing on Dewey's (1938) notion of technology as an art of production or the practical application of a technique for the purposes of problem-solving and inquiry, it is possible to view symbolic writing systems as a technology. Adopting a scientific method of movement observation and analysis in this research (see Chapter Two, "Understanding Movement") means that the practical application of Labanotation as a technique to document and interpret dance knowledge can be considered a technology. Curran (2001) argues that the function dance notation serves in providing a practical means to an end can be understood as a technology.

Labanotation, motion capture, key-frame animation, and digital video are used within existing notation applications to describe and record motion data. The use of these technologies is identified in the variety of applications presented in Figure 9. Technologies in Application. Each of these categories consists of varying computer

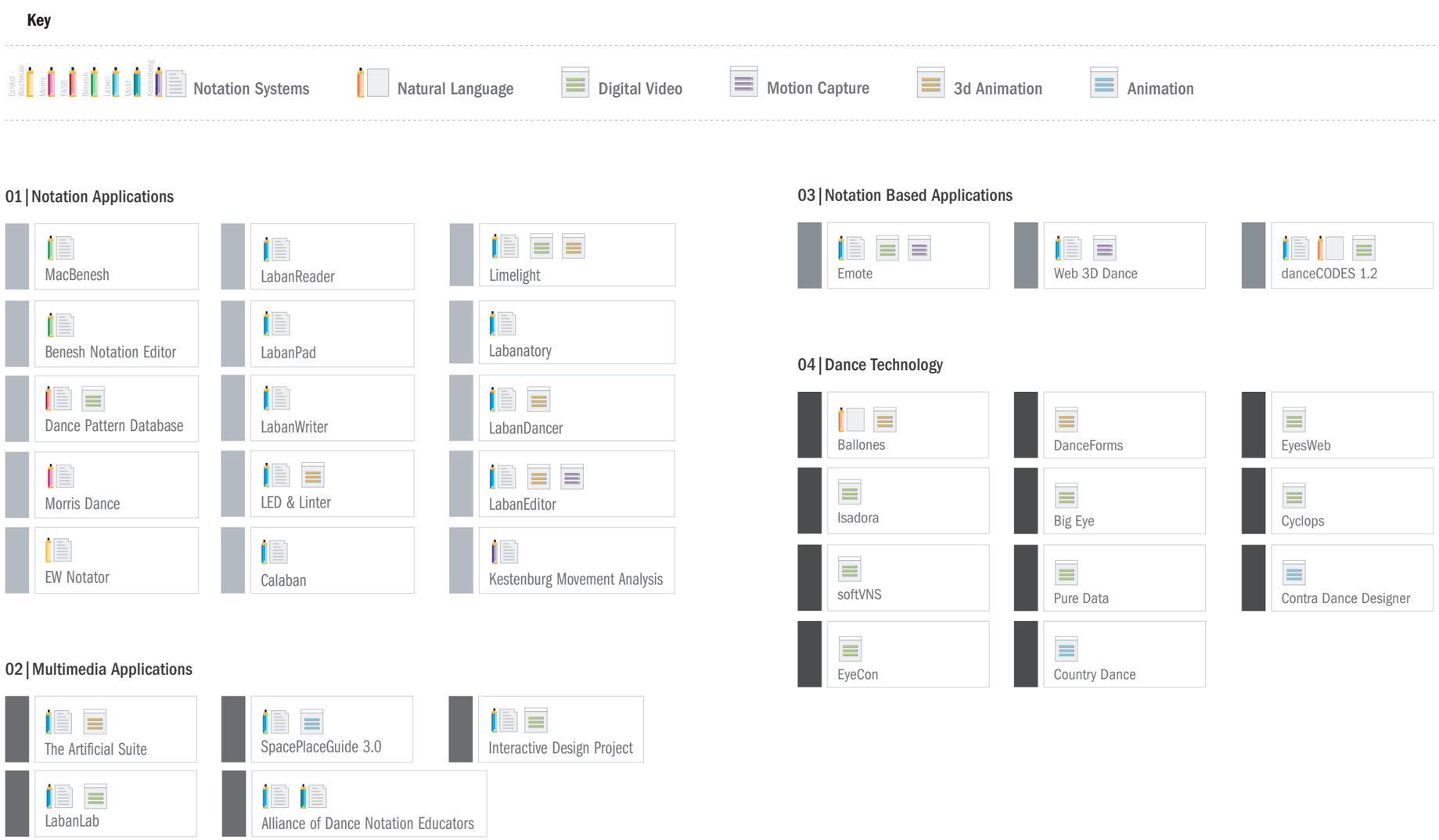


Figure 9. Technologies in Application

applications (identified in Chapter Seven, "Notation Applications") that make use of a particular technology or a combination of technologies designed to fulfil a specific function. While each application has a defined use, it is important to consider how effective the technologies they employ are in successfully achieving their objectives. It is necessary to examine and assess technologies that provide these functions when offering a comprehensive description and record of movement for the analysis or preservation of movement. In this examination, I consider the limitations of existing technologies in their ability to effectively describe and record movement within a specific context.

Evaluative Method of Technology That Preserves Movement

Before it is possible to identify a suitable use of technology, it is necessary to define an appropriate set of criteria to evaluate technologies that record and edit movement. It is central to this evaluation to construct a systematic approach to establish the extent in which an appropriate use of technology accurately records and edits movement. Using the literature available, (N. I. Badler and Smoliar, 1979; Calvert et al., 2002; T. Calvert et al., 2005; Furniss, 1999; M. Gleicher, 1999; K. Hachimura, Matsumoto, and Nakamura, 2005; R. Ryman, 2001; Venable, 2001b; Wang, 2004) I identify key aspects concerning the functionality, usability, and expediency of dance notation applications; and tailor these aspects to allow each criterion to specify a distinct condition. These criteria provide a sufficient framework to document the use and value of each technology. This has permitted a comparative analysis to determine a reasonable outcome.

The following criteria highlight the degree of functionality each of the investigated technologies is required to exhibit to demonstrate capabilities for its use. These uses include:

1. The ability to record the entire range of human movement at an appropriate level of accuracy allowing for the description of detailed nuances and stylistic movement;
2. A reasonably high level of flexibility and control during the editing process;

3. An appropriate ease of use in which nonexperts may operate the technology in question;
4. A relatively immediate approach to recording and editing movement;
5. Equipment that is easily used in a space where movement is usually performed and recorded;
6. Minimal storage space that allows for immediate transfers to remote locations; and,
7. Cost-effective provision to the dance community.

Technologies employed to record and edit movement play a fundamental role in determining the treatment and extent to which movement sequences are translated into digital form. Each technology under examination exhibits varying strengths and weaknesses in the method it employs to record and document movement. It is, therefore, necessary to closely examine the overall effects a technology may present in any given situation. The criteria as stated above highlight the efficiency and immediacy of a technology that acknowledges a need to remain user-friendly and economically viable to provide evidence of its overall suitability.

These criteria are applied to the examination of the following:

- Labanotation as it finds use in existing notation editors such as LabanWriter;
- Key-frame animation as it currently exists within the application DanceForms;
- Motion capture with an emphasis on the capturing of data; and,
- Digital video.

Mapping the technologies found in existing dance notation applications against the above criteria has established a method of analysis that I address throughout each technology under examination. I take a use of functionality that alleviates complex processes to facilitate the needs of the user as the measure of appropriateness for evaluation.

Labanotation

Before the advent of computer technology, dance notation systems were used to represent movement as signs on paper (Hutchinson Guest, 1984). Today, these notation systems operate within a digital environment in computer applications that facilitate the process of recording movement (Birmingham, 2001; Dance, 2008; K. Hachimura, Matsuoka, and Yoshida, 2002; Labanatory, 2007; LED and Linter, 2007; MacBenesh, 2003; R. Ryman et al., 1984). In this examination, Labanotation is evaluated within the context of a digital environment that finds use within the dance notation application LabanWriter.

Labanotation provides a technology that allows for a precise method for recording a wide range of human movements. Badler and Smoliar (1979) tell us that the semantic structure of Labanotation provides an explicit description of most human movement, and possesses the necessary capacity to facilitate more subtle variations of movement descriptions.

The comprehensive range of movement Labanotation offers in the description of dance underpins its function and proficiency as a technology to record movement. To utilise a technology with an expressive capacity of this measure requires a thorough understanding of movement analysis and an expert knowledge of its symbolic vocabulary (Hutchinson Guest, 1984).

Traditionally, the role of a choreologist trained in the use of dance notation systems is to translate symbolic representations of movement for dancers to interpret and perform (Hutchinson Guest, 1984). A choreologist is employed to observe and notate a number of dancer's movements for the period of time allocated for the creation and/or rehearsals of a new work. A reliable source of reference material such as a rehearsal involving live performers is essential to facilitating a record of movement in Labanotation (Hutchinson Guest, 1984). Should a rehearsal schedule be shortened, or a reliable source of reference material no longer is available, the ability of a choreologist to record movement using Labanotation would no longer be viable.

The nature of composing a score in Labanotation is a timely process that is relative to the complexity of the range of movement being described (Hutchinson Guest, 1984). Despite dance notation applications such as LabanWriter that no longer make it necessary to write its symbolic language, a solid knowledge of the practise of Labanotation still is needed to maximise its potential. The complexity of notating dance in Labanotation can be attributed to its nonintuitive symbolic representation of movement (Kahol, Tripathi, and Panchanathan, 2005). This suggests that a level more advanced than that defined by the evaluation criteria is required to facilitate the composition of Labanotation. This a fundamental concern regarding the accessibility and current practise of Labanotation.

The function of Labanotation, as found in existing dance notation applications, allows for an efficient means to record and edit notation. This permits the production of relatively small data files that may be easily accessed and digitally transferred to a location accessible via the Internet. The ability to archive files in a digital format ensures the preservation of data that may be printed and produced in a tangible form. Currently, the dance notation editor LabanWriter is available to users as a free application. This means that this particular notation editor is a cost-effective solution for members of the dance community who have access to personal computers.

Motion Capture

With an emphasis on capturing data, motion capture systems provide an accurate account of realistic human movement (Bregler, Loeb, Chuang, and Deshpande, 2002; Michael Gleicher and Ferrier, 2002; K. Hachimura et al., 2005). This involves the recording of a sensor or marker's point of reference during a sequence of movement. These sensors are usually attached to the human body where the recorded information, garnered as a result of this process, is translated to a computer-usable data format. Four methods exist in the motion capture process: (1) mechanical, (2) electromagnetic, (3) optical, and (4) video-based. Each of these processes provides varying degrees and amounts of accuracy in their ability to efficiently and accurately capture motion.

Mechanical motion capture uses an exoskeleton suit made up of metallic pieces to track and measure information from joint angles, and locates the position of limbs as a

performer moves. A disadvantage of this technique is its inability to supply ground plane calculations or to calculate movements that disconnect from it should a performer become airborne through a sequence of jumps (Furniss, 1999). Without the assistance of additional sensors, an exact directional position of the performer is unattainable (Furniss, 1999). Limits to the range of measurement devices; restrictions in the range of movement achievable by a performer; and the instability of an exoskeleton suit contribute to data errors and the loss of expressive movement (de Aguiar, 2003).

Electromagnetic techniques offer the absolute positioning of motion data in a near real-time environment, making this option an immediate and accurate solution for capturing movement (de Aguiar, 2003). This is made possible by the use of a fixed transmitter that tracks the movement of magnetic sensors covering the body of a mobile performer. The quality of resulting motion data may become distorted and unclear if the distance from the magnetic transmitter is too great. While this is the preferred technique for performance animation (M. Gleicher, 1999), it is highly susceptible to interference from surrounding magnetic fields, and may require the use of a specially built stage (de Aguiar, 2003; Furniss, 1999).

Optical motion capture employs the use of multiple cameras to record points and varying perspectives of motion garnered from reflective markers worn by a performer. Captured information from each camera undergoes a cleaning process to render the files useable for computation, and requires further processing time to provide the resulting data in a 3D format. This a lengthy process, and can result in the production of an inaccurate record of motion data from occlusion or the overlapping of markers during the capturing process (de Aguiar, 2003; Furniss, 1999; M. Gleicher, 1999).

Video-based motion capture offers the potential to capture movement data from digital video material without the expense and intrusion experienced by the above techniques (Michael Gleicher and Ferrier, 2002). While initial research in this area has progressed, the development of video-based motion capture and its performance in animation applications has yet to reach a satisfactory standard (Michael Gleicher and Ferrier, 2002; Zillner, Gelautz, and Kallinger, 2002).

To provide a definitive record of movement for preservation, motion-capture data requires further adjustment by a choreographer or notator (Calvert et al., 2002; R. Ryman, 2001; Wang, 2004). The editing of captured data presents a number of difficulties when reading, identifying, and implementing changes to complex information (Michael Gleicher and Ferrier, 2002). The volume of acquired motion data is relevant in file size to the amount of detailed motion that is recorded. Large data files become a problem in relation to the efficient transfer of information. Concerns about accessibility, usability, cost, and the expediency of motion capture as a technique to record movement at present outweigh the significant benefits it holds for capturing detailed human movement.

Digital Video

Digital video offers an immediate and viable solution for the recording and archiving of dance works (Windreich, 2002). The technology and equipment is cost-effective, convenient, and accessible to the dance community (R. J. Neagle and Ng, 2003). Typically, the recording of dance works using digital video technology involves recording movement in a rehearsal studio during the choreographic process, or videoing the completed work under performance conditions.

Research into the methods of dance preservation techniques within professional dance companies in Australia indicates the extensive use of digital video as an accessible technology for the documentation of dance (Anderson, 2005; Brady, 2005; Card, 2005; Fee, 2005; Greig, 2005; Gulash, 2005; Hughes, 2005; Lee, 2005; R. Martin, 2005; Saunders, 2005; Tyndall, 2005). Digital video technology provides choreographers with a means to enhance the creative process of choreography. An iterative process of development in which previously recorded rehearsal periods are reviewed brings new insight into the dancers' skills and abilities (Calvert et al., 1993; Kucks-Cho, 2005; Wang, 2004). This enables a choreographer to rework a sequence until it is perfected (Calvert et al., 1993; Kucks-Cho, 2005; Wang, 2004). The efficiency and ease of use made available by digital video means that dance companies and choreographers in Australia and Asia commonly use this technology for recording and developing dance (Kucks-Cho, 2005). While the visual distortion of video data can be an inspiration to the creative process, such data if taken as a precise record for the reconstruction of

movement poses serious implications for the safeguarding of choreographic works (Hutchinson Guest, 1984). This is because of the lack of visual clarity that digital video offers in the representation and communication of movement. If taken as an adequate reference for the preservation, dissemination, and interpretation of dance knowledge; it could bring about the gradual reinterpretation of dance works. This in turn presents distinct challenges for the integrity of a choreographer's work to be sufficiently preserved and communicated in its original form over an extended period of time.

The ability of digital video to accurately record a range of movement is highly dependant on the techniques employed to record a performance. To capture a complete record of movement, it is necessary to ensure that all dancers remain visible and within frame of a least one of the cameras. This could involve the use of a single camera placed at the rear of a dance studio to capture both the back and front perspectives of a performance through the reflection of a mirror positioned at the front of a dance studio. Alternatively, recording a live performance may require three or more cameras to capture multiple angles of performed movement. The methods of recording movement, either in a dance studio or from a live stage performance, are susceptible to ambiguity; particularly upon their reexamination. In spite of this, an advantage in recording live performances with digital video allows for the inclusion of the stage, music, costume, and lighting effects that other technologies do not incorporate.

Editing digitally captured material is difficult. In order to edit digital video data, it is necessary to have access to a computer-based editing suite. This is required to make composite, multiple takes of recorded data; and remove unwanted performance material. Otherwise, the original material could be rerecorded. This is a time-consuming process that demands the repetition of a performance until the required changes have been captured. As a format to record detailed accounts of rehearsal periods or live performances, digital video can generate considerable quantities of data (Windreich, 2002). It may prove costly and timely to transport this data to remote locations. Converting data to a compressed format suitable for transfer via high-bandwidth cables would require the use of additional software, and compromise the resulting quality of the material.

As a means to archive dance material, videotapes have a limited life span, and therefore are unsuitable for the long-term preservation of dance works. Added to this constraint, storage of this archived material would require specially constructed areas; able to maintain the capacity of the data collected, and to preserve the quality of the material for an indefinite period of time. Current developments in digital technology would allow the digital data to be archived in a DVD format. However, this adds another element to a process that would require further investment in digital technologies.

Key-frame Animation

It is possible through the development of the 3D animation package DanceForms for dancers, choreographers, and dance educators to record movement sequences in a 3D environment. As a tool to notate movement, DanceForms presents the dance community with an application more familiar to professional animators working with character animation development for motion picture or computer game industries (T. Calvert et al., 2005). This is an application that is customised specifically for use by dancers that know little of animation techniques, yet rely on a process of key-frame animation to record dance sequences.

The function and technology of dance notation applications is significant to the success in which complex processes may be facilitated more easily to allow for the accurate documentation of movement. The ability to achieve this using DanceForms is tied to a user's ability to set key-frames of dance poses to effectively document a precise record of movement. The capability of an animator is indicative of this level of artistry that requires talent and training (M. Gleicher, 1999; R. J. Neagle, 2003). Neagle (2003) tells us that a highly developed awareness of dance movement is necessary to achieve aesthetically pleasing animations.

This view espouses the skill set deemed necessary by professional animators to provide an aesthetically pleasing and accurate record of movement. However, I argue that an in-depth understanding of dance contributes to the potential dancers, choreographers, and educators have to animate a comprehensive range of movement. Key-frame animation is an arduous and time-consuming process (Bregler et al., 2002; de Aguiar, 2003; Pullen and Bregler, 2002; Sternberg and Essa, 2002). The time required learning the skills

necessary to use DanceForms as an application, and to generate key-frame animation, is considerable. The ability to achieve aesthetically pleasing animation would be relative to a user's knowledge of animation techniques, or an aptitude to develop these skills. Feedback concerning the usability of DanceForms is reflected in comments made by dance educators from the *Summary of Labanotation Survey by the Dance Notation Bureau in 2000-2001* (Venable, 2001b):

> We found DanceForms quite unsatisfactory. It wasn't interesting. It took way too long to get anything to happen. We've let that go (Venable, 2001b, p. 16).

> I used DanceForms with a student we had who was wheelchair bound. He was somebody with a very strong movement sense. He would create movement sequences and show the screen to dancers who could begin to try them out (Venable, 2001b, p. 16).

This represents two different interpretations of the application that offer a balance in users' perspectives on the usability of DanceForms. The contrast in opinions suggests that, while animation techniques may be difficult to master, a nonexpert knowledge of key-frame animation may allow a user to take advantage of the method in which this technology offers a record of movement. The provision of animated dance libraries within "Life Forms Dance Studio," a special version of the DanceForms program, would accommodate novice users in the process of recording and editing movement (R. Ryman, 2001). However, I argue that, from a creative aspect, the use of predetermined movement sequences poses limitations to the generation of movement for variations of the options available within these libraries.

Currently, DanceForms is a tool accessible to the dance community. This is indicated by the number of participants accessing their current user database (Credo Interactive Inc, 2005b). DanceForms also presents a relatively expedient method to edit and record movement. The application itself produces moderately small data files that remain accessible by digital transfer, and are easily archived.

Research Findings

An examination of Labanotation, motion capture, digital video, and key-frame animation, as discussed above, illustrates various strengths and weaknesses associated with each technology and its ability to provide a suitable method to record and edit movement. I designed a number of criteria also stated above in "Evaluative Method of Technology That Preserves Movement" to demonstrate their capacity to meet their objectives. The findings of the evaluation are documented in Table 2. Technology That Record and Edit Movement Evaluation.

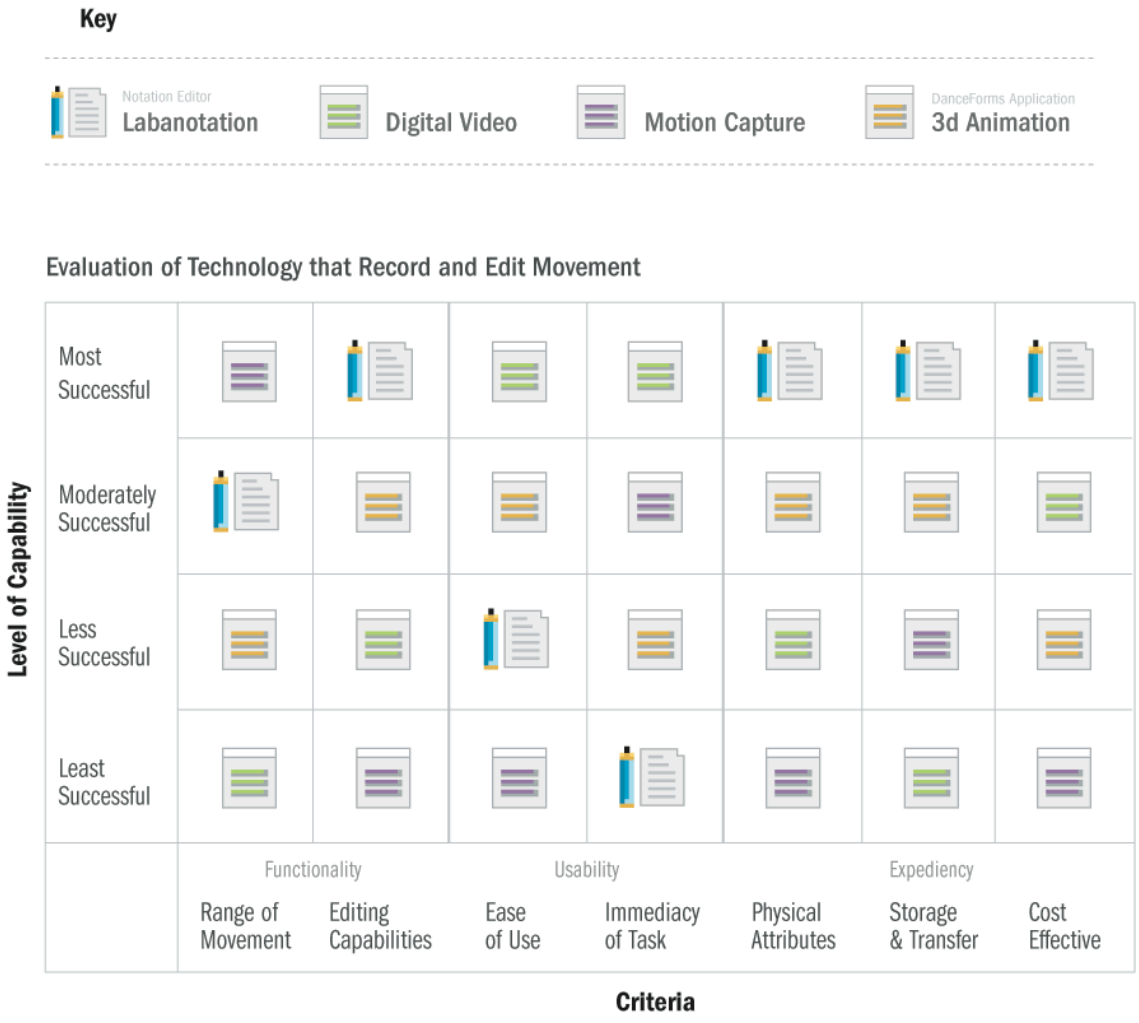


Table 2. Technology That Record and Edit Movement Evaluation

An evaluation of available technologies showed that they all were most successful in their ability to meet the parameters defined by the criteria. Therefore, it was necessary to reduce these findings to a single, appropriate use of technology. The evaluation

criteria were essential for the comparative analysis of each technology within a set framework. Further evaluation involved nominating a key criterion. Technologies found to provide a higher degree of accuracy in their description of movement had the advantage in circumstances where two technologies were found to be of equal value using the subsequent criteria. This distinguished the first criterion, "range of movement," as the basis upon which the following evaluation criteria were considered.

Motion capture provides an accurate and detailed account of human movement to a greater degree than Labanotation (K. Hachimura et al., 2005). Of all the technologies examined, the advanced technology motion capture systems are the most costly, labour intensive, timely, and the least attainable by the dance community. This suggests that motion capture is unsuitable as an accessible technology at this time. Research by Wang (2004); which illustrates and evaluates the strengths and weaknesses of notation-based, audiovisual, and motion capture technology; found that Labanotation provides the most rigorous and accurate description of movement. However, usability and immediacy play a fundamental role in determining the success of a technology to facilitate complex processes for greater user interaction. Given these determinates, motion capture becomes a less viable option.

The analyses of the various technologies indicate that the success and functionality of a technology generally is consistent with not only the level of complexity it encompasses, but also that required for operation. Thus, it was necessary to determine an appropriate solution that allowed for ease-of-use; a sufficient level of complexity in the description of movement; and a relatively simplified manner of recording and editing movement. Overall, through a method of comparative analysis, Labanotation provides a technology that best serves these purposes. My argument is reinforced by Wang (2004), who tells us that the development of existing and emerging technologies cannot supersede the significance of notation systems in the function they serve to record movement.

The evaluation of technologies that record and edit movement is limited by its specific focus. I designed criteria to specify conditions of functionality, usability, and immediacy in which Labanotation, motion capture, digital video, and key-frame animation were assessed. Limitations of current technologies found in available

literature offered a theoretical method of analysis to determine a suitable use of technology.

I identified fundamental issues concerning the accessibility and practise of Labanotation between the development of an ideal and an appropriate use of technology. The outcome of this examination necessitated further research into methods that enable greater accessibility of tangible dance records to the dance community in order to ascertain if Labanotation can provide a suitable use of technology to translate and visualise movement in a digital environment. I achieved this through an investigation of various uses of technology that facilitate the translation and visualisation of movement.

The Application of Technology to Virtual Movement

There are various benefits deriving from the visualisation of movement. They include the potential for the representation of movement to communicate the aesthetic and technical performance of dance for analysis and reconstruction. The virtual representation of movement becomes a powerful tool in the education of dance (Calvert et al., 2002; I. Fox, 1999; Herbison-Evans, 2003; Kalajdziski, Trajkoviæ, and Davèev, 2002; R. Ryman, 2001). A virtual environment presents a situation in which the technical execution of complex movements may be demonstrated and analysed (Herbison-Evans, 2003; Kalajdziski et al., 2002). Furthermore, it enables greater accessibility to emerging technologies utilised for their accuracy in the documentation of movement that facilitates the process of reconstructing that movement.

To enable the reconstruction of movement, a record of movement undergoes a process of interpretation and translation to realise its performance. Documentation that provides an understanding of the technical and qualitative attributes of movement serves as the foundation upon which movement is reconstructed. Approaches to the virtual representation of movement include the development of key-frame animation (R. Ryman, 2001); notation-based animation (Griesbeck, 1996; Hattori and Takamori, 2002; Herbison-Evans, Hunt, and Politis, 1989; R. J. Neagle et al., 2004; Singh et al., 1983); and motion-capture-based animation (K. Hachimura and M. Nakamura, 2001; Laban Capture, 2002; Web 3D Dance, 2003) that all require further interpretation by

specifically designed system models programmed to translate movement into an animated form.

The objective in which movement is visualised serves to provide an interpretation of movement that is used to specify distinct aspects of motion. These vary between levels of realistic and stylised motion. Technologies utilised in the visualisation of movement provide either an objective and precise account of movement devoid of expressivity, or a subjective representation of movement that is less precise but encompasses qualitative aspects of motion (Calvert et al., 1980). The distinctions between these types of visual information provide substantially different sources of information for their interpretation and, subsequently, produce diverse reconstructions of movement.

Lansdown (1995) maintains that the interpretation of symbolic data is beyond the means of computational interpretation. He argues that assumptions based on the information notation symbols contain can only be effectively interpreted by humans (Lansdown, 1995). While this claim was made more than ten years ago, it represents an area of contention surrounding the perception and interpretation of movement as outlined in Chapter Three, "Perceiving and Interpreting Movement." Furthermore, it points out the limitations of existing technology to translate movement descriptions that follow rule-based writing techniques and conventions of specific notation languages. This becomes an issue in a digital environment when assumptions that humans naturally make about the representation of symbolic information cannot be adequately communicated as data in a digital environment. In light of Lansdown's (1995) views, it is reasonable to suggest that varying levels of human intervention and the implementation of enhanced technical functions are required to assist the translation of animated movement from diverse forms of motion data (Calvert et al., 2002; T. Calvert et al., 2005; Michael Gleicher and Ferrier, 2002; R. Ryman, 2001; Wang, 2004). The relevance of this supplies us with an understanding of the extent to which technology is capable of interpreting movement. It highlights the necessity for the development of customised tools and expert systems to assist in the translation of, not only symbolic descriptions of movement, but also those offered by alternate uses of technology.

The interpretation and visualisation of movement illustrates the effectiveness of current technology to achieve its objective. Therefore, it is necessary to assess the manner in

which various technologies function to interpret and appropriately represent movement. The following examination considers the extent in which existing technologies have the capacity to effectively facilitate and interpret a reliable representation of movement.

Evaluative Method of Technology That Visualises Movement

To enable an efficient process of comparative analysis between technologies that interpret and visualise movement, the extent to which they function to substantiate their use needs to be established. Literature (Calvert et al., 2002, 2001; Kalajdziski et al., 2002; R. J. Neagle et al., 2002; R. J. Neagle and Ng, 2003; R. J. Neagle, Ng, and Ruddle, 2003; R. J. Neagle et al., 2004; R. Ryman, 2001) provided the basis upon which the evaluation criteria are established. The literature specifies distinct conditions necessary for each technology to meet; to provide evidence of its ability; and to represent a suitable account of movement in its reconstruction.

Evaluative criteria are designed to provide a framework for the examination of varying degrees of accuracy, aesthetics, spatial representation, immediacy, and accessibility of existing technologies to meet these requirements. Critical to this analysis is the manner in which these records disseminate evidence of a movement's technical execution and artistic quality for their reconstruction.

The following criteria are used to emphasise levels of performance each technology under examination is required to maintain in order to demonstrate capabilities for its use. The criteria specify that each technology will:

1. Provide an appropriate level of accuracy in the representation of movement for reconstruction and technical analysis;
2. Portray a reasonable level of movement aesthetic for qualitative analysis;
3. Demonstrate an ability to display multiple perspectives of movement;
4. Offer an immediate solution to visualise movement; and,
5. Provide an accessible solution to dance institutes, universities, and schools.

Difficulties surrounding an accurate record of movement identified above in "Evaluation of Technology that Preserves Movement" are further emphasised in their

interpretation and visualisation. When assisted by specifically designed system models to facilitate the interpretation of movement, varying technical approaches utilised to realise their visual result further impact their effectiveness to do so. It is, therefore, necessary to examine the benefits and limitations of Labanotation and digital video as reconstructive tools that facilitate the interpretation of movement without additional computational assistance. 3D animation derived from key-frame animation, notation systems, and motion capture data are examined for their capacity to successfully interpret and visualise movement in a virtual environment.

These criteria were applied to the examination of the following:

- Labanotation, as it is used by choreologists;
- Digital video, as it is used by ballet masters, choreographers, and dancers;
- Key-frame animation, as it currently exists within the application DanceForms (Credo Interactive Inc, 2005a);
- Notation-based animation, as it is used within prototype applications such as LabanDancer (Tom Calvert et al., 2005b) that used Labanotation as its data source; and,
- Motion-capture-based animation, as it is used within applications such as Web 3D Dance (Web 3D Dance, 2003) and LabanEditor (K. Hachimura et al., 2002; K. Hachimura and M. Nakamura, 2001).

Following a consistent framework of analysis addressed throughout this examination, the design of criteria established a method of evaluation that was implemented in the examination of the subsequent technologies. Mapping these technologies against the above criteria served to establish a suitable level of assessment to determine an appropriate outcome for the interpretation and visualisation of a correct account of movement.

Labanotation

Labanotation is a technology that provides an accurate and comprehensive vocabulary to describe human movement. The use of Labanotation as a technology necessarily includes the abilities of a choreologist or notator to effectively capture movement. This

is because scores of Labanotation are interpreted by choreologists to assist the visualisation of movement. Choreologists are employed to read, write, and interpret notation. The technique practised by choreologists to interpret and translate movement from a written score is referred to as "directing from the score." Through the demonstration of verbal explanations and physical movements, choreologists utilise the information contained within dance notation systems to reconstruct movement. The level of accuracy achieved through the method of visualising movement in the practise of directing from the score is contentious. It is largely dependent on a choreologist's individual experience and interpretation of notated movement. Difficulties associated with the perception and interpretations of movement were discussed in Chapter Three, "Authenticity of Movement" and "Perceiving and Interpreting Movement." Previous knowledge of a specific choreographic style, dance training, technique, experience, and personal judgement contribute to the manner in which notation scores are interpreted and translated (T. Calvert et al., 2005; Harrington Delaney and Fox, 2001; Hutchinson Guest, 1984; R. J. Neagle, 2003).

The advantage of experiencing a choreologist's interpretation of movement directly from a score provides dancers with a practise of reconstructing movement that is interactive and engaging. The combination of verbal descriptions and demonstrations of movement supplies dancers with a clearer explanation and understanding of movement. This facilitates a process of direct communication between choreologists and dancers in which movement concepts are interpreted and performed. The period of time required to reproduce a dance work from Labanotation is relative to the ability of a choreologist to interpret a score, and the amount of detailed movement requiring translation. Since formal qualifications are required to practise choreology, this level of professional practise should impact positively on their means of interpreting movement. Readers of notation scores benefit from the ease and efficiency in which specific sequences or phrases of movement can be located (Hutchinson Guest, 1984). A parallel can be drawn between the use of music and notation scores that underline the convenience and mobility they offer their readers as sources of reference material.

However, unlike musical scores, which enjoy widespread use among musicians and to a certain extent the general public, members of the dance community are unable to comprehend or utilise the facility of dance notation systems. The number of certified

professional Labanotators (choreologists that use Labanotation) is relatively small. In 2007, only thirty-eight (Mockabee, 2007) practising Labanotators were identified at the Dance Notation Bureau. This is a scarce resource, and there exist few other alternatives to assist the translation of Labanotation scores to performed movement. The accessibility and usability of the information contained within Labanotation scores then becomes a significant factor in the preservation and dissemination of dance knowledge. Wilmer and Resende (1998) tell us that Labanotation scores are difficult to read and interpret because of their level of abstraction. This means that the visual representation of Labanotation's symbolic language prevents the straightforward recognition of the movement it describes. At present, it is difficult to interpret the information Labanotation scores contain without the assistance of a professional choreologist (R. J. Neagle, 2003) or a thorough knowledge of the language.

Digital Video

The quality of the performance, the environment, and the visual perspective in which movement is recorded contribute to the level of accuracy that digital video technology permits. This accuracy then impacts the level of analysis and reconstruction possible. As a means of facilitating the process of reconstructing movement, digital video offers a description of movement that is ambiguous and circumstantial. Andrews (in Hutchinson Guest, 1984) informs us that digital video represents an impression of movement. In support of this, Parker and Macmillan (in Damle, 2002) tell us that digital video cannot supply sufficient information regarding the technique or concept of movement for its performance.

As a reference to facilitate the reconstruction of movement as closely to the original as possible, digital video is representative of the dancers and the dance; not the intent of the choreographer (Hutchinson Guest, 1984; R. Ryman, 2001; Wang, 2004). The vocabulary of a choreographic work is established in the actuality of its performance. Practical experience in the creation of new dance works sees the development of movement take shape during a lengthy rehearsal period. Typically, the resulting movement sequences are influenced and transformed by a performer's artistic capability. This is exemplified by a dancer's personal idiosyncrasies, individual interpretation, and physical capability to perform movements as intended by the

choreographer. This means that a flawless performance of the exact choreography is required to enable an accurate record of movement to be captured. Furthermore, reference to alternative casts of dancers introduces further variations to the performance and analysis of movement for its reconstruction. In light of this, performed movement is no longer ideal in its representation (R. Ryman, 2001; Wang, 2004).

The visual perspective used to record movement is vital in supplying an overall view of a performance, and ensuring that specific aspects of detailed motion are discernible. The visibility of group formations can be severely distorted if a full range of movement is not successfully captured. This medium is reliant on the viewpoint of the camera (R. J. Neagle and Ng, 2003). This is particularly apparent when an individual's view is either blocked or lost from the camera's range of vision. Lack of a third dimension in its visual representation renders this medium insufficient to explore the full range of movements (Naugle in Furniss, 1999). Archives of stage performances are further obscured with the addition of stage scenery, costumes, and lights (Wang, 2004). While this provides a comprehensive record for the technical restaging of the production, these elements can obscure the visibility of a dancer's movement and result in the adaptation of the intended choreography, provided the movement being recorded is accurate in the first place.

Digital video archives provide an instant visual reference of dance material that is readily accessible to dancers, ballet masters, rehearsal directors, and choreographers during the rehearsing and recreation of a dance performance. However, difficulties locating and referencing specific segments of recorded material (Andrews in Hutchinson Guest, 1984; Kalajdziski et al., 2002) do not attest to the efficiency or immediacy of this format.

Key-frame Animation

Key-frame animation enables the computer generation of movement in a 3D form. This is achieved by specifying key frames of motion that represent the fundamental poses of action for animation. These key frames constitute an animated sequence of movement, which undergoes a process of calculation and interpolation in order to generate animated movement. It is a technology that enables greater precision in the definition of

movement, and enhanced control over the resulting animation (Pullen and Bregler, 2002).

The degree of accuracy key-frame animation offers in the description and interpretation of movement is comparable to the role of notation systems (R. Ryman, 2001). It provides a record of movement that is free from performance error (Calvert et al., 2001) , and appropriately conveys the original intent of a choreographer (R. Ryman, 2001). Unlike notation systems, key-frame animation is limited in its ability to communicate the concept and motivation of movement. However, Yasuda (2001) maintains that the application DanceForms augments a user's ability to visually perceive movement. DanceForms facilitates the visualisation of movement from key-frame animation. The significance of this highlights the potential benefit this method of animation has in the education and examination of movement.

Sophisticated movement models are developed for the interpolation of key-frame animation to generate an appropriate representation of movement. Inverse kinematics assist the designation of movement by constraining the degree of motion an animated figure is permitted to perform (T. Calvert et al., 2005; de Aguiar, 2003). The generation of animated movement depends on the extent to which these models perform, and the capacity of an animator to compose a comprehensive representation of movement (N. Badler et al., 2000; de Aguiar, 2003; M. Gleicher, 1999). De Aguiar (2003) tells us that procedurally generated movement typically involves the interpolation of smooth splines that limit the degree of realism in the representation of human movement. A lack of detail and quality in generated movement also can be the result of an insufficient number of key frames used to define a movement sequence (de Aguiar, 2003).

Badler et al. (2000) argue that the facility of an animation system does not exclusively determine the quality of animation it produces. Highly skilled animators and the specific application of classical animation principles contribute to the construction of expressive movement (N. Badler et al., 2000). Research by Neagle et al. (2003) demonstrates the capacity in which varying subtleties of human emotion are discernible from computer-generated movement. It suggests that significantly low levels in the fidelity of movement do not inhibit a user's ability to identify expressive motion (R. J.

Neagle et al., 2003) , and that this medium presents a suitably accurate and qualitative representation of movement fidelity for its reconstruction.

Key-frame animation offers members of the dance community an accessible solution for a 3D visualisation of movement that is central to facilitating interactive methods of movement observation. It enables a three-hundred-and-sixty-degree perspective of motion to be obtained, which presents significant benefits for the technical understanding and education of complex movement. Real-time rendering caters to the immediacy of this medium, which allows for the visual manipulation of data to be easily selected and controlled.

Notation-based Animation

Advances in technology have seen the development of dance notation applications that interpret and translate notation scores into an animated form (T. Calvert et al., 2005). This method of translation can be broadly defined as notation-based animation. It is a method of creating motion for computer animation that utilises the symbolic vocabulary of notation systems as a data source. Strengths and weaknesses found in the translation of Labanotation provide a specific focus for this research. This is done to better understand how different technologies modify the structural makeup of Labanotation as a data source, to enable the efficient and effective composition of movement in a digital environment.

Neagle (2002) maintains that the mathematical structures of dance notation systems appropriately facilitate the virtual representation of movement. However, there is no direct method of translating Labanotation into a digital form (Kalajdziski et al., 2002). It requires the manual programming and development of tools to assist in its translation to a machine-readable format (T. Calvert et al., 2005). A programmer creates a translation model capable of interpreting the symbolic vocabulary of Labanotation (Calvert et al., 2001). These models are developed to maintain the correct interpolation of computer-generated animation. This in turn constrains the possible movements of an animated figure to ensure that it animates or performs within a realistic range of motion.

The accuracy and detail Labanotation provides as a tool to describe and convey the concepts of movement underpin the benefits it provides in translating notation to digital representations of movement (N. I. Badler and Smoliar, 1979; Calvert et al., 1980; Calvert et al., 2002). Variations in the symbolic description of movement provide comparable movement representations and, when used effectively, work to simplify the structure of a score and the interpretation process (Calvert et al., 2002; Hutchinson Guest, 1984). However, the implicit description of movement supplied by notation systems is a problem in relation to: (1) the development of exceptions in the interpretation process; (2) animated transitions; (3) the application of anatomical constraints; and (4) stylistic conventions of specific dance genres (Calvert et al., 2002; T. Calvert et al., 2005; R. J. Neagle et al., 2004; R. Ryman, 2001).

Sternberg and Essa (2002) tell us that the generation of a symbolic description of movement has yet to produce animation of a highly expressive quality. Neagle et al. (2004) theorise that a realistic virtual demonstration of movement is possible from a machine-readable format of notation. They use a component of LMA (Davies, 2006) to control the process of interpolation, and to produce aesthetically pleasing animation (R. J. Neagle et al., 2004). Loke et al. (2005) and Badler et al. (2000) refer to existing work that utilises Labanotation and the principles of LMA to enhance the qualitative aspects of computer- generated movement. This provides an insight into the facility of Labanotation and the implementation of Laban's movement principles to effectively generate the aesthetics of movement in a virtual environment.

Notation-based animation utilises the technology of 3D animation to generate a virtual representation of movement. It offers levels of accessibility and immediacy in its visualisation that are comparable to those found in 3D computer-generated animation. This extends to the capacity in which a virtual 3D environment allows the control of various viewpoints and perspectives of the movement to be examined.

Motion Capture-based Animation

Motion capture-based animation broadly defines the technique of generating animated movement from motion-capture data. Limitations identified earlier in the above evaluation of Motion Capture as a tool to record movement are exemplified as a product

of its virtual representation. These limitations refer to the visual quality and accuracy of the animation generated.

The level of precision in the virtual representation of dance is fundamental to facilitating a reconstruction of movement that sufficiently conveys the technique and aesthetics of movement for analysis. Gleicher and Ferrier (2002) argue that residual artefacts in motion-capture data, such as high-frequency noise, contribute to common visual errors in its animated representation, and disrupts the illusion of realistic movement. These residual artefacts can be recognised in the slipping or floating of a models feet, jitters in usually smooth actions, and extreme pops where the positioning of an object from one instance to another appears to be the least feasible (Michael Gleicher and Ferrier, 2002). Data processes for the removal of excess noise and artefacts from motion-capture data usually require additional manual editing for the effective translation of motion-capture data to animation (Michael Gleicher and Ferrier, 2002). Over-filtering techniques used to refine motion-capture data can produce adverse effects that result in the loss of key actions, such as gesture and the unnatural spatial orientation of an animated figure and its environment (Michael Gleicher and Ferrier, 2002).

The visualisation of motion-capture-based animation is a complex data source to draw on for the reconstruction of movement. Ryman (2001) and Wang (2004) claim that motion-capture-based animation is representative of performed movement. Similar to that of digital video, it embodies a record of movement that is subject to the limitations of the technology used to capture this information, and the inherent capabilities of its performers (R. Ryman, 2001; Wang, 2004). As a result, animation derived from motion-capture data no longer represents an ideal account of movement.

Computer-generated animation that uses motion-capture data as its source is limited in capturing a realistic representation of movement (Bregler et al., 2002; Wang, 2004). Important lifelike qualities and expressive characteristics of motion remain elusive in motion-capture systems because of the results of data processing and various computational techniques used to adapt and model human motion (Laban Capture, 2002). However, research examining various techniques to produce stylised computer animation from motion-capture data sees the implementation of traditional animation

techniques and the principles of LMA as an attempt to combat these shortcomings (Bregler et al., 2002; Laban Capture, 2002).

Motion-capture-based animation is visualised in a virtual 3D environment. This presents an environment that caters to greater immediacy and flexibility in the manipulation and demonstration of movement. In spite of this, access to motion-capture data that facilitates this representation of animated movement remains inaccessible to members of the dance community.

Research Findings

The investigation of Labanotation, digital video, key-frame animation, notation-based animation, and motion-capture-based animation has demonstrated various benefits and limitations each technology offers in the interpretation and visualisation of movement. A set of explicit criteria provided a specific focus for this investigation, and was used to determine the extent to which each technology under review met these objectives. These findings are illustrated in Table 3. Technology That Interprets and Visualises Movement Evaluation.

Having mapped the above-mentioned technologies against the criteria, the outcome suggests that Labanotation, as used by choreologists, provides the most accurate use of technology to interpret and visualise movement when compared with the other technologies described above. It also demonstrates digital video as an immediate and accessible technology to assist in the reconstruction of movement. Experimental research by Fügedi (2001) involving the comparative analysis of dance reconstruction from digital video and Labanotation tells us that Labanotation enables a higher level of precision and movement fidelity in the reconstruction of movement than digital video. Parker and Macmillan (in Damle, 2002) confirm that references supplied by notation systems are superior to video recordings in their ability to facilitate an understanding of movement concepts. The imprecision offered by digital video, and limitations to the accessibility of choreologists to interpret Labanotation, has meant that it has become necessary to look to the next suitable technology to provide an appropriate outcome.

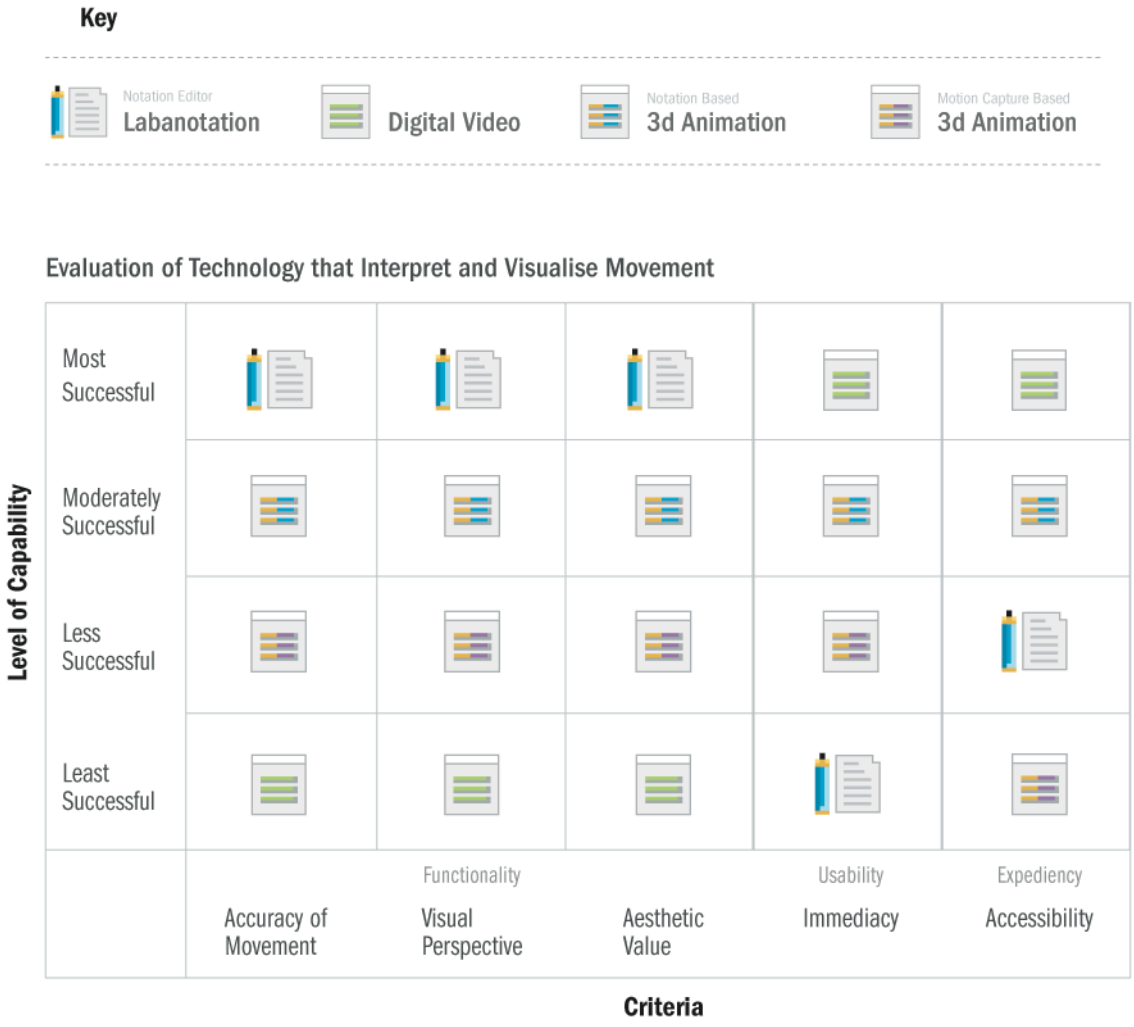


Table 3. Technology That Interprets and Visualises Movement Evaluation

The research literature identifies notation-based animation as the most appropriate technology to interpret and visualise movement. Neagle et al. (2004) and Wang (2004) tell us that real-time computer graphics are well-suited for facilitating the process of visualising movement from notation scores by demonstration of an animated figure. Badler and Smoliar (1979) and Calvert et al. (2002) confirm this by acknowledging the sound framework Labanotation provides in the definition and mapping of limb positions to an animated figure at distinct moments in time.

Calvert et al. (2005) discuss the necessity for an unambiguous, machine-readable representation of human movement to assist in the interpretation and visualisation of notation systems. While the development of intelligent system models to facilitate this process is outside the scope of this research, Calvert et al. (2002) tell us that a well-

structured Labanotation score provides a more efficient means of translation to animation. If we accept the notions put forward by Calvert et al. (2002), then we can recognise that a significant element to the process of interpreting notation to animation is found in the structure and composition of Labanotation scores.

The absence of a system that detects structural and syntax errors made during the composition of notation scores is not only a problem for the preservation of cultural archives, but for the translation of notation-based data to animation. I argue that methods of score composition that facilitate the correct grammatical structure of notation scores should be developed. If this potential could be realised, greater modes of assistance in the formation of Labanotation scores would result in higher levels of proficiency in the documentation of notation scores and their efficient translation to animated movement.

Summary

This research examines the capacity of existing technologies to provide an appropriate level of functionality, usability, and expediency in the documentation and subsequent modification of movement. The difficulties associated with translating a description of movement to an animated form are also discussed in relation to the types of motion data that provide a basis for its interpretation.

Two methods of evaluation were designed to examine the efficacy with which specific technologies could facilitate various needs of the dance community in an easy-to-use, immediate, and accessible manner. The results of the comparative analysis of technologies utilised in both the documentation of movement and those in its representation suggest that notation-based animation derived from Labanotation is a suitable use of technology to record, edit, translate, and visualise movement in a digital environment.

Computers are facilitating the composition, editing, and interpretation of dance notation systems. The careful composition and visual interpretation of Labanotation is fundamental to maintaining a precise syntactical and grammatical record of movement. This research proceeds on the basis that further research and development towards

supporting the processes of documenting and editing of notation scores is required (Singh et al., 1983; Wang, 2004) to assist in the composition and interpretation of movement. In order to achieve this, I begin Chapter Five by gaining an understanding of a design approach that could be used to enhance the conceptual development of novel design outcomes, and accommodate diverse use situations.

Part III: Research about Design

5 Design Methods

> Until we learn to comprehend we haven't a chance of learning how to control it (Nelson, 1957, p. 7).

Introduction

The nature, purpose, and process of design often are represented in literature as highly contentious (see J. M. Carroll, ed., 2003; Cross, 1984; Dourish, 2001; Margolin, 1995; Rogers, 2004; Suchman, 1987). Once grappled with, the resulting body of knowledge contributes to and impacts various perspectives and practises in a range of design-related disciplines. Because of this, a variety of approaches are demanded of designers and thinkers in this field to equip them to articulate the nuances required to define, describe, and contribute to the understanding of design and its practise.

In Part II of this thesis, I established the materials of the design situation. The focus of this chapter is to examine the variety of methods employed in the planning and production of design artefacts. Gaining a clearer understanding of the circumstances surrounding the approaches and objectives of various design methods emphasises the subtle, underlying strategies employed in design practise. I begin by developing an understanding of the way in which philosophic methods can assist in the analysis of design methods. I then proceed to discuss how this knowledge can be used to shape the design process, and realise a particular outcome. I do this in order to ascertain if an operational method for the planning and production of design artefacts offers a way in which complex information can be simplified in a manner that is relevant to the diverse practices of movement composition as Labanotation scores.

I conclude the chapter by suggesting that a method for the planning and production of design artefacts alone is not enough to support a way of thinking and acting in design. I argue that the combination of useful knowledge from both the arts and sciences is necessary for a way of thinking about design, and actually working with the stakeholders and materials of a design situation. I suggest that a strategy for design gains significance in the development of this research and the design of a prototype

application that facilitates diverse practises of movement composition as Labanotation scores. I further elaborate on a strategy for design, with regard to the design and development of the prototype application LabanAssist in Chapter Six.

However, before I advance my argument regarding the methods of the design process, it is important to understand the complexity of the area of design theory and its attendant practises. In this chapter, I deal with this complexity using a series of headings in an attempt to simplify the area. If we accept that the characteristics of design, the act of designing, and the nature of design all are complex concepts; then it is possible to see the benefit in the generation of an approach or strategy that supports the designer in negotiating and managing this complexity.

Characteristics of Design

Definitions concerning the nature and practise of design are both widely available and numerous (Atwood, McCain, and Williams, 2002). As an example of the multiplicity of views that exist within the field of design, Jones (1992, p. 15) provides us with a definition of design that serves as a means to "initiate change in man-made things." Alternatively, Simon (1996, p. 114) regards design as a way to manage the objectives of design by "devising courses of action aimed at changing existing situations into preferred ones." While Ehn (in Atwood et al., 2002, p. 126) considers design "a democratic and participatory process," this contrasts with Rasmussen's and Vicente's (in Atwood et al., 2002, p. 126) explanation of design as an approach to "creating complex sociotechnical systems that help workers adapt to the changing and uncertain demands of their job." If it is accepted that this is a limited representation of the available definitions of design, the consequences of this diversity present design theorists and practitioners with an overwhelming variety of theories and methods that can be called upon for the conception, planning, and production of design artefacts.

The resulting variation in response to design problems further underpins and adds to the reality that global differentiation is evident in the values, culture, and circumstances of its peoples. The diversity in which design is considered and practised resonates throughout the record of design history as a deliberation of its subject matter (Buchanan, 1992) rather than a coherent body of knowledge that establishes a

foundation for the discipline of design. While there is a need for the articulation of design as a discipline in its own right, this is not the specific intent of this research. Design contributes to the rich cultural fabric of society in the service it offers to enrich the human experience. For this reason, there is a necessity for design to draw upon a variety of established disciplines; not only to demonstrate the academic intellect and rigor of design practise, but also to enable the integration of knowledge from a range of disciplines to increase the potential for successful design outcomes that have a greater impact on society. In doing so, the interdisciplinary nature of design can be effectively augmented without reducing design to a subset of another discipline, or elevating it to a position of preeminence over others.

Cross (1999, p. 10) summarises the complementary range of activities designers use from a variety of paradigms in design practise as "designerly ways of knowing." This extends from Archer's (in Cross, 1984) argument that there is an effective way in which designers think and communicate that is fundamentally different from traditional scientific and scholarly methods of inquiry. In focusing on "designerly" ways of knowing, thinking, and acting (Cross, 2001, 2006) in a much broader sense, it is possible to appreciate the benefit a range of theoretical and practical knowledge can bring to the act of designing. By extending the boundaries of design to encompass scholarship from the arts, humanities, and engineering fields; designers may utilise the tools necessary to shape human experiences and address the complexities of design practise.

Rittel (1972a; Rittel and Webber, 1973) characterises design as the simultaneous evolution and understanding of a design problem and its solution. This view emphasises the continual challenges designers face in specifying and creating form, while Schön (1995) takes a more practical approach to designing, and focuses on the aspect of making design artefacts. In doing so, the act of designing becomes an interplay or conversation with the items and subject matter of a specific situation. Similarly, Glanville (2002) describes design as a circular and conversational method of creating innovative concepts and artefacts, while Krippendorff (2006a, p. xv) tells us that "Design is making sense of things." This is not so much a literal statement as it is an interpretative one, where the emphasis of design products focuses on the capacity of a product to be comprehensible to its users (Krippendorff, 2006a). These descriptions

briefly characterise design in a variety of ways that supply us with an understanding of various viewpoints that inform design practise. This suggests that the perspective we bring to the act of designing influences the way we think about, approach, and practise design; which directly impacts the design outcome.

In view of the diversity in which design is considered, this research proceeds on the basis that design is an integrative or transdisciplinary (Margolin, 1996) process of bringing differences together for the embodiment of a design outcome that enriches the human experience. While this description illustrates the manner in which design can be understood, it is necessary to further identify the central elements of design practise that we need to consider in order to enhance our ability to act effectively in design. This is because the nature of design and the act of designing are intimately connected to how we think about, practise, and evaluate design.

The Act of Designing

Successful design relies upon the integration of a variety of dynamic components. Individual, institutional, stakeholder, and end-user needs and requirements that embody personal and social values are elements of design that require careful consideration. These variables demand that design responds appropriately to variety and choice. This brings limitation and constraint to the design situation that ultimately results in compromise. Petroski (2003) argues that there rarely is a design outcome that is faultless to a point where it successfully satisfies an amalgamation of competing objectives. Hence, design is not perfect (Petroski, 2003). With this in mind, the results of designed objects or products do not attempt to represent a perfect resolution of circumstances in a design situation; nor is this possible. The ability of a designer to achieve an effective combination of these elements; and to produce an outcome that is useful, usable, and desirable; depends upon the approach taken in the act of designing to address these objectives.

Literature from the modern movement of design emphasises the creation of design objects from a scientific perspective based on objectivity and rationality (Cross, 2001). Typically, design involves the creation and organisation of materials for a distinct purpose. It involves the invention and formation of novel structures, while science

generally concerns itself with the discovery of the components of existing structures (Cross, 2001, 2006). Jonas (1999) discusses the notion that design could be regarded as the interface between "what is" and "what could be." While this concept underpins the creative and innovative nature of design, the aspect of uncertainty in "what could be" represents a central issue in the conception and planning of design. This is the difficulty associated with planning and envisioning the unknown before a final solution is conceived (Rittel and Webber, 1973). They are referred to as "wicked problems" (Rittel and Webber, 1973) because they are characterised as being ill-defined or indeterminate. For the designer, "wicked problems" are intrinsically complex due to the absence of a prescribed formula or solution to their resolution (Rittel and Webber, 1973). This is because the nature of understanding a problem is related to the approach taken to solve it, where the definition of a problem develops into a specification and resulting methodology that will impact upon the direction in which the solution is derived (see also Chapter Six, "Systematic Inquiry").

Dorst (2006) maintains that the capacity of a problem-solver or designer to understand a problem directly influences the nature of its wickedness. This suggests that the resulting varieties in which wicked problems are interpreted and resolved render them indeterminable. With this in mind, a specific design solution cannot be said to accurately or inaccurately embody the competing objectives of a design situation when the perspective of the designer, in the act of designing, is a dominant factor in its outcome. The capacity of a designer to manage the development of a design situation; determine a useful combination of knowledge to support its resolution; and devise a suitable course of action to achieve this; will directly impact the success of the design outcome.

Buchanan (1990) tells us that there are two distinct components to the practise of design. They involve the appropriate conception and planning of a specific type of product, and the ability to elucidate the results of its outcome from reasoning or principles (Buchanan, 1990). An example of this reasoning is Kunz and Rittel's (1970) "theory of strategic argumentation." The theory provides an argument for how a planned or a designed resolution should function under certain conditions that are substantiated by warranted stakeholder claims (Cross, 1984). This suggests that argumentation can be employed as a method of passing judgment regarding the type of

design decisions that should be made. Fundamentally concerned with design potentialities, dialogue-based planning processes make a shared process of learning, understanding, and negotiation possible (Krippendorff, 2006a; Liedtka, 2004). This process necessitates the participation of the potential users of a proposed product or service. In support of this, Aristotle (in Z. K. McKeon and Swenson, 1998) distinguishes between a user who knows the form of a product from practical experience, and a craftsman or designer who is guided by these insights in the creation of new products or services. This becomes significant when the purpose or intended function of a product is not realised to its full potential, and the fundamental design of a product fails to perform in an anticipated or appropriate manner to meet the needs of a specific community of users.

Rittel and Webber (1973) argue that testing methods based on scientific evaluation are not equipped to deal with the uniqueness of design problems or situations affected by the dynamic variables of conflicting objectives. Particularly in situations where the consequences of global differentiation and equity issues are considered, efficiency tests as measures of successful design are deemed inadequate (Rittel and Webber, 1973). In light of this, communication or argumentation that supports design thinking and reasoning can be leveraged to facilitate critical reviews of design concepts at various intervals throughout an iterative design process by supporting the simultaneous development of the design problem and solution (see also Chapter Seven, and Chapter Eight, "Task Analysis Workshop"). Design practises that involve the elucidation of design results provide a way of thinking that facilitates the production of products or artefacts (Buchanan, 1990).

The Nature of Design

Fundamentally, design is a human activity (Glanville, 1988). It is inextricably tied to our actions and how we compose our thoughts (Glanville, 1988; Schön, 1995). Petroski (2003) argues that, because design is an implicit part of our daily lives, we are instinctively aware of what it entails. The creative exploration and discussion of concepts; and the ability to envision future states and facilitating variety and choice; all are characteristics of design thinking (Jonas, 1999). This is how designers build novel ideas. If we accept that design is a fundamental aspect of how we think and act, then we

can begin to understand how strategic design thinking can assist designers to conceptualise and account for the constant change of modern day culture to offer innovative design solutions that shape and enrich the human experience. By augmenting Jonas's (1999) notion of design, it is possible to suggest that, in the act of designing, the designer is integral to the interaction between "what is" and "what could be." Again, the subjectivity of the designer as a significant factor in the design process is emphasised when the perspective of the designer and his or her involvement in the act of designing contribute to the outcomes of design thinking and working.

Buchanan (1990, p. 78) tells us that there are three basic issues in the nature and practise of design: the subject matter of design; the methods of design thinking and working; and the purposes or goals sought in design. Throughout the design process, designers experiment, invent, discuss, argue, review, and agree upon a set of specific circumstances in a design situation. This involves interacting with various users in order to gain an understanding of what the design situation is, and collaboratively formulate what a desirable solution could be. In actively formulating the components of a design situation (the subject matter) and proposing an approach for its reformulation (the methods of design thinking and working), there is a danger that designers may construct arguments and explanations for design outcomes that are well suited to the needs and purposes (the goals sought) of the design situation they themselves create (Rittel and Webber, 1973). This suggests that the involvement of the designer in the act of designing, and the perspective which they bring to design, are key factors that shape the design process. However, in the act of designing, it is necessary for a designer to obtain an objective account of user needs and requirements. In order to avoid constructing a design outcome that satisfies the goals of a design situation, as perceived by its creator, a designer's ability to consider these needs from an objective standpoint is vital to the success of the design outcome.

Returning to the second element of design practise, argument-based reasoning serves as a means to capture user-centred research though an exchange of information between the designer and various stakeholders to reach a common goal (Achmad and Haruo, 2003). In this light, design can be seen as a form of conversation in which elements of the design situation are negotiated between two parties to develop a desirable outcome. Hence the collaborative development of the design situation facilitates the collective

learning of required objectives between the designer and stakeholders through a cyclical process of negotiation and mutual understanding. This means that design becomes a shared or co-creative process which must consider the designer's interaction with the participants in the design process, and the individual understanding they each bring to the design situation. In the same way that dialogue-based planning facilitates a shared process of learning, understanding, and negotiation; conversation theory developed by Gordon Pask (1975) serves to make new knowledge explicit through conversation, learning, and mutual agreement. With this in mind, disciplines that can be leveraged for their ability to include the designer as an observer and participant in the design process, and to provide a framework in which a designer's subjectivity may be better understood (Glanville, 1999). I discuss this notion further in Chapter Six, "A Conceptual Framework."

Design Methods

In the past, a designer was thought to have made creative leaps and value judgments based on an innate sense of intuition (Archer, 1965; J. Christopher Jones, 1992). Portrayed as an innate sense of intuition, or even a "magical" element of creativity, early design methods alluded to a variety of forms of clarification or description as a foundation for innovation (J. Christopher Jones, 1992). It may appear reasonable to associate these aspects with a designer's ability to innovate; however, design methods that guide the practise of designing have a history that can be traced; as can their influence on contemporary design processes and strategies. This knowledge can be leveraged when points of understanding are used as a tool to help clarify the pluralism that exists in design and the confusion surrounding various methods of approach (Z. K. McKeon and Swenson, 1998). Design methodology can be broadly defined as the study of principles, practises, and procedures of design (Cross, 1984). However, the practise or act of designing requires an approach that facilitates the creation and production of artefacts, products, or services.

The examination of strategies developed by central and influential figures in design theory and practise illustrate the various methods of design thinking and working used to conceive and create design products (Alexander, 1964, 1971; Buchanan, 2001a, 2001b; Cross, 1984; Gropius, 1955; J. C. Jones, 1963; J. Christopher Jones, 1992; J. C.

Jones, 1997; Moholy-Nagy, 1947; Rittel, 1988; Rittel and Webber, 1973; Simon, 1973, 1996). An analysis of the literature provides a basis upon which the appropriateness of design methods to a variety of issues and problems in the act of designing may be carefully considered. In this way, a systematic design approach that supports the clarity and simplification of complex information may provide an insight as to how the design process for the prototype application LabanAssist can be shaped.

As Jones (1992) tells us, these methods are equally as diverse as the processes they describe. For situations where creativity, discovery, or innovation occur; there cannot be a standard method of application readily available for such circumstances (Z. K. McKeon and Swenson, 1998). Nor is the practise of design simply a matter of pronouncing a fitting set of ingredients that will do the trick. In this context, Simon (1996) describes design as an academically challenged "cook bookery" discipline. For this reason, gaining a clearer understanding of the circumstances surrounding the problems and objectives of various design methods will help to emphasise the subtle underlying strategies employed in design.

Interpretation and Analysis

This is by no means an exhaustive study; nor is it strictly chronological or historical in its account. Instead, I provide a general view of the design methods used during the late nineteenth to early twenty-first century to gain insight into the way in which design processes have evolved. In an attempt to identify the nature of design methods and the differences between the kinds of approaches described, McKeon et al. (1994), and Watson (1993), supply us with a schema for their interpretation and analysis. This provides a lens through which to analyse a variety of approaches utilised in design. It enables a designer's perspective and system of approach; designed to facilitate the processes of inquiry, analysis, and synthesis; to be interpreted. The recognition of a logistic, operational, dialectic, or problematic method in the examination of existing design practises provides a foundation for this understanding (Z. K. McKeon and Swenson, 1998; Watson, 1993). As such, they are not commonly used as a basis for the analysis of design methods in that they employ philosophy as an underlying theory. They are philosophic methods.

A logistic method is one of construction. It begins the development of a design solution from its smallest element, which is utilised as a foundation to produce an outcome. The designer adopting this method is void of a perspective in the creation of a design solution. This is because the practise of a logistic method is one in which individual judgements are withheld to allow for an objective and logical account of data analysis. Its necessary objectivity thus ensures consistency and certainty as a method of reasoning and decision-making, which is not subject to personal interpretation or bias. This is where the practise of design may be understood, not as a science, but as the rational solution to practical problems similar to those known to engineers and computer scientists (Z. K. McKeon and Swenson, 1998).

In circumstances where contradictions or conflicts arise in the development of a design situation, the designer that employs a dialectic method endeavours to reconcile these differences. Through conversation and the opinions of others, mutual understandings may be established to reach a common goal. In this way, a designer may assimilate known differences to design an inclusive or comprehensive solution that extends its value to a larger context—one in which an harmonious balance between the relations of a design situation from part to part, part to whole, and whole to part exist as a result of their mutual participation and unity (Scully, 2003). Design practises are tailored to meet a particular set of circumstances surrounding a design situation.

The problematic method, as suggested by its title, turns toward the resolution of a problematic situation as it is encountered from a designer's experience. This is where the relation of its parts, the materials, and functional elements of a design situation are significant to a whole, and are examined with regard to a whole that is significant to its parts. A designer that utilises this method creates the form of a product based on the analysis of raw materials or data, and seeks to synthesise these initially disparate or indeterminate elements into an organised and integrated whole (Watson, 1993). It is a method which is based on a particular correctness of the designer that stems from an inquiry into a felt or known difficulty in the conditions of a specific situation. Theoretical knowledge of the subject matter of design; gained from careful analysis of the elements of the design situation; guide and inform the synthesis of a design outcome (Aristotle, 2005; Dewey, 1938). Design practises that follow this approach are based on

discovery and invention that aim to transform the conditions of a problematic situation (Z. K. McKeon and Swenson, 1998).

An operational method takes the view that a single, clear-cut belief or statement of fact does not exist as a basis for thinking and working in design. In recognition of the pluralism of ideologies and worldviews, a designer's perspective and judgements made during the design process are central to the distinctions or arguments made in support of the actions taken to reconcile these differences. It looks for the validation of a design solution in the results of successful user testing. While it does not rely heavily on the foundation of theoretical distinctions, the operational method uses, in part, techniques from logistic, dialectical, and problematic methods (Z. K. McKeon and Swenson, 1998). In reference to the broad description of philosophical methods identified above, the analysis of the following literature regarding the practise of design cannot reveal a common or widely accepted interpretation of the methods utilised in design. Instead, it enables an understanding of the function or role various methods provide in facilitating the development of the design process.

Design Potentialities

The Design Methods Movements (Cross, 1984) of the mid- to late-nineteenth and twentieth centuries were largely concerned with design potentialities and the techniques associated with the economy of production (Moholy-Nagy in Zucker, 1944). The age of mass communication and industrialisation gave emphasis to the form, function, materials, and manner in which design products were produced. During this time, functionalism aligned itself with a distinct purpose for design which subscribed to Sullivan's (1896) well-known "form follows function" principle. This approach follows the notion that the form of an object is defined or shaped by the function a product is designed to perform.

However, the growing complexity of modern day culture necessitates the reexamination of this guiding principle to appropriately accommodate the changing environments of technology, culture, production, values, and society. This is expressed by Moholy-Nagy (1947), who tells us that the direct replication of an existing product's shape or form in a new material calls for a fresh understanding of design requirements, despite a

product's intended use or function. With an established career as a painter, photographer, sculptor, and industrial designer, Moholy-Nagy (1947) understood design as an integrative process of complex relationships that, when combined, embody an organised and coherent whole. Moholy-Nagy (1947) suggests that, to achieve this, requires a designer to understand or think about the interrelationships between an object's external physical manifestation, its functionality, and subjective qualities for human consumption that contribute to a complex whole. Characteristic of a problematic method, Moholy-Nagy (1947 p. 42) maintains that:

> The idea of design and the profession of the designer has to be transformed from the notion of a specialist function into a generally valid attitude of resourcefulness and inventiveness which allows projects to be seen not in isolation but in relationship with the need of the individual community. One cannot simply lift out any subject matter from the complexity of life and try to handle it as an independent unit.

This offers an insight into the circumstances surrounding the development of design from the traditional arts and craft movement, which provided an opposing voice to methods of industrial production commonly associated with decorative arts and architecture (Gropius, 1965). In reference to the term "profession," it should be stated that design as a discipline or an intellectual art has since come into its own, as a result of the evolution of traditional crafts (Buchanan, 2001a). In spite of this, a way of thinking in terms of a symbiotic relationship offers a different perspective of designing that considers human encounters and experiences (the internal aspects) in relation to the physical attributes and functionality of a designed object (the external aspects). In doing so, it provides a context or environment in which a product may be considered for its value and appropriateness in contemporary culture and society. A "design for life" (Moholy-Nagy, 1947) proposed a way of thinking about design which emphasised the physical and emotional elements of form and matter in design. Furthermore, it placed the intuition of a designer, and the ability to grasp a concept of the whole from the analysis of its parts, as central to the synthesis of a design product.

The Development of Design Methods

Design as a problem-solving activity marked a period of systematic design that was later described by Rittel (1972b, p. 321) as "first generation" design methods (Bayazit, 2004b; Cross, 1984). In particular, the methods developed by Jones (1963; 1992), an industrial designer; Alexander (1964), an architect; and Archer (1965), a mechanical engineer and industrial designer; involved the rigorous investigation and clarification of elements that posed challenges to the design of an ultimate solution. A variety of processes were created in order to systematically examine the underlying parts and hierarchical interconnections of meta-structures found in design problems that followed rational and logistic methods of investigation (Alexander, 1963; Archer, 1965; J. C. Jones, 1963). Generally, techniques of optimisation common in systems engineering, management, and operations research provided a foundation for this design approach.

The work of both Archer (1965) and Jones (1963) are indicative of an operational method in which organisation, sensibility, intuition, and experience are regarded as valuable elements in the design process. To offset the rationalist paradigm, they (Archer, 1965; J. C. Jones, 1963) suggested that such qualities enabled designers to make reasonable and creative judgements during the design process. This in turn facilitated the development of innovative design solutions. For Archer (1965), design concerns the reconciliation of conflicting factors in the design situation initiated by the discord between industrial functionality, production, and marketing requirements. In particular, he characterises four key elements of the design process. Beginning with a need, a model, the intent to embody a solution as an object, and a creative leap; a designer's judgement and experience is again critical to the synthesis of a solution (Archer, 1965). In situations where such judgement fails to achieve this, after much comparison and contrast with other fields of knowledge, a designer employs a rational method of analysis as a last resort to find an appropriate outcome (Archer, 1965).

For Jones (1963) , the act of designing involves the reconciliation of a supposed conflict between creativity and logic; where the development of imagination and reason, in isolation from one another, provides a way to focus on the analysis of design elements as distinct from their synthesis. He argues that taking a rational approach to design reduced the potential for error, and works to increase the efficiency of the designer;

while the assistance of computer technology functions as a memory aid. This provides the designer with the freedom to create more imaginative solutions by not being weighed down with numerous technicalities and details. However, the disconnection between the relationship of analysis and synthesis in this method of operation has little chance for convergence when treated so disproportionately (J. C. Jones, 1963).

In contrast to Jones, Alexander (1964) worked with the uncertainty of establishing design requirements. He (1964, p. 23) developed a practise in which the "fit" or "misfit" of conflicting relations between an object's form, human need, and context in the design situation were evaluated for their suitability to a design outcome. Characteristic of the dialectic method discussed further in Chapter Six, "Strategic Design Thinking," he sought to eliminate the conflicts introduced by human tendencies or needs in reference to the physical design components established by architectural design and urban planning processes. A reductive approach to the analysis of design patterns or diagrams provide a way to resolve the complexity of design problems in a precise, step-by-step process to achieve the desired form or synthesis of an object (Alexander, 1971).

While "first generation" design methods subscribed to individualistic and ideal processes to solve problems, a shift in attitude that recognised the complexity involved in structuring and formulating design problems characterised the basis for "second-generation" design methods (Rittel, 1972b, p. 320). Design as systematic planning saw the introduction of argumentation into the design process as a means to resolve conflicting interests found in the controllable and uncontrollable effects of ill-structured problems (Rittel, 1972a). Rittel (1972b) maintained that participatory methods focusing on critical argument, judgment, and reasoning between stakeholders and designers involved in the design process offered a logical way of analysing and determining the significance of problematic design issues.

Fundamentally operational in approach, Horst Rittel, a mathematician and urban planner, dealt with the complexity of uncertainty and its consequences (Krippendorff, 2006a). In doing so, he prompted designers to examine the assumptions they made in the design process, and brought the potential of empirical research to the fore (Krippendorff, 2006a). However, for Rittel (1988), there were no clearly definable moments between the definition of a design problem, its synthesis, and evaluation. A

designer's mental ability to simultaneously understand and manage design problems through a process of reasoning, therefore, determined its resolution. It was in the imagination of the designer that alternative plans and solutions for such problems were invented and manipulated prior to its actualisation (Rittel, 1988).

The notion of simultaneously developing a design problem and its solution created greater division among second-generation design methods. For Simon (1973); with a background in political science, economics, and engineering; there was no real distinction between the structures of well- or ill-formed problems. They were unstructured. In *Sciences of the Artificial*, Simon (1996) preceded the developments of the "Design Methods Movement," which arguably set the stage for a design science by establishing a logistic method for rational decision-making and problem-solving processes. Primarily, Simon's interests lay in establishing a science for design in which artificial intelligence and cognitive processes provided a rational approach to the management of complex systems. "Satisficing" and "bounded rationality" are terms used to describe the motivational constraints and imposing limitations of the human capacity to process information that he (Simon, 1979, p. 3) saw as key contributors to the resolution of less than optimal design problems.

In addition to this, Simon (1996, p. 5) characterised four indicia which describe man-made products as that of "the artificial." Termed "artefacts," they operate as an interface between an internal and external environment. While the internal and external aspects of an artefact's relationship to the environment in which it operates shares similarities to the distinction that was made earlier with regard to Moholy-Nagy in "Design Potentialities," above, the two are profoundly different. For Moholy-Nagy (1947) , the internal elements of a product or object refer to its subjective qualities with regard to human use; while, for Simon, it is the internal substance or matter of an artefact's structure and organisation. This makes a clear distinction between a fundamentally human-centred design approach and a mechanistic approach. Furthermore, it illustrates the difference between a problematic and logistic method of approach, in which Simon (1996), employing the latter, extends the treatment of dynamic entities or materials to the immaterial and simulated reproduction of human thought. For Simon, the analysis of the least parts of a design situation provides a foundation for the construction or

synthesis of a solution. This is a method in which the designer's perspective is impartial to productive processes in order to generate what is arguably a valid scientific outcome.

Design Research and Studies

The various approaches adopted throughout the Design Methods Movement between the 1940s and the 1990s represent distinct ways of thinking about the purpose and practise of design. The diversity of approaches stem from a sign of the times, a designer's background, and the perspective in which they formulate a course of action to examine or resolve the elements of a design situation. The degree in which this understanding extends to encompass the broader implications of contemporary society and values dictates this approach. I argue that the approach taken to understand, conceptualise, and visualise the complexity of a design situation rests on the capacity of the designer to formulate an outcome that appropriately considers not only the parts of a design situation but their combination as an integrated, organised whole.

Design theorists of the latter period of the Design Methods Movement rejected earlier design practises that focused purely on methods as a way of designing. In an attempt to counteract the process of logical analysis and ordering principles, Jones (1997) focused on experimental art practises that dealt with chance and possibility. In doing so, he sought to open up the opportunities for design outcomes, and placed greater emphasis on originality and inventiveness in the design process. The rational analyses of design elements were, therefore, indispensable to the creative synthesis of design outcomes. For Jones (1997), the use of a notation system provides a means in which rational process can be leveraged to enhance creativity. However, for Alexander (1964), analysis and synthesis were integral to one another. He saw the creation and manipulation of abstract forms as a way of inventing a reality (Alexander, 1964)—one in which an integrated, organised whole could be created to resolve conflicting elements in a design situation (Alexander, 1964).

These abstract forms or patterns represent a way of working with the independent relationships of dynamic forces (Alexander, 1964). Rather than adhere to complex mathematical or mechanical methodological procedures for their development, the natural formation of such diagrams or patterns drawn from the experience and reflection

of a designer suggests a way of working in design comparable to that of an art. Alexander (1964) argues that it is not a particular method that leads to the creation of these patterns, but it is the patterns in and of themselves which provide powerful tools for communication. They enable a designer to shape various elements of the design situation. Guided by the insight developed from and through their creation, patterns provide a language for the designer in which the fusion of abstract relations and experimentation may be expressed in a new form (Alexander, 1971). This is where an understanding of the idea behind the creation of each pattern is key to the synthesis of form, as opposed to any prescribed formula or method considered apart from the reality for which they are designed (Alexander, 1971).

Archer (1979) also shared a similar view and claims that, while logical and mathematical procedures provided a rational solution for the structural development of design objects, such an approach followed a mode of reasoning quite foreign to the actual intentions of designing. Archer (1979) maintains that this uneasiness was due to the cause, effect, and division of analysis and synthesis during the design process. The aim of design was really a communicative activity, in which the obscurities of design elements were minimised in order to find a fit between the requirements and provision of a design outcome (Archer, 1979). However, I argue that an approach that takes into consideration the relationships between the materials, function, form, and manner of designing; as a means to create products that are valuable to a specific community of practise; should also carefully consider the subject matter of design in relation to its form, utility, and the circumstances surrounding its medium of use in a technological society. Products are designed to adapt, not to a fixed need, but provide a place for action that facilitates the needs and intentions of diverse users in dynamic situations.

After a period of disillusionment with the state of design methods and procedures, Archer (in Bayazit, 2004a, p. 16) went on to characterise design research as: "… systematic inquiry, whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning in man-made things and systems." Comparable to Archer, Downton (2003, p. 2) also gives focus to the role of inquiry and tells us that: "Design is a way of inquiring; a way of producing knowing and knowledge; this means it is a way of researching." Roth (1999), however, presents a contentious view of the role that research plays within the design community, and

argues that difficulties arise in design research, since widely accepted standards for design process, presentation, and evaluation have yet to be established. These debates exist because of the fundamental differences between the notions of design studies and design research. This division illustrates design as either a practise of making and giving form to objects for use; or as a process of devising strategies that draw upon interdisciplinary knowledge to resolve complex situations (Roth, 1999). In response to the confusion surrounding the meaning of design research at the time, Buchanan (in Roth, 1999) rhetorically questions the possibility of a new model for design based on the relationships between theory, practise, and production. Buchanan (2001b) later replied to this by providing a comprehensive view of the various types of design research; the boundaries of design (discussed earlier in "Design Potentialities" above); and the potential development of design as a field of inquiry. The significance of this suggests that, by identifying a situation as problematic, by means of inquiry, design is a way of finding problems as opposed to being understood a purely problem-solving activity. Furthermore, design becomes an activity where significant problems are addressed if understood to be problematic to a particular set of circumstances, as a result of inquiry.

As with every field or discipline of knowledge, there is a concern for the theoretical underpinnings in which the subject matter of its field can be appropriately dealt with and discussed; that is to say its boundaries. This is particularly the case with a discipline such as design, which continues to establish a rich body of knowledge through a variety of sub-related design disciplines and methods of interdisciplinary approach. Regardless of the terminology used to define the various applications of design to philosophy, history, methods, research, or studies; the changing environment of modern day society and culture adds to the pluralism of perspectives in which the purpose, practise, and principles of design undoubtedly will continue to be points of contention. Nevertheless, I argue that it is in the very nature of difference that a variety of perspectives may enhance our understanding of the pluralism that exists in design. Through the careful consideration of the variety of ways in which we think, act, and work in design; we may recognise these differences, and find a mutual point of understanding to act as a foundation from which to develop an appreciation and tolerance for such diversity. In doing so, we will gain the knowledge and power to move towards developing greater coherency in the discipline of design, and begin to seek new ways of thinking and

acting in response to the changing conditions, contexts, and perspectives in a technological age.

Summary

The way in which leading design theorists treat the practise of analysis and synthesis in the design process provides a common point of reference for the interpretation and analysis of design methods. This examination also illustrates the ways in which research in design can be shaped. For the purposes of this research, I adopt an operational method for the planning and production of design artefacts. An operational method enables me to make a variety of distinctions in the process of designing, which move the development of the design process forward. This adds significance to my role as a designer, the judgements I make, and the perspective in which the research is undertaken. This focus becomes central to the formation of the design process. Furthermore, I will also subject the resulting design product to an iterative process of evaluation and modification to reconcile potential issues found during the product development phase. In this way, the design process for the creation of the prototype application LabanAssist can be shaped to simplify the use of complex information and interaction.

However, in view of the dissatisfaction with the outcomes of the Design Methods Movement and the function of methods in general, I argue that there is a distinct need to employ a strategy for which an ability to manage or work with diverse perspectives and dynamic situations in design may be developed. This is in opposition to a design process that seeks to offer a solution or the resolution of a distinct problem. Instead, it is a strategy or a way of working that encompasses the processes of inquiry, analysis, and synthesis to guide the act of designing and enable a designer to manage open-ended dynamic circumstances in the ongoing development of designed outcomes. This strategy enables useful knowledge from both the arts and sciences to be utilised effectively to assist the act of creating design products that enhance communication, the human experience, and creativity. This gains significance for the design of a prototype application that facilitates the diverse composition of movement by members of the dance community. I turn my attention to the development of a strategy for the design that will be operational in structure and relevant to the methods of movement

composition for the design of the prototype application LabanAssist in the following chapter.

6 Design Strategies

> Individual researchers may set their own strategy and agenda, but a centre of design thinking reflects a commonly held strategy, explored in individual variations. The focus gives coherence to research and enhances the impact and significance of research (Buchanan, p. 5).

Introduction

This research discusses the dynamic nature of the design process. It seeks to better understand the combination of design aspects considered necessary for the ongoing process of actually designing. Subsequently, it addresses how these aspects add to the complexity of design, which impacts on our ability as designers to act effectively in the process of designing. A dialectic framework drawing on cybernetics is proposed as an approach to better understand the designer's capacity to act as an observer and participant in the creation of a design solution that embraces the social, interactive, functional, and interdisciplinary elements of design.

In Chapter Five, I argued that the designer has a role that is integral to the design process and its ultimate solution. Because of this, multiple viewpoints and their implications may be considered via a second-order cybernetics design structure. To facilitate this, conversation theory offers a means to reveal and resolve contradictory ideas through a series of interactions. The expanded knowledge that results using this structure assists with the subjectivity of a designer's experience, knowledge, creativity, and capacity to act in an iterative design process. Obtaining a reflexive account of user and stakeholder needs will further develop understanding derived from discussion and mutual agreement to reflect a constructivist perspective.

For the purposes of this research, I propose a poetic strategy for the creation of design products in which both scientific and common sense approaches may be equally considered and argued as necessary. This process includes the formulation and

reformulation of a design situation to achieve realisation. It takes into consideration the transformation of the subject matter for design that considers its environing conditions and circumstances as dynamic with regard to the potentialities for the creation and development of a design product. I argue that this provides a strategy for the discovery, invention, production, and formation of connections between various elements of a design situation that encompass elements of dialectic, rhetoric, and grammar. This research examines the way in which a systematic design strategy characterised as a productive science or poetics can facilitate the design of a product that embodies the necessary structure to support the interaction of complex information as an integrated and organised whole.

A Strategy for Design

Designers often refer to the practise of design as being intrinsically chaotic, unstructured, iterative, and unpredictable (Conklin, 2006; Dorst, 2006). This is understandable, bearing in mind that design typically deals with invention and the unknown. However, when the act of designing is approached with an understanding that developing a response to a design situation is intimately connected with the success of the design outcome, a strategy for its creation holds significance (Rittel, 1972a). This is because the subject matter for design, created by the designer, is embedded in what is particular. The context for design presents designers with a unique set of circumstances for which they are required to develop an appropriate course of action to gain an understanding of diverse situations of thinking, acting, and making. In light of the design methods previously discussed in Chapter Five, a systematic process or a methodical way of working can been seen to emerge throughout the variety of ways in which design is practised. Nelson (1957) claims that a similar conservatism found in the gradual development of forms in nature can also be recognised in the design process. The methods proposed by Jones (1997) are, however, an exception to this where judgment, chance, and random possibility are drawn on to enhance creativity. Regardless of whether the creation of structures, patterns, relations, or processes stem from natural or artificial sciences; Dewey (1938) tells us that ,when subject to inquiry, the logic of science and common sense share a common pattern. This suggests that design can be considered less a series of creative accidents than a strategy of approach when subject to a method of inquiry. However, due to the differences in subject matter

applicable to science and common sense, the elements that constitute their makeup will have a varied effect on their treatment if found to be problematic.

Systematic Inquiry

For both Mead and Dewey (in Corti, 1973), the object of inquiry is based on the settlement of propositions concerning a problematic or indeterminate situation. This has significant relevance to the problems that Rittel and Webber (1973) also characterise as indeterminate or wicked problems. Where the two conceptions of the term differ, the approach taken is to identify, distinguish, and resolve an indeterminate situation. Inquiry begins with the identification of a problematic situation that is considered indeterminate because of a sense of doubt felt in an observed, existential condition or situation. However, it is the qualities in the situation that are doubtful; not something that is perceived by the inquirer (Dewey, 1916, 1938). Should the latter be the case, such problems, by their confused and obscure nature, cannot be resolved. These types of problems are seen to be imagined in the mind of the inquirer, and are without context in existing conditions of a situation. An example of this is described by Archer (1965, p. 77) under the terms of a "transactional theory of perception." This is where a viewer's personal experience contributes to or diminishes a phenomenological understanding of what it is one perceives. Critical to the concept of inquiry is the objectivity in which practical judgment is exercised, so as not to be confused with the reasoning of a kind that leads to moral or value judgments (Dewey, 1916). This suggests that an uncertainty or real living doubt is the key motivator for which belief or warranted assurance is sought (Corti, 1973). This is achieved through inquiry or by means of questioning to better understand the likely conditions and elements of the situation that are uncertain; in other words, the issues that makes a situation doubtful (Dewey, 1938). A situation then is considered problematic as a result of inquiry.

When an indeterminate situation is no longer doubtful, the conditions of the situation are considered determinate and no longer necessitate further inquiry (Dewey, 1938). While determined situations are not strictly defined, they provide an indication or a starting point for which the possibilities and treatment of such elements can be considered in resolving them. For Rittel and Webber (1973), the notion of wicked problems suggests that, by their inherent wickedness or indeterminacy, such

problematic situations are never fully resolved. I argue that a method of analysis seeks to provide an in-depth understanding of the elements of a design situation and the interrelationship of its constituent parts. An indeterminate or undefined situation by method of analysis does not permit the extent of its conditions to be known. At best, this approach can only facilitate a less than ideal resolution due to the vagueness or ill-defined nature of the problem. Therefore, when faced with a problematic situation, it is necessary to remove the wickedness or impossibilities from the problem in order to provide a concrete platform with which to develop a solution. Nevertheless, while these methods of approach differ, the identification of a problematic situation alone does not present an appropriate course of action for its solution.

A Unifying Concept of Design

Because of the lack of a given process in which to plan, design, and make products for an intended use; design may serve itself better when considered as a type of attitude (Moholy-Nagy, 1947). According to Gropius (1955) , the objective of the Bauhaus School of Design was to take a principled approach to humanising the practise of design. The basis of this principle saw design as a unity of all forms of creative endeavours in relation to the fundamental nature of living, and sought to bring about a new bearing on life (Gropius, 1955; Moholy-Nagy, 1947). This in turn called upon the ingenuity of a designer to find a solution based on the surrounding economic, social, and technological conditions of modern day society; rather than a ready-made formula (Gropius, 1955). While the resulting outcome of this intention was largely mistaken as an overt fixation with the form and style of designed objects, it aimed at bringing into fruition a modern "architectonic" art (Gropius, 1955). A derivative of the Greek term *architectonikê*, architectonic refers to the characteristic qualities of "the structural design that imposes order, balance, and unity upon a work or an entity." (Gove and Merriam-Webster Inc., 1986, p. 113). An architectonic art is a principled approach that gives order to the productive elements or scientific methods of knowing, doing, and making in the design process (Buchanan, 1995; Z. K. McKeon and Swenson, 1998).

In a similar yet profoundly different way, Simon (1996) makes reference to an architectonics of music. He does this, however, to provide an organising principle for the creation of alternatives or variations of a theme, which are guided by the underlying

substructures of a larger system. This is where the invention of new structures, for example of a melody or of a rhythm, is calculated for their potential and the scope of what can be known technically. Such structures are examined for their capacity to be manipulated and controlled and, in this way, created. The term architectonic in this view is understood more as an art of scientific calculation. Then again, Schön (1995) provides us with a different view in which the underlying structures or schema of musical notes, known to musicians, provide a basis for invention in a very different sense. I argue that this is where the performance of music is a personal expression of creativity, and not something that is objectively assessed and formulated for its potential to project in a variety of forms; such as one in which a musician has a "feel" for the situation in which they perform and are actively engaged. Through a familiarity with the variety and potential for which the vocabulary of musical notes can be arranged, sound becomes an instrument for creativity and invention. Creativity enhanced by the art of improvisation enables a musician to impose an order and structure on the music and sound they produce; rather than inventing musical variations and themes based on the prediction of variability and formulaic structures. In a sense, musicians are also designers.

Just as a choreographer forms an understanding of the physical capabilities of a dancer; a designer seeks to understand a client's needs and requirements given these possible variations. In recognition of such needs, I argue that designers create specific criteria to direct the focus of a design purpose or goal. While a choreographer may be guided by the cultural sensitivity of a work, the aesthetic quality of a dancer, or the genre of music; the way in which he or she shapes the relationships between these elements to form a unified whole characterises a particular way of working—an art. Like most arts, design takes a disciplined approach to creatively develop, make, and produce a design product. Whether it be a performance, a novel product, or information technology; management it is indeed artful in its making. A principled approach that provides order to the elements of knowing, doing, and making is architectonic in its function. An architectonic art, therefore, imposes unity and balance upon a work. It assists the process of orchestrating all of the elements of a performance to come together as a unified whole: a composition.

This marks an important distinction in which the structure given to the form and matter of a product is considered an art that relies upon a knowledge of various materials, tools, and skills for its production (Moholy-Nagy, 1947). I argue that the significance of this characterises design as a unifying art that draws upon a variety of knowledge to formulate a solution. One area of knowledge in particular is the materiality and skill required to produce physical artefacts to create anew. This is commonly referred to as design or production techniques. This also suggests that the role of a designer is one that takes into account a broad perspective of the knowledge that contributes to the realisation of a design solution. In doing so, it requires a sense of resourcefulness on behalf of the designer to draw upon specialised knowledge from other productive disciplines. An approach which involves an aspect of collaboration in the process of formulating the elements of a design situation is in stark contrast to the approach of first-generation design methods or Simon's (1996) method of scientific calculation. Rather than begin with a close examination of the relationships between the underlying parts of the design situation, an architectonic art concerns the essential unity of all forms and creative ways of thinking, doing, and making. It provides a strategy or schema that gives coherency to a particular way of working.

A Unifying Idea for Design

For Dewey (1938), an idea gives unity to a situation and marks the possibility for its solution. In the context of design, it does so by providing a designer with an insight or the ability to see more clearly into the relationships between the elements of a complex situation. This gives weight to Kant's (1901, p. 91) saying that "Thoughts without content are void, intuitions without conceptions, blind." I argue that this, however, relies on a designer's ability to grasp these associations, which augments creativity and guides the direction of the design process. This means that the experience of the designer has a significant impact upon the resulting outcome of a design product. While such experience may be claimed as a flash of pure insight at a significant moment in the design process, an expanded view understands that knowledge developed from practical experience provides a designer with an informed intuition. This, in turn, guides the design process, which then is said to be operational in its method. I argued in Chapter Five that knowledge developed as a result of this provides designers with a line of reasoning that carries the design process forward; one in which a designer distinguishes

between different user needs and requirements to develop an argument as to how design products should function. Buchanan (1995) refers to the concept of forethought as a type of universal, or architectonic, art concerned with the aspects of production and making such as discovery, innovation, argument, and planning. Highly relevant to design and possibly how design is understood today, the term first characterised by Aristotle in the *Poetics* (2005) distinguishes forethought as an element separate from its application to a specific subject matter or way of making (Buchanan, 1995). The concept of forethought is also in contrast to the belief that an innate sense of intuition offers an adequate explanation for the mysterious creation of highly successful design products. In support of this, Watson (1993, p. 95) tells us:

> Not only is knowledge organised by ideas to form sciences, but knowledge itself is already a unity of concepts as form with intuitions as matter, and intuitions are a unity of the forms of intuition with the matter of sensation. There is thus a three-layered structure of form and matter: the matter of sensation united by the forms of intuition gives empirical intuitions, intuitions united by the concepts of the understanding give knowledge, and knowledge united by the ideas of reason gives the systematic unity of a science.

This suggests that an informed sense of intuition is guided by a unifying idea or the thought behind the planning and making of design products as recognised in the notion of forethought. Nelson (1957), however, argues that successful design achieves a sense of wholeness or unity in connection with its surrounding environment, which is less of a physical relationship than it is social. The nature of design previously discussed in Chapter Five, "The Act of Designing" and above in "Systematic Inquiry" refers to the wickedness or uncertainty of design problems. Cross (1984) tells us that Archer (Archer, 1979) also recognised that the types of problems arising out of everyday social situations were of a similar nature to those defined by Rittel and Webber (1973) as wicked and tame problems. In devising a designerly way of thinking and doing, Archer (1979) came to understand the nature of these of problems as being innately human. Because of the growing awareness surrounding the methods of design practise, research and education took a fundamentally human-centred design approach towards addressing these problems (Cross, 1984). Returning to the notions put forward by Moholy-Nagy

and Gropius as early as 1947, it is possible to appreciate the aim of the Bauhaus School in creating a vision of design that was fundamentally concerned with humanising the design process. Rittel's (1972b) methods of argumentation and participation also introduced a what-ought-to-be approach to design. This not only illustrated an awareness surrounding an accountability for conflict resolution and the implications of design outcomes, but led to the development of a theory of technology concerning instrumental knowledge (Dubberly and Rith, 2007).

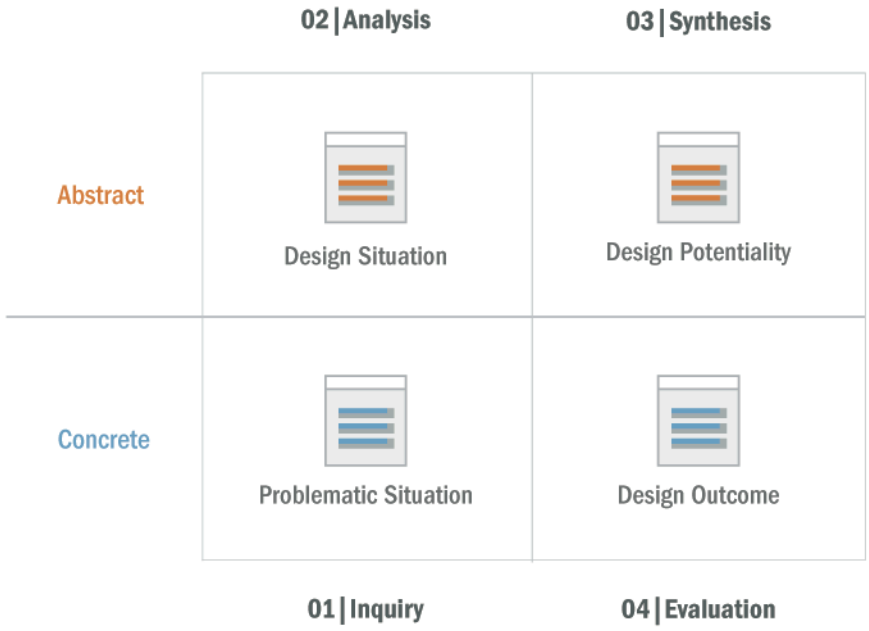
Although as early as 1916, Dewey (1916) characterised the art of experimental thinking as way in which different modes of practise can be controlled and developed. This characterization underpins the way in which an idea can give shape to the practise of designing. In this process, the incremental acquisition of meaning or knowledge over time is instrumental in informing and regulating human action or practise (Dewey, 1916). Operational knowledge is acquired as a result of inquiry into a problematic situation, to which the physical making and experimentation of a proposed resolution is not only vital to its success but also controls and informs its practise (Dewey, 1916). This is achieved through the progressive development of iterative prototypes during the design process, which involves their evaluation by potential users of the proposed object or artefact. In the course of resolving a problematic situation, the object of knowledge is not the intent in which thinking sets out to achieve, but is the result of what is made in the process of experimental thinking (Dewey, 1916). Under the terms of instrumentalism, referred to as "the logical version of pragmatism," knowing is derived from the physical experience of doing, making, and thinking (Dewey, 1916, p. 170). Furthermore, the re-contextualisation of objects or things as products of design is intimately affected by knowing and thinking in a practical sense of the term, and is necessarily grounded in experience. This means that practical judgments made on behalf of the designer play a critical role in the design process in situations where inquiry is used a method to further explore a problematic situation.

Theory and Practise

Judgments concerning the kinds of practical and theoretical knowledge that can be utilised in the move towards finding a solution for a problematic situation are critical to their treatment and resolution. Dewey (1938) characterises these modes of working and

thinking as nonscientific and scientific approaches. Nonscientific or common-sense approaches can be broadly described as the qualities of doing, sensing, and feeling. In relation to the practicalities of working and making, these qualities function to shape practical judgments. In doing so, judgments or beliefs facilitate the physical actions taken to create products concerned primarily with use and enjoyment (Dewey, 1916). An example of this can be found in the visual and performing arts such as literature, sculpture, singing, and dancing. The subject matter with which such judgments interact, between knowing and doing, are used to shape and transform physical objects or things (Dewey, 1916). They do so on the basis of what is known to be appropriate to a particular situation from prior experience. It is important to distinguish that this type of activity is not one that derives from an intellectual understanding. Rather, that it is practical and operational in its utility (Dewey, 1916). This is where a sense of purpose is felt or known through the experience of doing. In contrast to this, the nature of scientific methods of working and thinking involve the abstract examination of entities far removed from concrete experience (Buchanan, 2006). This disconnection or objectivity regulates interaction to prescribed transactions or conventions of working; derived from a body of knowledge to which they subscribe. Thus, the activity is intellectual and seeks to establish the working relations between entities in order to rationalise their behavior and effect. The products of scientific inquiry are of a conceptual and intellectual nature, which contribute to theory and knowledge.

While fundamentally opposed to each other in practise and procedure, a combination of theoretical knowledge and practical experience can facilitate the controlled progression of inquiry to meet a distinct purpose (Dewey, 1916). This, in turn, presents a paradox between the modes of practise to which scientific and common sense approaches suggest (Dewey, 1916). This is one in which the scientific abstraction of things, removed from the restrictions of existential conditions, works to simplify complex situations. It follows that the greater the abstraction of problematic elements are from the restrictions of environing social and cultural conditions, the greater the possibility and freedom there is to examine the potentialities and alternatives for their solution. Through the process of ideation that involves the abstraction and representation of everyday objects in a symbolic form, scientific practises can assist the development of the unknown, rather than establish what is already known (see Figure 10. Design Thinking). This is achieved through diagramming and drawing or other forms of



Reference: After Evenson, S & Dubberly, H 2007, (ed Ebenreuter, N) Pittsburgh, Pennsylvania.

Figure 10. Design Thinking

symbolic representation such as the practise of Labanotation and modelling that facilitate the objective evaluation of things or objects. Through the symbolic representation, modification, and development of things or objects removed from their environment; and therefore detached from their conventional meaning; scientific methods of abstraction and modelling can work to facilitate the generation of design concepts through the processes of brainstorming and ideation.

The contradiction in terms comes in to play when the objects or subject matter of design are developed by nonscientific practises alone. Just as scientific practises subscribe to the conventions of their own making, when things or objects are left untouched to develop in a natural environment, they too succumb to a process of gradual and habitual adaptation on the basis of self-interest. With this in mind, scientific methods of abstraction present a practicality uncommonly associated with its procedures that assists in the reformulation of everyday objects and things to more appropriate modes of practise (Dewey, 1916). Such an approach necessitates the successful integration of both scientific and nonscientific practises. This is dependent on the ability to work with contingency and possibility in the design situation, and to devise an appropriate course

of action that leads to the development of a potentially, useful, usable, and desirable outcome.

Strategic Design Thinking

At its core, design thinking seeks to address contemporary design problems by combining useful knowledge from the arts and sciences (Buchanan, 1992) to assist in the development of appropriate design outcomes. There exist four areas of design thinking that encompass the design of: (1) "symbolic and visual communications"; (2) "material objects"; (3) "activities and organised services"; and, (4) "complex systems or environments for living, working, playing, and learning" (Buchanan, 1992, pp. 9–10). While these areas are represented as distinct from one another, knowledge used to support design thinking is not mutually exclusive to these domains of design inquiry (Buchanan, 1992). Instead, each area draws on a variety of different disciplines to assist in its development, which reflects the transdisciplinary nature of design (Margolin, 1996). Because of this diversity, Buchanan (1992) tells us that the greatest challenge of design thinking lies in our ability as designers to gain insight from the application of design thinking to a variety of problems and situations that benefit the intellectual development of design practise.

To illustrate the application of strategic thinking to design, I argue that Pask (1969) provides us with an early example of this by which the introduction of a systems-oriented approach to architectural design prompted the development of a cybernetic theory of architecture, and impacted existing design practises. In *The Architectural Relevance of Cybernetics*, Pask (1969) describes a shift in thinking during the Victorian era that changed the conceptual design of architectural structures by considering their development within a part of the larger ecosystem of a human society. This was done to overcome the limitations of existing architectural rules and a lack of a prescribed formula to adequately address the problems of the time (Pask, 1969). By conceptualising a design situation in the context of a dynamic human environment, or a whole, a new way of thinking facilitated innovative design techniques and enabled evolutionary practises and novelty to enter the design process (Pask, 1969). Furthermore, Pask (1969) proposed the development of five specific areas as a result of this approach, which included the advancement of computer-assisted design procedures

and a variety of disciplines that deal with a broad understanding of "civilisation," city, or "educational systems." In establishing *The Architectural Relevance of Cybernetics*, I argue that Pask (1969) provides a way to contextualise design in an intellectual and technological culture which can be drawn upon to enhance design thinking and the strategic development of effective design practises and outcomes (N. Ebenreuter, 2007). Moreover, this approach takes a holistic approach to designing; as opposed to examining the constituent parts of a situation outside the context of a large whole.

A further application of strategic thinking to architectural design can be seen in the work of Alexander (1966), who understood cities as dynamic living environments. In dealing with the changing and conflicting conditions of the built and natural environment, he was largely concerned with the sustainability of meeting human needs. He sought to eliminate the conflicts introduced by human tendencies or needs in relationship to the physical components established by architectural design and urban planning processes (1966). To achieve this, he developed numerous design patterns and diagrams, known as "patterned languages," that offer a way to resolve the ongoing and evolving complexities introduced by the developing needs of a technological society (Alexander, 1971; Alexander, Ishikawa, and Silverstein, 1977). This method of approach provides a holistic framework in which independently functioning parts or subsystems of a larger system, environmental or otherwise, can be developed. The significance of this is the organisation of individual functioning components, relevant to the design situation, to be integrated into a larger complex system over an extended period of time. As a result, the cumulative development of an evolving system provides a way to accommodate the continual shifts in human needs.

In parallel to Pask's (1969) work, this method of approach has also had a significant impact on engineering and computer programming disciplines known as object-oriented programming. While taking a fundamentally materialistic approach to design, the approaches to strategic thinking illustrated by Pask (1969) and Alexander (1966) contrast significantly to Simon's (1996), where he extends the treatment of dynamic entities or materials to the immaterial and simulated reproduction of human thought. Instead, Pask (1969) and Alexander (1966) offer an holistic framework for the development of dynamic human interactions with regard to the changing conditions of

the built and physical environments that extend to a digital environment. With the ever-increasing complexity surrounding the management of dynamic social systems, technological development, and the sustainability of the environment in concert with the changes in contemporary culture; strategic thinking may not offer immediate solutions to complex situations. It does, however, offer an alternative way of working that contributes to an ongoing collaborative effort toward alleviating the contradictions that arise in the nature of designing of new ways of living, working, and playing.

A Conceptual Framework

As in design, cybernetics can be thought of in a variety of ways. Cybernetic concepts are utilised in a variety of disciplines, which suggests the nature of its adaptability as a conceptual framework. Mead (in Glanville, 2004) regards cybernetics as a common language that communicates among many disciplines; while Von Forster (in Glanville, 2002) maintains that the influence of cybernetics and its successful integration into a variety fields therefore renders its utility unnoticeable. Cybernetic reasoning in the form of second-order cybernetics can be applied to an almost infinite range of situations because of its concern with human qualities of communication, collaboration, and knowledge creation. In comparison, design thinking can also be applied to any area involving human experiences. The range for its application is vast. However, a specific subject matter for design neither exists nor is possible. Design is fundamentally concerned with the unknown. As a result, designers are required to create the subject matter of design from their understanding of a specific set of circumstances. If we accept that, in the act of designing, a designer creates the subject matter for design, then the development of design products or services becomes embedded in what is particular. Typically, the application of design is subject to a specific field of knowledge and a community of practise that a designer wishes to propose new ways of thinking, working, and acting to enrich the human experience. As an approach to developing a subject matter for design, second-order cybernetics and conversation theory offer designers a conceptual framework to support and enhance design thinking through interaction, conversation, learning, and understanding.

Second-order cybernetics is essentially concerned with the extent of our knowledge and the manner in which it is acquired (Pangaro, 2006a). Derived from a constructivist

epistemology where the world is invented, objectivity and understanding are a result of interaction, mutual agreement, and self-reflexivity. Cybernetics offers a theoretical framework in which human-centred design practises that involve collaboration and participation can be effectively managed. This is achieved by considering the process of design as conversation (Glanville, 1999; Schön, 1995).

Pask's (1975) Conversation Theory is a dialectic framework that offers a mode for inquiry and the exchange of information through a looped series of interactions (conversation) to reveal and resolve contradictory ideas. Fundamental to second-order cybernetics is the function of an observer. It concerns the manner in which an observer becomes an accepted participant in the act of observing, and allows for the subsequent understanding derived from such actions (Glanville, 2002). Therefore, during the development of a design situation or its subject matter, a designer is acknowledged and accepted as a mutual participant in the act of knowledge creation. In doing so, the designer becomes a necessary element in the development of the design process, and enables designers to act subjectively. By interacting with various stakeholders involved in the design process, understanding is created through conversation and mutual agreement. This involvement is interactive and productive so designers affect and are affected by the interactions in which they participate. However, it is without control or direction. The interaction is circular, and represents the culmination of the participant's interpretations (Glanville, 2001). In support of this, Jones (1992, p. 73) argues that:

> Methodology should not be a fixed track to a fixed destination, but a conversation about everything that could be made to happen. The language of the conversation must bridge the logical gap between past and future, but in doing so it should not limit the variety of possible futures that are discussed nor should it force the choice of a future that is unfree.

Through conversation, multiple viewpoints are expressed and internalised by those engaging in the discussion; the result of which is a shared understanding of what is known from that which was previously unknown. Central to this interaction is that participants enter into the conversation with different perspectives and individual understandings that are distinct from any others (Glanville, 2001). Glanville (2001) tells

us that the basic epistemological position of conversation theory requires this form of diversity in order to facilitate interaction since, without difference, there is no basis for discussion among participants or the possibility for the reciprocal understanding of something new (Glanville, 2001). This view is also shared by, Barnlund (1979) who tells us that communication ceases to be productive without a context of difference or conflict to initiate change.

For Pask, it is important that, in the course of interaction, understandings are not communicated (Glanville, 2004). They are, however, built collaboratively through conversation in which participants derive meaning from their interpretation of the discussion. This new-formed understanding is then offered to participants for further interpretation and comparison to the original, which eventuates in mutual understanding and agreement. With this in mind, it can be said that knowledge is constructed from the interactions we create; in which the product of mutual agreement from conversation provides a foundation for what is known (Pangaro, 2006b). When taken as an approach to thinking and working with the subject matter of a design, a designer's ability to act subjectively, as understood in a second-order cybernetic framework, is integral to knowledge creation. However, when establishing the purpose or goals sought in design, there remains a matter of responsibility which the designer must consider. To avoid satisfying their own sense of purpose, it is necessary for designers to appropriately consider the implications of their interpretation of the design situation, and the intent behind the actions they propose in developing a suitable outcome. In light of this, I argue that it is necessary to draw on Von Foerster's (in Krippendorff, 1996) seminal contribution to cybernetics, who saw it as an ethical imperative to "act always so as to increase the number of choices." More recently, Krippendorff (1996, p. 141) argues that the words "for others" be included in the description as a way for design to extend this approach to accommodate user needs.

Second-order cybernetics is the cybernetics of observing systems, as opposed to systems that are observed passively from an objective point of view. In the course of conversation in which differences are identified and considered, an awareness of self and identity emerge (Pangaro, 2006b). When a distinction is made between self and other in observation, observers become aware of their own identity, which enables them to act autonomously and observe oneself (Glanville, 2002). Drawing on this idea, it is

possible to act in a subjective manner that includes the observation and interpretation of not only others, but also ourselves during conversation. This suggests that it is also possible to reflect upon and consider the observations and actions we propose from our understanding of a specific situation. As a result, observers become personally responsible for the observations they make, their interpretation of these observations, and the resulting actions derived from this understanding (Glanville, 2002). In addition to this, Glanville (2001) makes explicit the qualities necessary for a conversation, as he suggests Pask intended it to occur, in a set of operational and inspirational requirements. These requirements describe elements of the procedure and the necessary attitudes of those participating in conversation as prerequisites for a conversation to be considered successful.

It is important to note that Krippendorff (1996) has also compared the notion of otherness within a second-order cybernetic framework. However, in *The Semantic Turn*, Krippendorff (2006a) describes a second-order understanding as a necessary component of a human-centred design approach. This understanding recognises the need to develop a greater awareness of the multiple perspectives of diverse individuals. While this approach shares distinct similarities to this research, the distinguishing element between the two lies at their foundation.

A Poetic Strategy for Making

Establishing the elements of a design situation and creating structures to manage dynamic use situations requires the integration of theoretical, practical, and substantial components in design, often represented as contradictory in philosophic and design literature. I proffer the notion that a strategy; which unifies elements of form and matter, theory and practise, and methods of analysis and synthesis; is essential to the formulation of a design situation. This is not in a purely static sense, but one that is dynamic and provides a fundamental basis for invention and the execution of new ways of thinking and acting, previously discussed from a user's perspective in Chapter One, "Design Purpose," and Chapter Two, "Symbolic Communication." I argue that such an approach necessitates the use of productive practises that incorporate these elements.

Aristotle (2005) provides us with one such strategy to assist this development, which includes elements of dialectic, rhetoric, and grammar for creative productive purposes. Within the *Poetics* (Aristotle, 2005), the form, function, manner, and materials of design products are considered. Aristotle (2005) characterises these in terms of the liberal arts in which: (1) the art of dialectic highlights the contradictory elements of design situations; (2) rhetoric, the counterpart of dialectic, is an art of discovering effective means of communication; and (3) grammar as an art of composition is based on structures of syntax and speech or language. In the *Poetics*, language is treated as it is in the creation of poetry; where the "poet" or "author" of metre, verse, discourse, thesis, or an idea can be equally substituted for the terms "maker" or "creator." In support of the use of the liberal arts, Watson (1993, p. 10) characterises the notion of "reciprocal priority," in which commonalities among the differences and treatments of subject matters concerning words, things, action, and thought can be inclusive of one another. This suggests that the *Poetics* represents a totality of arts or doctrines that in turn translate from one primary focus for the consideration of others, in order to determine and establish an organised, integrated whole (Watson, 1993).

This research has undertaken to deliver the transposition from symbol to action that is grammatically correct. It finds a basis upon what is made or created is a result of individual thought and ideation. To achieve this, a comprehensive understanding of the elements that constitute the creation of a unified concept of design is required in order to treat particular subject matter and the circumstances of the design situation appropriately. McKeon (1987, p. 107) argues that: "The arts of communication and construction are arts of conjoining form and matter in the concreteness of experience and the individuality of existence." Kouwenhoven (in Rand, 2001, p. xiii) adds to this when he tells us that the basis for the term "art" is "to join, to fit together." The liberal arts, therefore, can be leveraged to provide a strategic framework for the discovery, invention, production, and formation of connections between various elements of a design situation to create a unified whole; where problems associated with the differences in knowing, doing, making, and saying can be treated by a particular art and method of approach, relevant to the situation at hand (R. P. McKeon, 1987).

However, a poetic strategy is one that guides the development of a design solution as opposed to imposing a distinct set of rules on a particular way of working, thinking, or

making. It is architectonic in structure, but not in a fixed sense of the term; where its function is not taken to represent a predetermined model, plan, or frame of reference. Rather, it is an art or a way of working that provides a means to guide and inform the design process. Skepticism surrounding such strategies are expressed by Alexander (1963) when he tells us that a designer's mind can be trapped by a mindset and persistence to follow well-known and accepted elements already established in design practises. In this way, design becomes a way of reproducing variations of existing or known elements and structures rather than a way of producing innovative solutions (Alexander, 1963). He (Alexander, 1963) argues that the design components created by the designer shape the design process, and cannot be structured into a systematic process which impacts on a designer's ability to change his or her way of thinking. Jones (1997) also highlights similar concerns surrounding the circumstances that destroy a designer's ability to innovate. I argue that this happens if creative processes and ways of thinking are cemented by rigid habits and frames of reference. For this reason, a strategy for design offers a point of departure in which a design process can be shaped. This is based on relations developed in the act of designing; determined by a designer's sensibility and knowledge developed in the act of doing. It incorporates the capacity for design components to be shaped by the designer, which forms a basis for the strategic direction in which the design process can then be developed. The methods utilised in this type of design process are operational in function.

For the purpose of this research, and having an understanding of the philosophies espoused in the *Poetics*, a poetic strategy is adopted to assist the creation of a unified concept of design. This is demonstrated through a process of inquiry, analysis, synthesis, and evaluation discussed throughout the remaining chapters of this thesis. This process is illustrated in Figure 11. Design Process Model, which includes a set of design techniques in Figure 12. Design Techniques that support each method in practise to reach a design outcome.

A Place for Creativity

Through this research, I describe the designer's relationship in the act of designing as an integral element of the ultimate design solution. A second-order cybernetic framework is offered as a means to facilitate a designer's capacity to act effectively as an observer

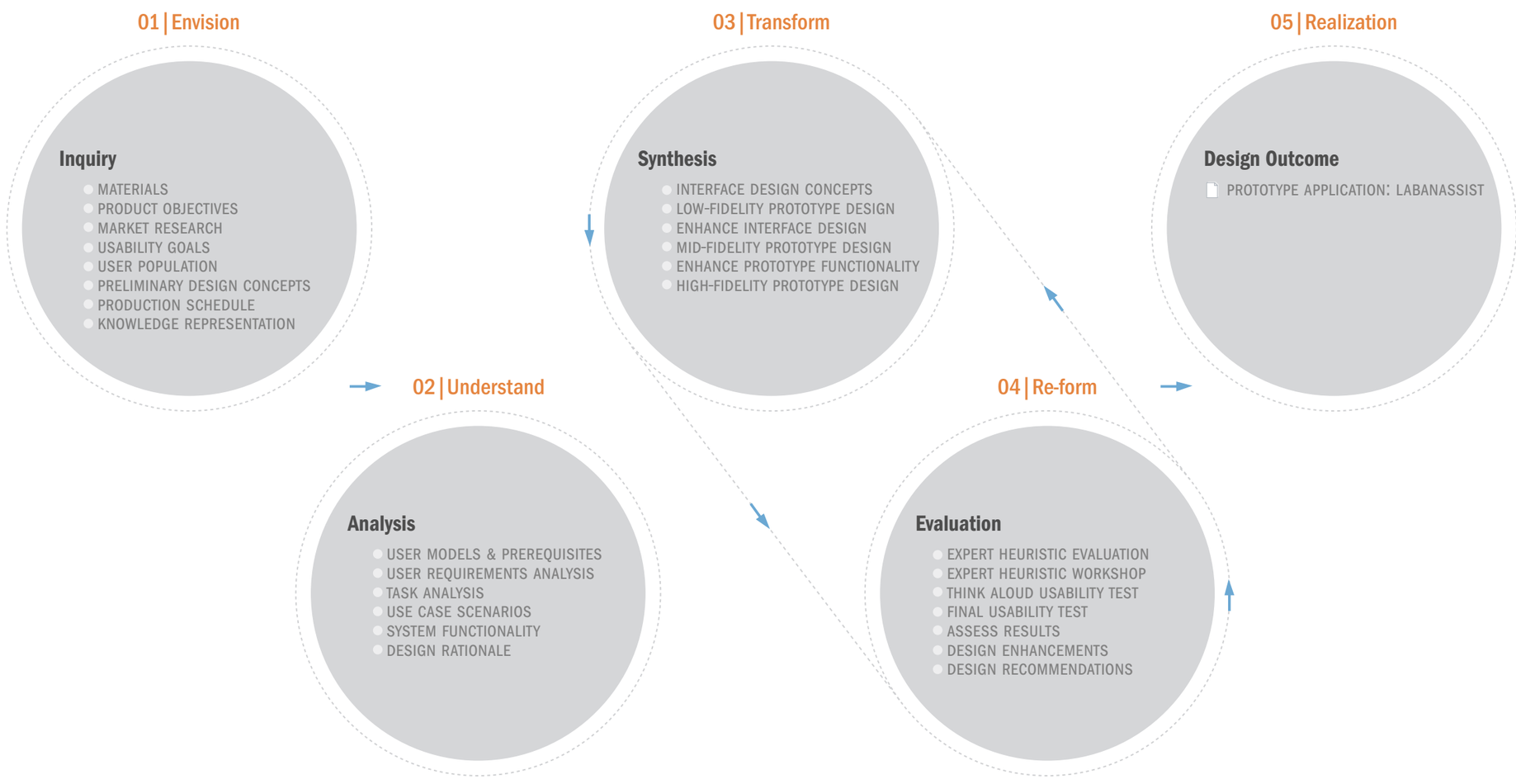


Figure 11. Design Process Model

01 | Envision

Product Concept

Definition Document
- Create high concept product statement
- Identify product objectives
- Identify usability goals
- Identify high-level constraints
- Identify high-level functionality

Market Research
- Identify product environment
- Identify user population

Production Schedule
- Create production timeline

Preliminary Interface Designs
- Design initial screen concepts

Knowledge Representation
- Create argumentation schematic
- Movement Family Tree

02 | Understand

Frame

User Profiles/Modeling
- Create student personas
- Create lecturer personas

User Prerequisites
- Define prerequisites

Hierarchical Task Analysis
- Perform expert interviews
- Perform student workshop
- Develop hierarchical user task structure

User Requirements
- Persona needs
- Shared persona needs
- Persona needs vs functions

Develop Use Case Scenarios
- Descriptions/Charts

Functionality & Task Analysis
- Task Analysis
- Hardware specifications
- Interaction design

Design Rationale
- Model movement structures

03 | Transform

Design

Interface Design Concepts
- Map interface objects & actions
- Create design screens

Low-fidelity Prototype Design
- Create storyboard prototypes
- Create questionnaire

* Heuristic evaluation

Enhance Interface Designs
- Develop mid-fidelity designs

Mid-fidelity Prototype Design
- Design usability tasks
- Create usability test
- Create questionnaire
- Create interface walkthrough

* Think aloud usability test

Enhance Prototype Functionality
- Develop high-fidelity designs

High-fidelity Prototype Design
- Usability tasks
- Usability tests
- Usability questionnaires
- Usability interface overview

* Final usability test

Review
- Definition Document
- Product Concept
- Requirements Analysis

04 | Re-form

Test & Evaluate

Expert Heuristic Evaluations
- Effect
- Severity
- Extent

Expert Heuristic Workshop
- Define problems
- Complexity rating
- Brainstorm solutions

Preliminary Usability Tests
- Think Aloud: test 1
- Usability questions: test 1

Analyse Results
- Review
- Enhance

Final Usability Test
- Usability questions

Analyse Results
- Review Evaluation
- Enhance design solution
- Complete specification

05 | Realization

Design Outcome

Prototype Application
- LabanAssist

Figure 12. Design Techniques

and participant in the co-creation of a design solution. This is achieved by characterising the design process as a conversation in which the role of the designer becomes an observer-participant in the conceptual development of a design situation. I argue that a second-order cybernetic framework provides an explanation for a designer's actions by acknowledging his or her presence in the design process. In light of this, designers may better understand the complexities of interaction, the actions derived from interaction, and the outcome these actions have in the act of designing. As an approach to understanding and mutually agreeing upon users' needs and requirements, conversation theory can be effectively utilised to enhance a designer's capacity to conceptually develop novel design solutions in participative situations.

Furthermore, it provides a method to enhance interaction in circumstances where information garnered from a reciprocal interpretation of shared understandings can provide a foundation for developing the constraints of a design situation. Participants involved in the co-creation of a design solution are understood to act as intelligent or knowledgeable beings that are responsible for their actions (Krippendorff, 2006a). In this way, an understanding is developed between participants in the design situation that enables communication and understanding to interconnect. Knowledge gained from this can be leveraged to establish an appropriate purpose or set of goals for the design situation (see Chapter Eight, "Task Analysis Workshop" and "Design Rationale").

I argue that, through conversation or the act of designing, we as observer-participants create our own meaning from any given situation. When fully understood, we formulate a suitable response to this situation based on the information available to us. As a result, the outcomes we propose cannot bear a particular correctness or incorrectness either in relation to the understandings we derive from conversation, or to the combination of elements we seek to address and challenge. Therefore, it is reasonable to suggest that the process of conversation and design share the common elements of interaction, negotiation, agreement, and knowledge creation. This involves a discussion or conversation between the designer and: (1) various users and stakeholders in the design process; (2) the construction of new knowledge that participants mutually create and agree upon; and, (3) the elements of design and materials in a circular process of design iteration (N. Ebenreuter, 2007).

However, developing our own meaning during conversation or the act of designing offers little guidance as to the appropriateness of this understanding or the resulting course of actions taken to develop a design outcome. To enhance this process, I argue that design thinking provides a means to facilitate and inform the meanings we construct. This is achieved by integrating useful knowledge from various fields of inquiry to support the development of new productive practises. When employed effectively, design thinking enables designers to introduce evolutionary and innovative ideas into the design process for the advancement of theory and design practise, as exemplified earlier in reference to the development of Pask's (1969) cybernetic theory of architecture (see Chapter Six, "Strategic Design Thinking"). Without a means to connect useful knowledge to the context of modern day society, the potential for design to effectively enhance the human experience is reduced. As a means to facilitate communication and understanding, I argue that a second-order cybernetic framework that utilises methods of conversation theory has the potential to provide designers with a greater understanding of a design problem and its reformulation. To support this, design thinking offers a way to expand the intellectual capacity of design and the development of design outcomes. Designers are then able to draw on interdisciplinary knowledge from the arts and sciences to develop plans with actionable outcomes. Once developed, these plans will provide better solutions for addressing and managing design problems and their reformulation.

The reformulation of a design outcome is, however, distinctly different from its solution or resolution. The reformulation of a design problem is one in which an endless variety of potential circumstances, unknown to the design situation, can be managed. One such example is the vast potential and scope for which movement can be described. This is different from the design of a product that offers a determinate solution to a particular need or desire. Instead, the unfixed nature of design potentialities that can take shape is therefore unknown. This is because of the creation of a dynamic or evolving set of circumstances in which diverse interactions can take place. However, the nature of this indeterminacy by way of description or name is in no way indeterminate or wicked as Rittel and Webber (1973) suggest. It is an extension of the potentialities offered by a generative system, where the variables for their reformulation differ significantly from facilitating rich user interactions that meet a distinct end. While it may appear useful to compare and contrast the benefits of a second-order cybernetic framework and

conversation theory against other theoretical approaches and methods, Rogers (2004, pp. 131–132) argues that to do so is not only untenable but also impossible. De Zeeuw (2001) tells us that conversation theory is not considered a theory in and of itself, but rather as the study of interactions to enhance values. Given this assertion, should conversation theory find greater application in the field of design, the potential and understanding of its application as a model for generating novel design solutions through conversation could be further explored for its principled approach. The development of task structures that facilitate the description of movement in Chapter Eight, "Task Analysis Workshop" and "Design Rationale" provide examples of the application of conversation theory to the generation of novel solutions that enhance the design of communication.

Summary

For the purposes of this research, I adopt a second-order cybernetic framework that is dialectical and sits within a poetic strategy as a way to facilitate designerly ways of knowing, thinking, and acting to inform making. In doing so, it enables a design situation to be developed that considers the diversity of its users through interaction, reflection, mutual understanding, creativity, and innovation as essential elements of a human-centred design process. The following research through design approach in Part IV of this thesis proceeds on the basis that a systematic design strategy characterised as a productive science or poetics can facilitate the design of a product that embodies the necessary structure to support the interaction of complex information as an integrated and organised whole. In Chapter Seven, I begin with the examination of interactive functions within existing dance notation applications and similar applications designed to capture movement. I do this in order to better understand the functional elements of existing notation applications, and to support the reformulation of a design outcome that enhances the composition and interpretation of movement for a variety of user interactions. In particular, the poetic strategy I propose takes into careful consideration the treatment of matter and form in a dynamic set of circumstances.