Chapter 5

Project I. Eyetoy

This project forms part of my investigation into an understanding of human movement for designing movement-based interaction with technology. The project serves as a starting point for developing an understanding of movement as input for interaction in order to inform interaction design. It comprises an analysis of movements produced by interaction with the Sony Playstation2© Eyetoy™ games. The Eyetoy games are being used as a prototype of future systems that are based on human movement and computer vision. The games utilise free body movements performed by players as input and very basic computer vision to sense that input. The analysis was undertaken with the following objectives:

1. to understand movement as input for interaction
2. to find ways of describing and representing movement
3. to explore the use of Labanotation as a design tool in movement-based interaction design
4. to explore what perspectives are offered by Suchman's (1987) analytic framework for understanding and analysing movement-based human-computer interaction

These objectives were addressed by performing two key activities. The first activity involved analysis and transcription of the players' movements using an existing movement notation, Labanotation. The primary aim of this activity was to examine the ways in which this notation, for representing and recording human movement, might provide designers with a useful tool when designing interactions that involve the moving body as input; specifically, a design tool that might support their considerations of the forms of human movement and the possible interpretations of that movement by technology.

The second activity involved applying Suchman's (1987) analytic framework to the analysis of the players' movements in interaction with the Eyetoy games. The aim of this activity was to see what perspectives the framework offered to interaction design, particularly an understanding of human movement as input.

These two activities are described in detail and the results of the project are presented in the following sections. The Eyetoy games are introduced and the experimental setup is described in section 5.1. A rationale for the choice of research methods is given in Chapter 4. Preparatory data analysis is described in section 5.3, prior to discussing the results of the movement analysis using Labanotation in section 5.4 and the application of Suchman's analytic framework in section 5.5. A critique of Labanotation is presented in section 5.6. The chapter concludes with the findings from the project.

5.1 Introduction to Eyetoy

Eyetoy is a motion detection technology consisting of a video camera that plugs into a Playstation2 game console. The Eyetoy games can be played using movements of any part of the body, but tend to be played mainly with movements of the arms. Players interact with the game by moving their limbs to do things like selecting a character, reaching to a spot and striking at stationary or moving objects. The player has no direct physical contact with the technology; instead their movements are sensed by the Eyetoy camera. The input movements performed by players are generally in response to game-initiated events. They are performed as physical actions and simultaneously represent a corresponding physical action in the game's virtual space. Here the term *virtual space* is used to refer to the internal world of the game and *playground* to refer to the space of the physical world from which the player influences the virtual space, after Konzack (2002). In Eyetoy, these two spaces merge, as the player's body and movements are input to the virtual space and conversely, the playground is composed of a 3-dimensional physical space within which the player is located, that has a projection of the gamescape on one side of the space, directly opposite the player. A mirror video image of the player is inserted into the gamescape so the player can see themselves in the 2-dimensional virtual space. The Eyetoy camera functions best with balanced lighting. Errors in input can occur with suboptimal lighting conditions. During game-play, only certain areas of the screen are deemed active at any point in time depending on the game context. By active, we mean that the player's movements are able to be sensed by the camera and registered as input. The technology is constrained to detect movements in the lateral plane and does not register depth as movement in the sagittal plane. There is an optimal distance for motion recognition of the player, given by a certain calibrated distance from the camera. See Demming (2004) for a study that focuses more specifically on the usability of the games.

An examination of the available games was undertaken to identify the most suitable games for the study. A *suitable* game was taken to mean a game that was seen to elicit a range of movements while at the same time being fairly quick and easy to learn. Two of the twelve Eyetoy games, *Beat Freak* and *Kung Foo*, were selected for use in this project. Here follows a brief description of the two games.

Beat Freak (see Figure 5.1) requires the player to move their hand over a speaker in one of the four corners of the screen at the same time as a CD flies across the speaker. The CDs fly out from the centre of the screen and reach the centre of the speaker cone in time with the music. The active area for input in this game is the circular zone representing the cone of the speaker, which is positioned in each of the four corners of the screen. For a given event such as a CD flying out from the centre to the upper left corner, the target area becomes active for a specific time period in which the user's movement can be registered.

Figure 5.1 Beat Freak

Figure 5.2 Kung Foo

In *Kung Foo* (see Figure 5.2) the player has to move their limbs to strike Wonton's (the bad guy) henchmen. This prevents the henchmen from reaching the middle of the screen, which otherwise causes the 'loss of a life' for the player. The henchmen appear randomly from pagodas positioned at the sides of the screen. Extra points are gained by breaking wooden boards and hitting Wonton himself. The active area for input is the area corresponding to any of the moving henchmen, Wonton or the stationary wooden boards.

5.2 Experimental setup

The experimental setup is described here to set the scene for the analysis to follow. Eight participants, four female and four male, were recruited to play the two games. Before playing, data on demographics and previous experience with the games were collected. The participants were warmed-up with a series of yoga stretches to minimise the likelihood of injury. The participants were introduced to each game by using the game's Help feature. They then played each game twice on the *easy* level and once on the *medium* level. The participants were filmed from two angles. One view captured a projection of the participant's mirror image in the gamescape; the other view captured from front-on the participant's full body whilst playing. See Figure 5.3 for a diagram of the experimental setup. After playing, the participants were interviewed about their experience with the game and given a questionnaire with usability related questions.

5.3 Initial data analysis

Three of the eight participants were initially selected for analysis on the basis of variation between their movement styles. The actions and movements were identified from these three and then compared against the remaining five participants to ensure we had not overlooked any movements used for interaction. This enabled an iterative analysis of the actions and movements used in playing Eyetoy. We used Labanotation and its system of movement analysis to analyse and transcribe selected movements of individual participants. We did not transcribe the entire video footage, instead focusing on samples of movement phrases that illustrated the participant's characteristic movement styles (in line with the method of selective transcription for Interaction Analysis described by Jordan and Henderson (1995)).

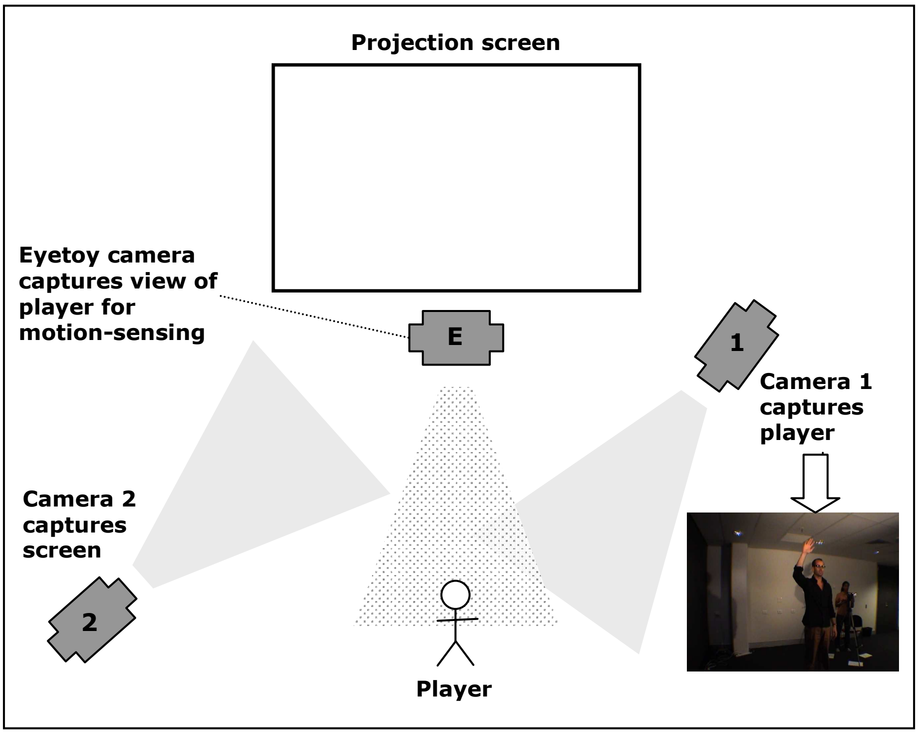

Figure 5.3 Experimental setup

The video recordings were viewed multiple times by the research team, individually and together, in order to determine:

- The flow of interaction for each game
- The actions taking place in each game
- The specific movements used to perform these actions

These viewings were correlated with notes taken during observation of actual game-play.

From this process a set of four actions (*Selection, Strike Moving Object at Fixed Target, Strike Fixed Target, Strike Moving Target*) was identified as basic to successful game-play. The actions in Table 5.4 were then further examined to determine the specific types of movements used to perform them (see fourth column of table). We identified an initial set of movements; these were further checked and performed with the games to ensure that they were effective for interaction, eventually settling into a set of seven characteristic movements (see Figure 5.5). Each characteristic movement in this set was defined and illustrated with an evocative example. Buur et al. (2004) also employ evocative or metaphoric descriptions of movement in their *Video Action Wall* method for tangible user interaction design. The movements identified constitute a taxonomy only for the movements produced by the two games we studied in detail. Other Eyetoy games use a set of movements which partially overlap with those in the table in Figure 5.5.

The actions and movements listed in the table in Figure 5.4 were further analysed within two separate activities: movement analysis using Labanotation and Suchman's analytic framework. Each of these will be elaborated upon in the next sections.

5.4 Movement analysis and Labanotation

The activity of analysis and transcription of movements using Labanotation is presented here. For each of the actions in Figure 5.4, each participant's selected movement phrase was transcribed into a movement script using the

Action	Description	Game	Movement
Selection	Navigation and selection of game choices and settings	Both	Wave
Strike Moving Object at Fixed Target	Coincide with object at target location	Beat Freak	Reach, flick
Strike Fixed Target	Strike as soon as object appears	Kung Foo	Slash, punch
Strike Moving Target	Strike as soon as object appears	Kung Foo	Slash, punch, slap, swat

Figure 5.4 Actions and characteristic movements for game-play

Movement	Description	Evocative Example
Reach	To extend the hand toward an object or destination	Stretching up for the biscuit tin
Wave	To move the hand or arm to and fro repeatedly	Waving goodbye
Slap	To hit something quickly with an open hand	Thigh slapping
Swat	To hit hard and abruptly	Swatting flies
Slash	To swing the arm quickly and freely through space	Cutting through grass with a scythe
Punch	To strike an object with a closed fist with force	Punching
Flick	To deliver a light, sharp, quickly retracted blow	Flicking away a piece of dust on one's coat

Figure 5.5 Characteristic movements of game-play

Structural form of Labanotation. The expressive quality of the movement was analysed using the *Effort* description. The process of notating was done by each researcher individually before arriving at an agreed form for each participant's movements. This involved a reflective cycle of revisiting the video data and re-enacting the observed and notated movements for a practical and bodily understanding of Laban's theory (after Newlove (1993)), while refining the transcription. One of the virtues of transcribing the movements into Labanotation was that it forced a certain rigour upon our practice of movement analysis as we had to agree upon the transcribed form in order to have a common understanding of the analysed movements. This required us to re-examine and observe more closely the recorded movements and the motivations for those movements.

For each of the four actions, a comparison of the notated movements across the three participants was then made to identify areas of similarity and difference. From this comparison, for each action we extracted the essential features of the movements required for the functioning of the interface from the player's perspective—we termed these *functional movements*.

A broad overview of the range of description available in Labanotation was provided in Chapter 3, section 3.4. We found in our project that we only used a small set of the descriptive forms of Labanotation; specifically directional destination, relationship (to virtual and physical objects) and dynamics (expressive quality) in terms of Effort. This was because of the particular forms of movement people used when playing Eyetoy. This does not imply that other kinds of systems would not exploit more of the options available within Labanotation.

5.4.1 Examples of Labanotating

In this section, a detailed transcription in Labanotation is provided for two of the four game actions—*Strike Moving Object at Fixed Target* in Beat Freak and *Strike Moving Target* in Kung Foo. These two examples were chosen because they most efficiently demonstrate the application of Labanotation in this project.

For an understanding of the model of the body and principles of movement used in Labanotation, refer back to Chapter 3, section 3.4. For our purposes here, we have deviated from the standard Laban convention for normal position of the feet being in ballet first position; instead, a normal carriage of the body is understood in this context as a person standing erect with feet hip-width apart and arms held relaxed by the side of the body, unless specified otherwise in the starting position. The symbols on the body staff below the double line represent the starting position of the body. Any movement is then described as a change from this starting position.

Structural description

For the Strike Moving Object at Fixed Target action the notated movements for participant 2 are presented in Figure 5.6. We have extended the diagram by augmenting it with symbols for game events occurring on the screen. This allows us to depict the point of interaction between the movements of the player and the events and input mechanism of the interface. The *point of interaction* is when the player's movements are treated as input or control to the system. It is suggested that Figure 5.6 is read with reference to the guidance provided directly below on how to read the diagram.

How to read the diagram: The structural form of Labanotation is read from the bottom to the top, with time in the vertical axis. Time can be split into measures (rows in the diagram), just as in musical scores. Each measure has been numbered to facilitate explanation. The vertical staff represents the body, the centreline being the centreline of the body, the right hand columns represent the right side of the body and likewise for the left. The columns are used for main parts of the body, such as S—Support and A—Arm; for example, movements of the arms are written in the 'A' column. Symbols for indicating direction and level of movement in space can be combined and placed in the columns associated with the major body parts. Timing and duration of movement are indicated by the position and length of the symbol. No symbol in a column implies no movement. A wide range of symbols is available to give more detailed information; for example, the degree of

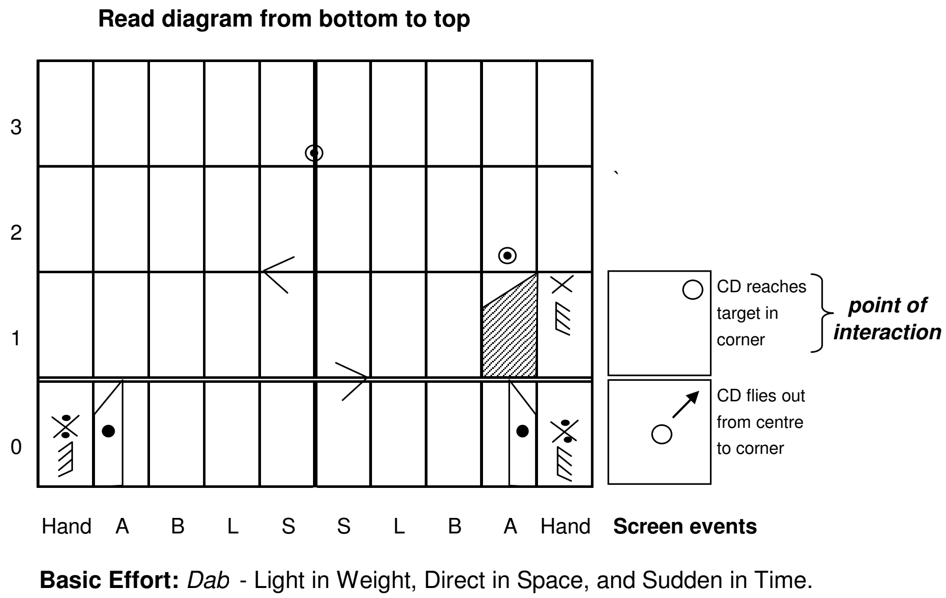

Figure 5.6 Labanotation for Beat Freak action Participant 2

contraction of the hand. See the legend in Figure 5.7 for symbols used here.

The notated movement for Strike Moving Object at Fixed Target action of participant 2 in Figure 5.6 shows, in row 0, the player in a starting position with both arms bent at the elbow (the position of the lower arm is indicated by the placement of the symbol in the outer half of the A—Arm column), the fists lightly closed (indicated by contraction of the hand) and held just in front of the navel and the weight evenly distributed on both feet, feet about hip width apart. The game events are indicated alongside the body staff—here a circle representing a flying CD is displayed emerging from the centre of the screen and moving towards the upper right corner of the screen. In the first measure 1, the player reaches to the right upper front with the right arm; the hand opening as they fully extend their arm. They shift their weight to the right (indicated by the caret symbol > in the Support column) as the right arm extends. The point of interaction occurs when the arm is fully extended to the upper right at the same time as the CD reaches the upper right speaker on the screen. Then in measure 2, as the player lowers their right arm to the starting position (indicated by the 'back to normal'

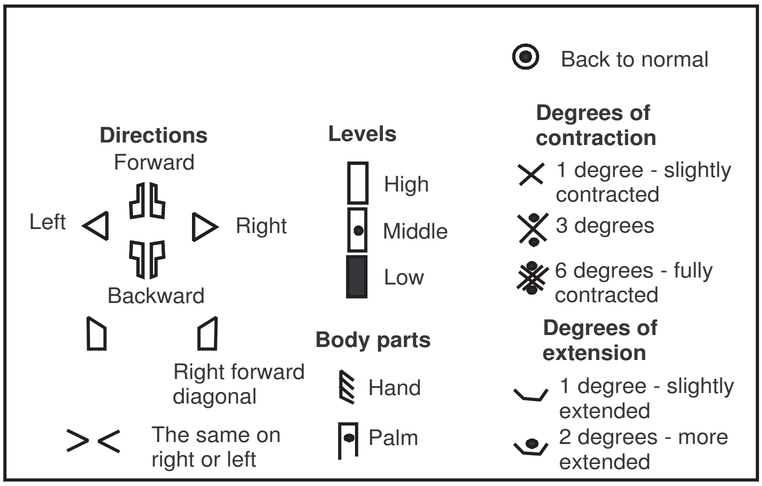

Figure 5.7 Legend of Labanotation symbols used in this study

symbol), they shift their weight to the left and then in measure 3, they return to centre. Here the use of the 'back to normal' symbol has been redefined to indicate a return to the starting position for that body part, rather than the usual convention of the normal carriage, in order to simplify a problematic transcription. The redefinition of symbols in the notation was confirmed as legitimate by a representative from the Labanotation centre.

For the Strike Moving Target action in the Kung Foo game the notated movements for participant 5 are presented in Figure 5.8. The notated movement shows, in row 0, the player in a starting position standing with feet wide apart, knees slightly bent, hands out to shoulder height, arms slightly contracted, palms facing forward. After the game event occurs—a henchman jumping out from lower left pagoda—in measure 1, the player strikes out with their left arm to the lower left. After successfully striking the target, in measure 2, the player returns to their original starting position (indicated here by the 'back to normal' symbol). Figure 5.9 portrays the corresponding performance of the Strike Moving Target action for participant 5.

Each action was performed by each participant with idiosyncratic movement styles. The general form of the movement tended to be similar across participants for each action, given that the game event dictated the point

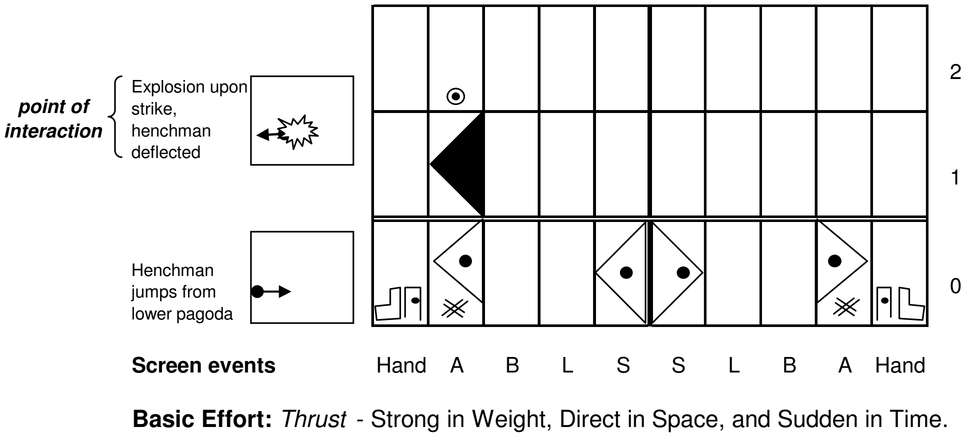

Figure 5.8 Labanotation for Kung Foo action Participant 5

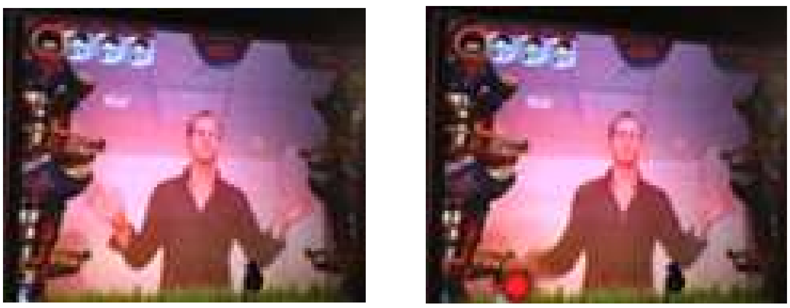

Figure 5.9 Performed movements for participant 5, Kung Foo

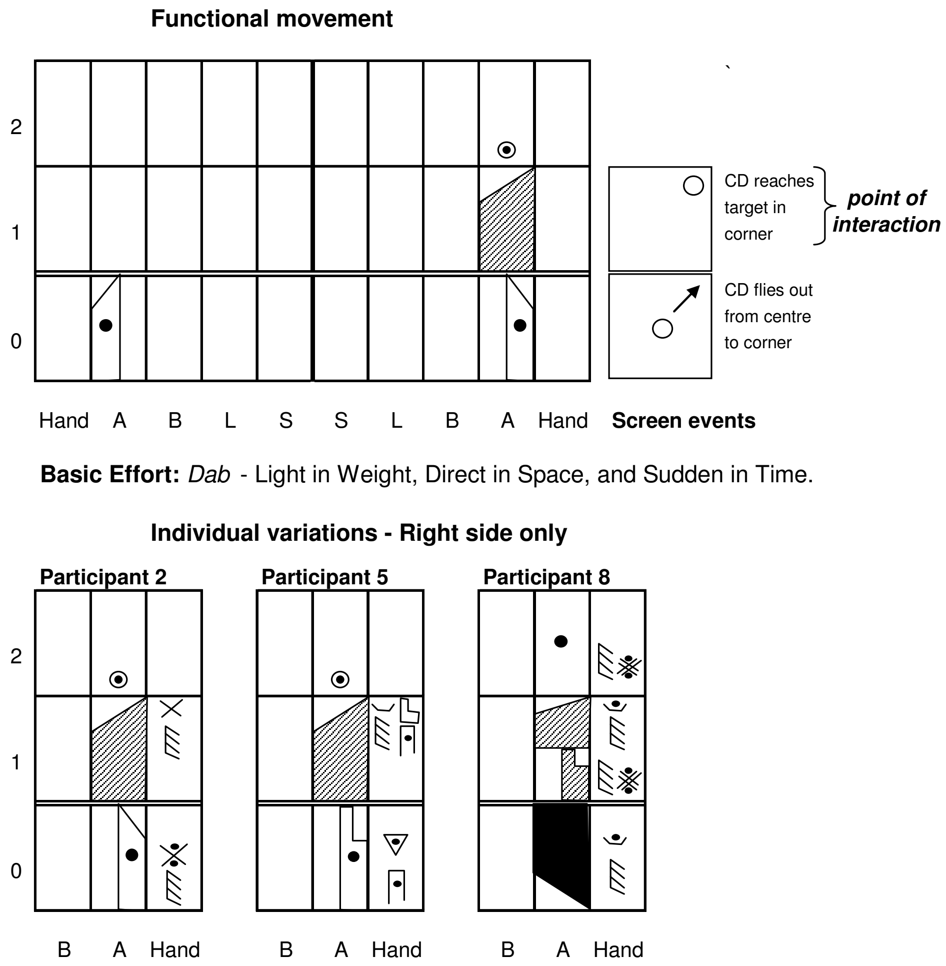

Figure 5.10 Functional movement and individual variations

in space and time for interaction. This similarity could be depicted on the functional movement script. The observed variations in performance of movements were in the particular ways people organised their bodily movement and the characteristic style of movement exhibited by each participant, as previously described in Figure 5.5. These variations and subtle nuances in performance could be suppressed on the functional movement script (see Figure 5.10) if they were incidental to the functioning of the interface. If it were important to explicitly describe allowable variations, then these could be included on the diagram in some form.

Effort description

In Beat Freak, the Effort characteristic for participant 2 was identified as a basic Effort action of Dab (Light in Weight, Direct in Space, Sudden in Time). We observed that all the participants exerted the same Effort characteristic of Dab for the Strike Moving Object at Fixed Target action in Beat Freak. Similarly, common Effort characteristics across participants were identified for the Kung Foo game actions (Thrust or Slash for the Strike Fixed Target and Strike Moving Target actions). The types of Effort identified for each game action resonated with the typical physical action associated with that game. In the Beat Freak game, the player reaches out to strike the flying CD at a known point in space as part of a rhythmic activity dictated by the beat of the music. A typical physical action was lightly and quickly reaching to a point in space and retracting. This could be classified as a Dab Effort action.

In the Kung Foo game, the player strikes attacking henchmen or breaks wooden boards as part of a martial arts fighting situation. Physical actions that express some degree of force, speed and directedness were typical and could be classified as a Thrust Effort action (Strong in Weight, Direct in Space and Sudden in Time). Sometimes participants performed physical actions with an Effort of Slash that indicated some spatial uncertainty or imprecision by the player. In the Kung Foo game, the point of interaction was less predictable than in the Beat Freak game, as the player is confronted with a swarm of attacking henchmen. The Effort of the observed movements in Kung Foo varied predominantly in the participants' relationship to Space. As can be seen from the Effort cube (Figure 3.8), a Slash is similar to a Thrust except that they are on opposite sides of the dimension of Space; the former is indirect and the latter is direct.

5.5 Interaction analysis—Suchman

The players' actions and movements were further analysed using Suchman's analytic framework for interaction analysis of human-machine interaction.

This enabled the exploration of the relationships between bodily actions and the corresponding responses from technology from the perspective provided by this particular framework.

We have taken Suchman's analytic framework and used it here to analyse the interaction between the player and the Eyetoy interface, for the two games chosen. We adapted the framework to fit our particular context, as follows. The column labelled "Actions not available to the machine" has been split into two, to bring out the details of the movement description for the user's actions. The column labelled "Actions available to the machine" describes the input of the user activity via the motion-sensing video camera. The column labelled "Effects available to the user" consists of the output available to the user in the form of visuals and audio. In the original framework, there is a fourth column on the right-hand side, labelled "Design rationale", for the machine. The term 'design rationale' is commonly used in software engineering and HCI to denote the motivations, justifications, trade-offs and reasoning behind design decisions Moran and Carroll (1996). We have relabelled this column as "Game context" to avoid confusion of terms and to clarify the game context in which specific actions are occurring. It captures the design assumptions about user behaviour.

An example of a fragment of the interaction analysis for the Beat Freak game-play by participant 8 is given in Figure 5.11. The data is purposely laid out in the table (after Suchman) so that the columns labelled "Actions available to the machine" and "Effects available to the user" constitute the interface of the system that is available to both human and machine.

The critical point here is that the machine has available only what is in the grey column of the table for interpretation of the interaction—and the human user has everything else! Laying out the interaction in this form makes clearly visible the perceptual asymmetry, between the human and the machine points of view, that Suchman wanted us to see in her original work. We can see that the player has an exceptionally rich perception and interpretation of the action and game activity. The resources continually available to the user consist of the visual display, sound output, the game action and events—all of which are synthesised by the user to create a space in which

The User			The Machine	
Actions not available to the machine		Actions available to the machine	Effects available to the user	Design rationale
User activity/action	**Movement description**	**Motion detection via video camera**	**Output: Visual display and audio**	**Game context**
Awaiting start of game.	Ready position: Standing feet hip width apart, both hands held at navel, closed fist.	Calibrated image of user	Gamescape Visual text: "Countdown"	Game starts
Attempt to hit CD as it intersects speaker cone.	Reach out to upper front left with left arm, fingers spread.	(no machine input besides image of user)	CD emerges from centre and travels to upper left speaker.	Event – CD launched
Successful strike on the beat.	Left hand intersects speaker cone simultaneously with CD.	Motion detection over area representing upper left speaker cone as CD passes through it	Speaker vibrates and CD shrinks. Sound of cymbal clash.	Event – successful strike
Return to ready position.	Lower left arm to ready position.	(no machine input besides image of user)	Gamescape with animated characters dancing along	Pending next event
Waiting for next event, rhythmic sway to music.	Shifting weight side to side.	(no machine input besides image of user)	Gamescape with animated characters dancing along	Pending next event

Figure 5.11 Interaction analysis for the Beat Freak game-play by participant 8

to perform meaningful physical actions within the context of the game. As humans we are able to create the necessary context for a satisfying experience, regardless of the sophistication of the technology. We create a world to inhabit and within which to perform movements as part of meaningful actions for interaction. The moment of interaction is embedded in a gestural phrase (Benford et al., 2005) that is part of an overall activity that gives the movements their meaning and distinctive quality. For example, in the Beat Freak game the player reaches out to strike the flying CD as part of a rhythmic activity dictated by the beat of the music. In Kung Foo, the player strikes attacking henchmen as part of a martial arts fighting situation.

In contrast, the machine (in the grey column) has limited resources available for interpretation of the action. This is related to the choice of input technology for Eyetoy—a single camera provides motion detection of the player's movements within its frame of view. The machine perception is thus limited to motion detection typically over a narrowly defined spatial area within a given time period, as directed by the context of a particular game event. For example, in Beat Freak, the machine detects motion only in the area corresponding to the speaker cone when the CD is passing through it. Likewise, in Kung Foo, the machine detects motion in the area(s) corresponding to the moving henchmen as they jump towards the centre of the screen. This particular technology implementation makes no attempt to track or recognise human movements—it simply detects motion.

The analytic framework derived from Suchman was valuable in two key ways. Firstly, it made clearly visible the resources available to the user and to the machine for perception of action. Its prime function was to lay out the sequence of interaction and the interpretation of the interaction from both the human and the machine points of view. Secondly, and most significantly in terms of understanding movement, we were able to describe the movements as actions occurring in context, without losing the situated and contextual aspects of the performed movements. For example, the player is involved in an act of striking an attacking opponent in Kung Foo. The movements performed to effect this action, in a particular instance, took the form of the player moving their left arm to the lower left side, with a slashing quality. In between defensive strikes, the player was observed to perform readying or preparatory movements, such as shifting their weight from side to side. The richness of perception for the player is in sharp contrast to the machine's simplicity of perception of the action. Here the machine makes no assumptions about what the player is doing with their body. This simple approach bypasses the difficult task of correctly interpreting human action and instead, enables a diversity of physical actions by the user to achieve the same goal of successful game-play.

5.6 A critique of Labanotation

Traditionally Labanotation has been used in dance and movement observation for recording both natural and choreographed movement and for exploring movement. Practitioners of Labanotation would normally be trained movers or observers of movement. The exploration of the use of Labanotation for representing movement that occurs in movement-based interaction with technology has identified a range of advantages and disadvantages for its potential use in design. In this section, these advantages and disadvantages are described through the concepts of functional and performed movement, simplicity and specificity, context of movement and ease of reading and writing, presented below.

5.6.1 Functional and performed movement

We can distinguish between functional and performed movement for the design of movement-based interaction. For a given game action, the functional movement represents the essential properties or the general form of the movement required for effective operation of the interface. A functional movement (or sequence of movements) will be performed by different people in individually characteristic ways, but should nonetheless achieve the same effect (for example, hitting a CD in Beat Freak to score points). Performed movement thus describes the actual, distinctive movements produced by particular bodies. These variations in individual performance of physical actions can be described in Labanotation. For example, the player is involved in an act of striking an attacking opponent in Kung Foo. The movements performed to achieve this action, in a particular instance, took the form of the player moving their left arm to the lower left side, with a slashing quality. In between defensive strikes the player was observed to perform readying or preparatory movements, such as shifting their weight from side to side. All of this detailed description of the actual movements can be represented in Labanotation. However this may result in a design representation that is unwieldy and obscures the relevant aspects of the interaction to be modelled. Relevance is of course dictated by the particular application under design. The choice of how to notate the movement depends upon the context and aspects to be emphasised in the recording. What may be more fruitful is to identify and represent the relevant properties of the movements as they occur in the flow of interaction and at the point of interaction. The functional movement script, augmented with computer interface elements, is intended to play this role, as it provides an overview of the interaction sequence with the movements of the *player as the central focus*.

5.6.2 Simplicity and specificity

Labanotation is an extensive and flexible notation system. One of its main principles in notating is to use simple description for simple movement. On the other hand, if you need to be very specific about the movements to be recorded or performed, then its comprehensive symbol set gives it great expressive power. This expressivity and flexibility enables choice for designers, about what they represent as significant and relevant aspects of movement that is treated as input to technology. In this project, we chose to record the observed movements of the players as fully as possible, to ensure that we had a deep understanding of the movements used for interaction and also to ensure that we understood the essence and power of the Labanotation system. From this rich description, we were then able to pare down the movements to the general form required for interaction with the Eyetoy interface.

One of the challenges is to explore the tension between simplicity and specificity for describing movement as input for interaction and the corresponding interpretation of that input by the input technology system (in this case, video-based computer vision), without unnecessarily constraining the possibilities for individual action and performance. To aid clarification of this challenge, we will refer to another similar game system, the Intel Play^{TM} Me2Cam, that is also based on human movement and computer vision (D'Hooge, 2001). This system has a more complex computer vision input technology that involves head and hand tracking. When we have a simple description of movement, it is more open to interpretation in performance. Depending on the form of input technology this could mean that more or less demands are put on the interpretation of the input data by the computer to extract sensible data. Conversely, the more specific the description, the less interpretation or leeway in performing the movement and possibly less variation in input data to be interpreted by the computer. Alternatively, more sophistication of the input technology is required to correctly recognise the input as a human movement. This echoes the accuracy/ambiguity polarity for movement description using natural language raised by Badler and Smoliar (1979) and Høysniemi and Hämäläinen (2004). The concern of Høysniemi and Hämäläinen (2004) is with the interpretation of movement by the computer vision system—the level of accuracy is related to the input device technology and the parts of the body being treated as input. In cases where the design of the computer vision system is still open, then a more ambiguous and less precise description is warranted.

Interestingly, the Eyetoy interface exploits simplicity through its input technology and subsequent ease of mapping from user input to machine response. The fact that it does nothing more than detect motion within well-defined spatial and temporal constraints (it does no tracking or sophisticated motion recognition), means that the user is at liberty to perform any kind of movement to accomplish a specific game action, as long as that movement is registered as motion by the machine in the appropriate place at the appropriate time. A player could be standing on their hands and motioning with their legs instead of using their arms! There is thus no discrimination between variations in individual movement styles for specific game actions. In this case a simple and flexible mechanism for mapping human input to machine response enables a richness and diversity in the performance of movements for user interaction. The mechanism underlying this form of interaction is composed of four elements: position, area, timing and duration. It can be easily programmed for different games and different levels of skill by varying the value and range of any of the elements. It also easily accommodates multiple players in the same playground, but cannot distinguish between them.

In comparison, the Me2Cam interface has a more complex input technology and correspondingly more complicated mapping from user input to machine response. It has been designed for a single player with the vision algorithm optimised for a single head and two hands. One of the games, Bubble Mania, involves the player and a giant bubble-making machine where different game behaviours result depending on whether the player hits a bubble with their hand or head. In terms of movement description, we would have to describe in some detail the possible and likely movements of the hand and head in relation to the rest of the body and to the bubbles in the game's virtual space. One of the strengths of Labanotation is its extendability to whatever level of detail is required for a particular system.

5.6.3 Context of movement

The context of movements performed in game interaction influences how a movement is represented and interpreted. What is considered significant for interaction varies with each Eyetoy game. The representation in Labanotation of the movements performed for the Eyetoy games as a movement script included reference to the game events occurring on the screen. Labanotation allows for reference to other people, objects, music and spatial environment. It can easily be extended to describe a person's relation to virtual or computerised events, objects and environment, as we have done for the Eyetoy games in our movement scripts (see Figure 5.10). The concern here is to find ways of representing movement that retain their reference to actual, lived movement as performed in a specific situation.

5.6.4 Reading and writing

Once familiarity is gained with the notation, the reading and writing of Labanotation becomes easier. It is a visual representation that uses an indirect representation of the moving body. The notation is not immediately intuitive, unlike a stick figure representation of the body (although a stick figure suffers from ambiguity and a lack of precision, especially in three dimensions). However, this is overcome once the notation system is learned as it is logical and systematic. It is based on a simple principle that the symbols for spatial direction and level of the major parts of the body indicate change. The body staff then becomes a strong graphic pattern of the movements occurring throughout the body over time. Patterns within sequences of movement become easily discernable. Easy comparison can be made across a set of performances of a movement sequence by different people for a given action. The similarities and variations are immediately visible, as illustrated in the individual movement scripts of performed movements (see Figure 5.10).

The symbols are simple to draw, but observing movements correctly requires training of the eye and a thorough understanding of the notation system and the human body. Personal enactment of the notated movements can facilitate learning. The virtue of learning such a movement notation system is that it offers a certain perspective on movement and a way of seeing and thinking about the moving body that may extend one's existing understandings; it is a tool to think with. For those that do not require such an in-depth understanding of human movement, but still need to visualise the outward form of the moving body, computerised animation systems exist that can read Labanotated movement scripts and generate a life-like human figure that dynamically performs the notated movements (Calvert et al., 2005). Computerised Laban editors are also available to facilitate the recording of notated movements (Neagle, Ng, and Ruddle, 2003).

Høysniemi and Hämäläinen (2004) provide a notable counter-example of attempting to use Labanotation in an iterative design process of a game that is controlled by children's intuitive movements. They found that the representation of movement in Labanotation was too detailed for the design needs of their system and found it difficult and laborious to use. They preferred to describe observed movements gathered from children playing Wizard-of-Oz game prototypes using more straightforward visualisation techniques such as video sequences. However, the written form of Labanotation has an economy and flexibility over video- or image-based representations for the exchange and communication of notated movements between designers, recalling the work of Harper and Sellen (1995) on the affordances of paper.

5.7 Findings

One of the significant findings from this first project was the recognition that the games provided a context in which to perform meaningful movements and the particular game context engendered different types or styles of movement, with different qualitative character. The two games studied engendered quite different movements. Beat Freak produced highly regular, repetitive, reaching movements of the arms to the high and low diagonals as dictated by the beat of the music. It was played in an almost semaphore-like way; an observation that can be potentially useful for interactions that require a limited set of stylised or idiomatic movements. In Kung Foo, the player(s) tended to perform fast, striking and slashing movements to the side of the body, with the arms or legs. Kung Foo has an interaction style that is spatially and temporally unpredictable. The interaction is driven by the game; game events such as attacking henchmen trigger action by the player.

Suchman's analytic framework provided a way of organising and structuring the interaction between player and machine that enabled a clear focus on the relationship between the movements and actions of the player and the sensing and interpretation of the player's actions by the machine. The description of the player's movements within the framework ensured that the movements could be understood in the context of the game-play, from both the perspective of the player and the perspective of the machine.

Laban movement analysis, but not the notation itself, provides a language and vocabulary that translates readily to interaction design. Both the functional and expressive aspects of movement can be described. Laban movement analysis is beneficial for developing movement observation skills and sensitivity and awareness to movement and the kinaesthetic aspects of movement. The actual process of notating in Labanotation forced rigour in movement observation, analysis and description. Part of the work of notating was re-enacting the movements of the players to acquire a bodily understanding of the movements and the system of movement analysis. Although Labanotation can be used for visually representing the moving body in interaction, with the body as the central focus, it does require some skill and effort in reading and writing that may prevent easy uptake of the Structural description in interaction design work. The language and vocabulary of Laban movement analysis can be readily used to describe the functional and expressive movements of the player in the frame of Suchman's analytic framework, thus combining movement analysis with interaction analysis (Loke et al., 2005a, 2007).

The above set of findings all contribute to the proposed design methodology. An additional finding, orthogonal to the methodology, is that the Eyetoy interface consisted of a simple and flexible mechanism for mapping human input to machine response and yet enabled a richness and diversity in the performance of movements for user interaction. This finding can be used as a design heuristic when considering the choice of input technology and the mapping of user actions to machine responses.