DESIGN FOR ‘QUALITY OF USE’:

EMOTION AND PHYSICAL INTERFACE DESIGN

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ABSTRACT

With recent technological developments in motion capture there is an opportunity to redefine the physical interactions we have with products, considering human needs in movement at the forefront rather than subservient to the machine. This paper reports on the exploration of emotional reaction to gestural interface design using Laban’s Movement Analysis from the field of dance and drama. After outlining the current status of Gesture Controlled User Interfaces and why the use of Laban is appropriate to help understand the effects of movement, the results of a workshop on new interface design are presented. Teams were asked to re-imagine a number of product experiences that utilised appropriate Laban effort actions and to prototype and present these to the group. Several categories of devices, including direct manipulation, remote control and gesture recognition were identified. In aligning appropriate movements to device functionality, utilising culture and analogy and where necessary increasing complexity, the interfaces embody a number of concepts relating to gestural interface concepts.

KEYWORDS

Interaction design, emotional design, Laban Movement Analysis, dance.

1. INTRODUCTION

This paper explores how we can balance, extend and if necessary complicate user interfaces to make better use of the human body. In product design, physical interaction with products has been dominated by the field of Ergonomics, which aims to ensure that all products are dimensionally fit for use and do not induce injury. Despite this, in many cases the physical operation of products is subservient to the technology behind them. For example the trend for continuing reduction in mobile phone size led to buttons that were difficult to operate (Balakrishnan & Yeow, 2008). Interface Design, the other main user-centred field in design, has come to focus on the use of software in our electronic devices (Raskin, 2000). And while touchscreens are currently dominant (Zhai & Kristensson, 2012), the next generation of devices will make use of gesture recognition technology to allow more than a finger to be used in the control of our product and environment.

While Gesture Controlled User Interfaces (GCUIs) have been around for the last 30 years (Bhuiyan & Picking, 2011; Buxton, 2012), recent developments in motion detection and analysis (Figure 1) have made the hardware and software more widely available for researchers. This has resulted in an increase in attention to the applications and possibilities of such technology beyond its original use in gaming. For example, Kuhnel et al (2011) have conducted studies on the use of three dimensional gestures using a mobile phone to control a smart home environment. This utilises the motion sensors in the phone to detect basic swipes, tilts and points to control various devices. In revisiting the workstation interface, Bhruguram et al (2012) have suggested replacing a mouse with camera and motion detection technology while retaining the conventional movements associated with a mouse. This retains the familiarity of a known paradigm rather than reinvent it from first principles. When attempting to define a new, hands-free system for basic interactions with a CAD system, Jeong et al (2012) utilised simple static gestures based on a number of fingers for selection, translation, etc. but these cannot be considered to be intuitive. Despite research on set-ups and applications of GCUIs, there is less understanding as to what gestures should be employed and why.

Figure 1. Emerging generation of gesture recognition technology, including the Nintendo Wii, the Sony Playstation Move, the Microsoft Xbox Kinect and the Leap Motion Controller

There are many precedents for satisfying physical interaction with products: we have all experienced objects, such as SLR cameras or musical instruments, containing mechanisms or actions that are a delight to use. What is it about particular movements and actions that appeal to us and how do they relate to the human body? A language of kinaesthetics is required to understand and describe the combination of movements and sensory feedback that trigger different emotional responses in users. Malizia and Bellucci (2012) advocate the use of participatory design to align gestures of the interface with cultural factors, and also personalisation for individuals to make it as 'natural' as possible – rather than a proscribed set of movements that must be learnt. In this work we therefore present a workshop where design students were invited to reimagine product interfaces. To achieve this we utilised Rudolf Laban's (Davies, 2001) movement studies, which are widely used in the field of dance and drama, to help quantify and understand physical product interactions.

2. QUALITY OF USE

We have named this more holistic approach to movement 'quality of use'. This deliberately challenges the 'ease of use' maxim which, while opening up new levels of design inclusivity (Clarkson, Coleman, Keates, & Lebbon, 2003), has in many cases stripped away interaction to the point of invisibility without considering the emotional vacuum this leaves (Lee, Harada, & Stappers, 2002; Norman, 2004). For example, using an old fashioned typewriter with its careful paper feed, swinging key presses and swiping carriage returns provides a much more vivid experience than the limited experience of typing on the latest tablet. We contend that while the number of steps, sequences or motions may seem beyond the minimum required, it may in fact be desirable to improve the feel, whether through balance, symmetry, speed or quality of motion. Examples of the issues that affect quality of use are outlined below.

2.1 Ergonomics

Ergonomics and human factors are critical in ensuring that products are easily used by as many members of the population as possible. In addition, it is concerned with ensuring that the physical demands will not cause stress or injury over a period of time. These principles should apply to the design of any gestural interface: in reintroducing larger motions there is a danger of fatigue. For example, consistent use of a swiping gesture could cause shoulder pain if it causes the arm to be raised for a prolonged period of time. In encouraging more intuitive gestures and phrasing movement, however, it may be possible to avoid the kind of repetitive strain injuries caused by the constricted positions and repetitions demanded by current computer workstations.

2.2 Gesture

Gesture is closely associated with speech and communication – it is used for emphasis, inflection and explanation. In this sense it is something that we do unconsciously and is associated with our intentions. Prescribed gestures should therefore align with the intended or desired emotional reaction of the user: you do not open your arms to danger or smile when something is sad. These universal gestures or motions are fundamental and should be considered in relation to the functionality of the product interface.

2.3 Culture

As well as communication, gestures are closely related to culture. Some authors advocate that preset gestural vocabularies are not appropriate in the development of 'natural' interfaces as the cultural differences between groups can mean that a gesture in one location has a completely different meaning from in another (Liebenau & Backhouse, 1992). Similarly, different cultural groups can be more or less expansive in their use of gesture. For example, Latin and Mediterranean countries are often more expressive than northern Europeans and this can be observed in the number and size of gestures during conversation. These variances should be considered when prescribing gestures that may be used across cultures, or accommodating the development from within different cultural groups.

2.4 Complexity

Complexity is the most counter-intuitive of the themes we have identified for quality of use. A gesture might be simple and ergonomically sound, but there may nevertheless be an opportunity to make it more physically or culturally rewarding by extending it. There is a danger that if something is too difficult to complete then it undermines usability, but if by complicating an interaction it puts the user in touch with themselves or the functionality of the product then it is worthwhile. For example, getting water from a faucet at a basin could be a more rewarding experience. Often hands are slippy, dirty or cold when trying to turn or press the required tap, and current motion detectors can result in a frustrating waving of the hands. With more sophisticated motion detectors, water streams could be teased out in fun and evocative ways that may involve an element of learning but be ultimately more satisfying and provide greater control.

3. LABAN STUDIES

To understand more deeply the nature of movement in relation to the human body, we have looked to the field of dance. Rudolf Laban's (Laban, 1960; Laban & Lawrence, 1974) movement studies are one of the most widely used and cohesive theories of human movement, recognising the physical and expressive variations behind human motion. Despite being based in the arts, and forming the basis for concepts such as dance therapy (Bartenieff & Lewis, 1980) Laban worked with engineers to analyse the movement dynamics of industrial workers in the 1940s (Davies, 2001) and senior management (Moore, 2005). There have been a number of previous studies examining the use of Labanotation in the context of product interaction (Loke, Larssen, & Robertson, 2005; Loke & Robertson, 2010). Hekkert et al (2003) describe the development of a photocopier and scanner that uses the metaphor of dance to create a more meaningful user experience. Such research into using more people-orientated interactions using dance and movement as inspiration (Bull, 1987; Kendon, 2004; Sheppard et al., 2008) have resulted in the importance of kinaesthetics – the quality and effects of movement – being more fully considered in design (Moen, 2005, 2006). By developing a clearer formulation of the motivation for movement in relation to products, we aim to connect existing work on dance and drama with interaction design in a way that will place emphasis on the emotional reaction of users.

3.1 Effort Actions

'Effort' is the inner attitude towards a motion factor and is applied to (or through) eight basic Effort Actions. These are descriptively named Float, Punch, Glide, Slash, Dab, Wring, Flick, and Press, and have been used extensively in acting schools to develop the ability to change quickly between physical manifestations of emotion. Laban uses the 'motion factors' of Weight (W), Time (T), Space (S) and Flow (F) to describe movement sensation in each effort action. Each has opposite polarities that reveal the subtleties of movement, e.g. reaching for an object and punching someone may be mechanically similar but the use of movement, strength and control in each case is very different. Figure 2 shows the Laban Effort Graph which allows motion factors to be documented. For the two examples, the different qualities of motion result in different effort actions: reaching for an object becomes a pressing action.

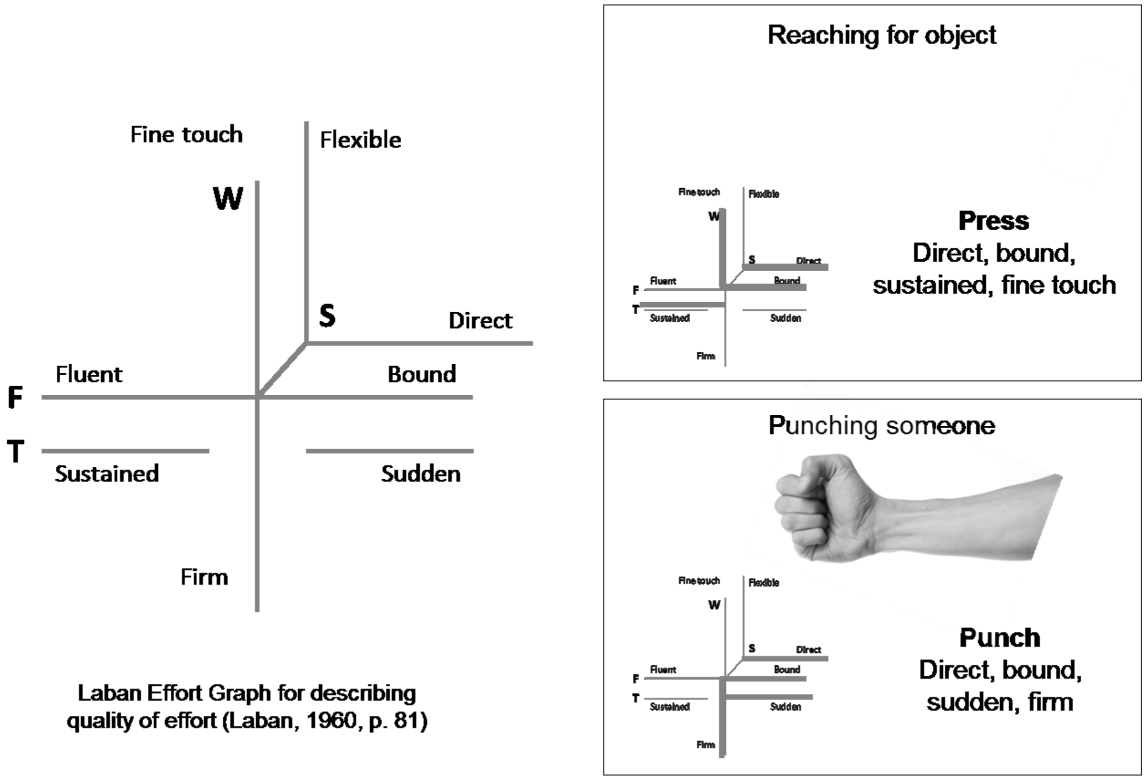

Figure 2. Laban Effort Graph for describing quality of effort (Laban, 1960, p. 81) and illustrating how motion factors can affect mechanically similar movements

We can therefore use motion factors to describe a range of effort actions: Figure 3 shows how the eight basic effort actions can vary with different emphases on the motion factors. The effort actions have been organised radially with direct effort actions towards the top and sudden actions towards the right. This framework is useful in considering how movements relate to different Laban effort actions.

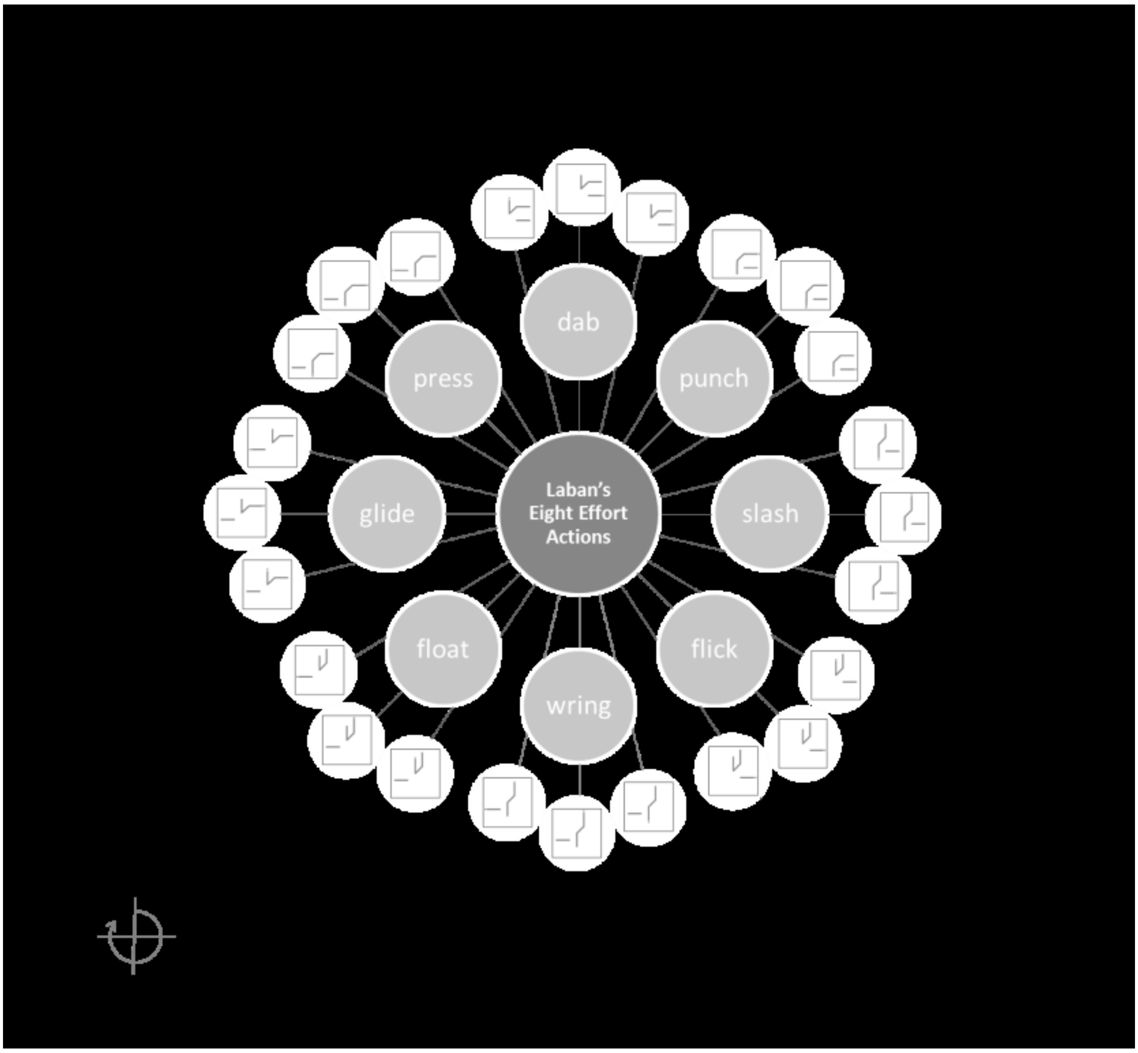

Figure 3. Laban's eight Effort Actions, with notation and examples of use (Laban, 1960)

To illustrate how this notation can be used to capture product interactions, an example has been included for two different kinds of lighter (
Figure 4). Using the Clipper lighter requires a squeezing-pressing motion, its mechanism making effective use of tactile and audible feedback to prepare the user for the flame to be lit. The Zippo lighter, however, uses a two-stage process to reveal and strike the flint. Flipping the lid and thumbing the flint are both highly evocative motions that, when combined, provide the product with a greater sense of movement and drama than the simple depression of the Clipper. The motion factors of Time, Weight, Space and Flow are integral to identifying the nature of the effort actions at each stage of any product operation: speed can be quick or sustained; weight can be strong or light; space can be direct or indirect; and flow can be bound or free. The effort applied to each of the movement actions and sequences provides the key to understanding the emotional response within the sequence – the feel of the movements cause different reactions in the user.

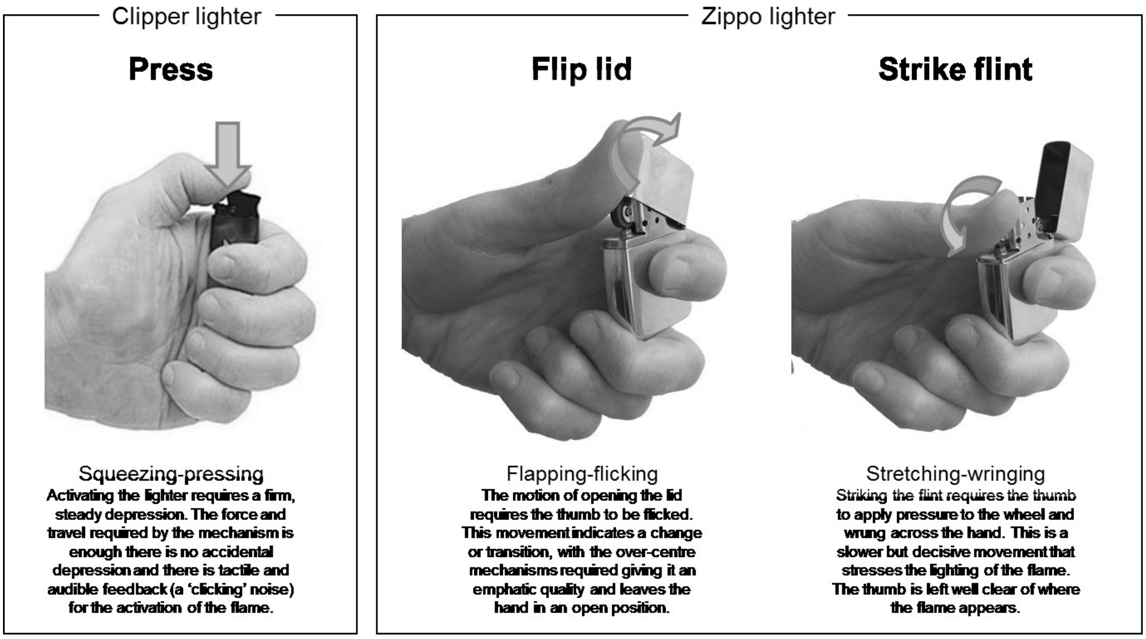

Figure 4. Application of Laban's effort actions to the use of Clipper and Zippo lighters

4. WORKSHOP

This section presents the results of a one-day workshop for an undergraduate Emotional Design and Experience class. After being introduced the basic concepts of Laban and experiencing a series of movement exercises, teams of three were invited to re-imagine a number of product experiences that utilise appropriate Laban effort actions. The themes provided for consideration included domestic, medical, industrial, commercial/office and retail use. Card, masking tape, flipcharts and marker pens were provided to allow spatial prototypes and storyboards to be constructed and demonstrated to the group.

4.1 Articulating emotional response

When articulating emotional reaction to the different Laban movements, it was important to encourage clarity in expression. Many models of emotional reaction exist, but a useful and easy to understand model is Plutchik's Wheel of Emotion (2001). This consists of eight basic emotions which combine to form eight advanced emotions. The emotions are co-ordinated in pairs of opposites, with intensity of emotion and indicator colour decreasing towards the periphery of the wheel (Figure 5). Teams were asked to refer to this when describing their interface, and to clearly identify any emotions not covered by the wheel.

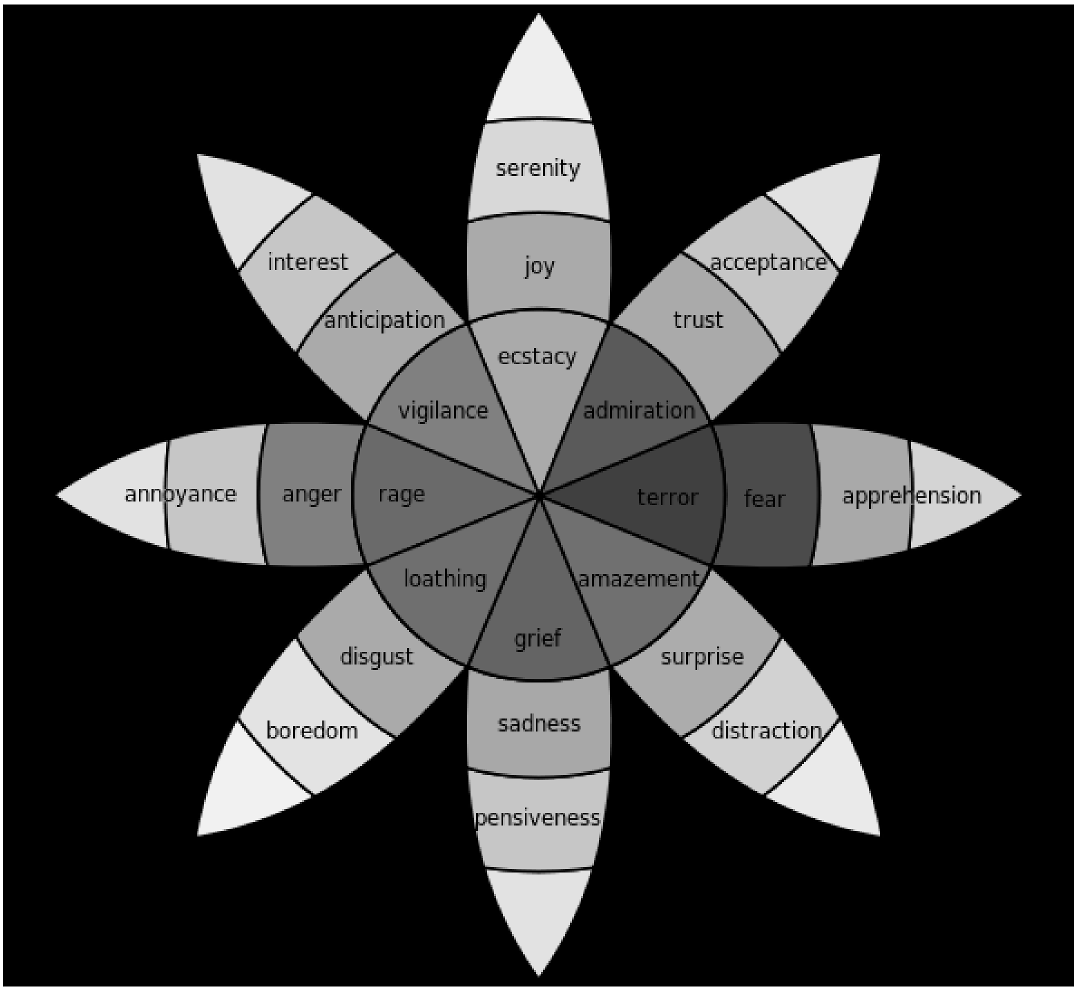

Figure 5. Plutchik's Wheel of Emotion, showing eight basic and eight advanced emotions

4.2 Output

In constructing their interface, teams were asked to identify a particular product or task within their allocated topic where the interaction could be changed through use of a more vivid physical interface. The interfaces developed by the teams included a defibrillator, a call centre telephone, a warehouse forklift, a shopping trolley, a hi-fi system, a hospital bed, and a TV. After identifying all the functions required of the interaction, appropriate Laban motions were trialled through the use of cardboard prototypes. These were by necessity very rough and ready but allowed the teams to practically explore what the interactions felt like. A sample of the models as used in the demonstrations are shown in Figure 6.

Figure 6. Examples of output from the workshop, including a supermarket trolley, defibrillator, hi-fi remote control and TV

5. DISCUSSION

In the demonstrations of the interfaces and through discussions, different categories of gestural interfaces were apparent. *Directly activated* devices required physical operation and the ideas of Laban were used to focus on optimising and improving the actions used. An example of this was the shopping trolley interface. The team proposed that the trolley was split into two major areas for storage: an adjustable upper shelf where delicate items such as vegetables could be placed and a lower area for large, bulky items. The more delicate placement and adjustment of the shelf is aligned with the *dabbing* actions, which are delicate weight but focussed in direction. These were felt to align well with a sense of care or vigilance in the user. It was suggested that by including sloped or inclined shelves in the lower storage area, *punching* actions, with emphasis on firm and sudden movement, would be appropriately decisive to reinforce the secure storage of the items.

Remote controllers are a common for the operation of many current devices. Combined with the use of motion sensors, it is possible to incorporate aspects of gesture into the interface design. One of the teams decided to review the operation of a hi-fi and chose to utilise a stick-like device that could be bent and twisted to control the music being played. By bending, twisting or waving the stick it was possible to adjust volume, skip tracks and turn the system on/ off. While learning and executing the gestures associated with this interface could be considered more complex than the push of a button, it highlighted the increased satisfaction that can be achieved through effective physical movement. In particular, the *wringing* motion used for volume adjustment, with its firm but flexible movements, utilised the full body in a way similar to dancing. It also included an element of metaphor in turning the neutral stick into a smile, reinforcing the pleasure of music.

A *gestural recognition* interface involves no direct contact with an object and relies on movement in space. In redesigning a TV control interface with the intention of making the experience more of a cinematic ‘event’, one team described a set of gestures for switching channels, turning on/ off, and adjusting volume. Interfaces such as these require the definition of a gestural vocabulary that is easy to learn and culturally appropriate as well as incorporating motions that make effective use of the body. As well as identifying the *flicking* and *pressing* gestures that might be expected for changing channel and on/off functions, the team also identified a diagonal *slashing* motion for volume adjustment. This is a flexible and firm movement, but with different speeds can be used to change the volume either quickly or slowly. As well as incorporating much of the body in a dynamic movement that suits the change of state being induced, it also relies on a cultural analogy of the growing triangle symbol that often indicates volume pictorially.

Table 1. Different categories of movement in product control

Type of control	Issues	Examples from workshop	Embodiment
Direct activation	How physical manipulation can be made more rewarding. Quality rather than ease of use.	Supermarket trolley	Precise motions for placement of vegetables, larger punches for storage of heavy goods.
Remote controller	Mixes physical contact and movement at a distance. Paradigm for control is important.	Hi-fi remote	Manipulation of a stick-like device to mimic characteristics of dance, and utilisation of metaphor.
Gesture recognition	Control achieved entirely through movement of the body in space. Requires definition of an appropriate gestural vocabulary.	TV control	Alignment of motion with function. Incorporation of variations in magnitude and reliance on cultural analogy.

These three categories of controller have been set out in Table 1, along with the main issues for consideration and examples from the workshop. An interface which incorporated a number of different elements was the defibrillator device. It was proposed that this would consist of a pair of gloves worn by the person to administer the electrical charge for resuscitation, with an auxiliary indicator unit. Operation consisted of four distinct elements:

1. touch fingertips to switch on
2. spin hands to charge
3. press chest to administer charge
4. interlock fingers to switch off

In switching the device on by touching the fingertips, it encourages a moment of precision and poise. Spinning the hands with a *whipping-slashing* movement to charge the gloves is highly dynamic, providing the user with an increased alertness and is also highly visible to onlookers, indicating that something is about to happen. The pressing motion of administering the charge is a firm and direct movement that is appropriate for the transmission of energy from one individual to another. And by interlocking the fingers to switch the device off, there is a physical and visual sense of closure. Throughout its operation, the gestures and functionality of the defibrillator are closely interrelated, and although it is a speculative device it embodies many of the possibilities of utilising movement effectively.

6. CONCLUSIONS

This paper discusses how Laban's effort actions can be applied to the area of GCUI, and highlights that while ergonomics are fundamental to human-machine interactions, issues such as gesture, culture and complexity can be utilised to engender greater satisfaction in the physical operation of products. The results from an exploratory workshop are presented, where interfaces were re-imagined to optimise physical movement. While the exercise worked well in understanding the role of the body in relation to operation of the interfaces, it was found that Plutchik's Wheel of Emotion did not align obviously to Laban's effort actions or include a number of feelings that were identified as desirable in the interface design, such as pensiveness or security. It is therefore recommended that for similar, body-orientated interface research that other emotional frameworks are explored for their suitability. Three categories of GCUI, direct activation, remote control and gesture recognition, have emerged, and these may be of use in structuring further investigations into the use of gesture.

ACKNOWLEDGEMENTS

The authors would like to thank the students involved for their participation in the workshop.

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