Imitation Games

Designing rock climbing environments to encourage kinaesthetic learning through imitation

A report on practice-led research submitted in partial satisfaction of the requirements for the degree of Master of Design in Design Innovation and Environmental Design at the Glasgow School of Art

Philip Hughson

Supervisor: Brian Dixon
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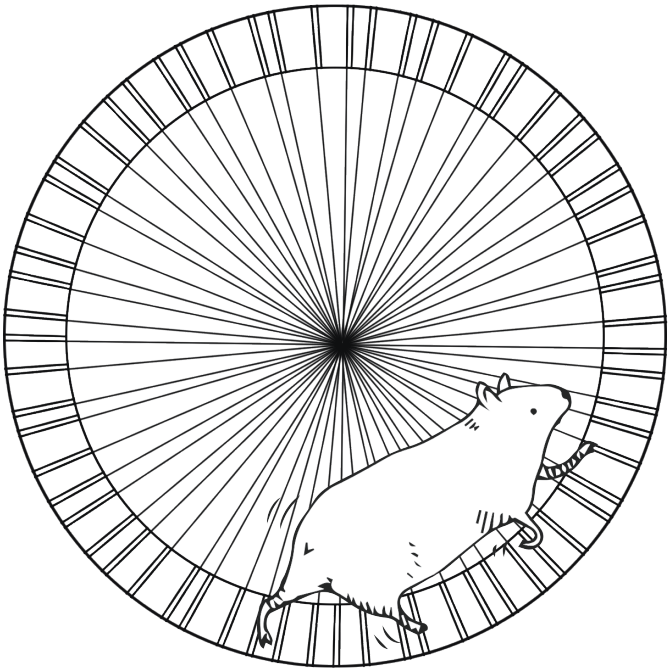
Imitation, if it is not forgery, is a fine thing. It stems from a generous impulse, and a realistic sense of what can and cannot be done.

- James Fenton

Art begins in imitation and ends in innovation.

- Mason Cooley

Abstract



There has been much development in design for rock climbing (training) in recent years, but most of this has focussed on the acquisition of performance attributes such as strength and endurance, comparatively easy to measure, rather than on quality of movement, despite the latter's importance having been recognised in recent climbing literature. In sports such as dance and martial arts, imitation, a very widespread process in human culture, is a common means of transmission of such kinaesthetic knowledge, suggesting the possibility of projecting from these domains to rock climbing. To investigate this, a system of opposing frames of ideas and research is created to support design ideation, leading to the creation and testing of an "experimental system" in the form of a "climbing roundel", a "propositional environment" for imitative kinaesthetic learning in rock climbing. Brief testing of this environment finds it to be supportive of some forms of imitative learning in climbers, suggesting that further research may be fruitful. It also generates design propositions for a roundel-based climbing structure and a system of video recording and projection.

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Contents

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(excluding quotes)

Introduction

This text describes a practice-led design innovation research project carried out between June and August 2015 at the Glasgow School of Art, examining the following question: *how might rock climbing environments be designed to facilitate kinaesthetic learning through imitation*?

The project aimed to conceptualise, build and test environmental design concepts in order to answer this question. It can be understood in four phases, as illustrated in the diagram overleaf.

1) Framing of the research question
2) Framing of ideas
3) Design experiments
4) Conclusions

The justification for carrying out this research is covered in section two. My personal motivations and background in relation to it are described in section three.

The key design theory ideas underpinning this project are: the pragmatist notion of truth being an event, or "something that happens to an idea"; a critique of reliance on user-centred design if "radical innovation" is of interest, with a model of opposing frames of reference to encourage projection of ideas used instead; and a concept of design knowledge being created by "experimental systems" rather than consisting in answers found to pre-defined problems or questions. These and their application are described in section four.

Important conceptual background on kinaesthetic learning, movement physiology, rock climbing and imitation are given in section five, although these details are necessarily brief.

Section six describes the "design data" collection methods that were used: interviews, case studies, participant observation and background reading. Since, as is common in design research[1], the research question was defined during the research, the reasoning process that led to this definition is described, followed by an account of the framing and synthesis processes. It should be understood that the data collection took place during both these processes. The last part of section six describes ideation, refinement and selection of ideas for design experiments.

Section seven describes the "experimental system" (or environment) created, and the seven design experiments carried out within this system, and section eight covers the results of these.

The final sections cover conclusions, limitations and suggestions for future work and design applications, as well as some reflections on method.

In general this report is written in impersonal style, but I have included reflections on my development during the project in an appendix. Additional appendices give details of interviews and other evidence collected, as well as describing the practical construction of the prototype and detailing equipment, software and programming code used.[2]

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1 As described, for example, by the Research Council's double diamond model (see Hunter n.d.).

2 Though I claim no particular expertise in these areas, I was on several occasions grateful to other authors for saving me hours of experimentation - or years of study - by pointing out practical considerations, such as the necessary light output of projectors for use with climbing walls: these details are included to permit similar such imitative time saving.

Limitations of scope

This research does not claim that imitation is the only or the best means of kinaesthetic learning, or that it is not already used in rock climbing to some extent: it merely seeks to explore the possibilities that exist and their possible benefits.

Neither does it aim to provide design solutions for a particular audience (such as professional climbers, or commercially run indoor climbing centres). The interest is devising environments to support processes which improve rock climbing ability. Such learning is taken as worthwhile in its own right and will not be justified[3] or narrativised[4] further.

The environmental context for these ideas is taken to be artificial climbing facilities, owing to the greater design control we have over these compared to the outdoors, although ideas that would work outdoors on "real rock" are not precluded.

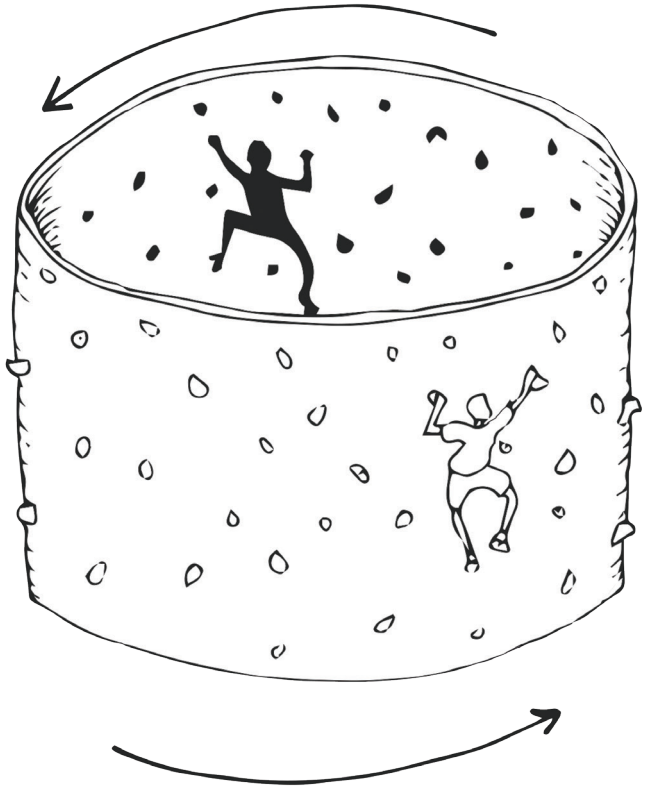


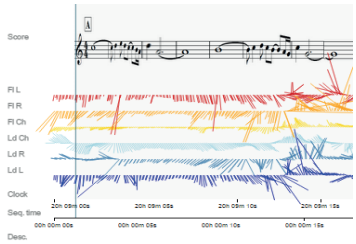
Figure 1. A sketch of the "climbing roundel" idea eventually tested .

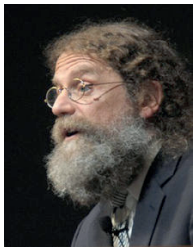
3 That said there is much evidence activities like climbing have benefits beyond their own domains. Writing it the RSA journal, Kelly Lambert (2015) notes that much of the human brain is concerned with movement, and that as rates of physical activity and manual work have decreased in the past century, often aided by "good design", so rates of depression have increased.

4 On the grounds that people are fundamentally imitative creatures but that there is only so much a person can reasonably imitate, one could easily built "scenarios" of people imitating the habits of rock climbers rather than of other "cultural groups", thereby hypothetically becoming happier and better adjusted personae (because, following Lambert, motion defends against depression but is much less present in humanity's habit repertoire than in times past). The author would suggest experimentation with such ideas in the flesh than argument on paper.

INTERESTS

PREVIOUS WORK





How can motion be represented?
- by the body itself / by video / by notation / by trails / internally / externally / stigmergically

Why represent motion?
- ~~curiosity~~ / ~~archival~~ / to create form / ~~to represent hassle~~ / to learn

How can we learn movement?
- ~~rote learning~~ / experimentation / instinct / ~~teaching~~ / by imitating others

What environments do I know well enough to design effectively where imitation could be used more to improve quality of movement?
Dance / running / parkour / football / skiing / cycling / rock climbing

Definition of RESEARCH QUESTION:
"How might rock climbing environments be designed to encourage kinaesthetic learning through imitation?"

Theory: psychology, ethology design

Tradition

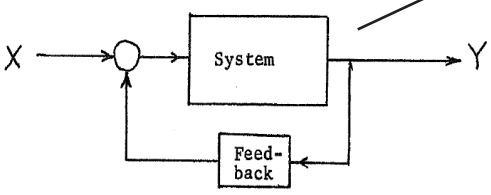
Imitation is a widespread and innate capacity. It is cognitively efficient.

Other sports: martial arts / dance / swimming

Rock climbing

Novelty

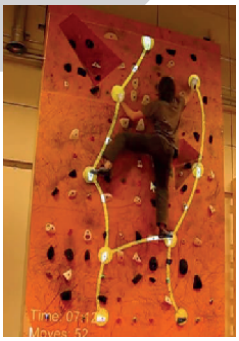
Design practice (case studies)



Feedback systems are interesting and generative...

Q: How can I generate ideas to answer this question?
A: By opposing frames of reference

Digital visualisation doesn't necessarily work well



BACKGROUND READING

COLLECTION OF RESEARCH DATA

INITIAL EXPERIMENTS

SYNTHESIS

Framing of question

Deduction and arbitrary decisions to frame my interest

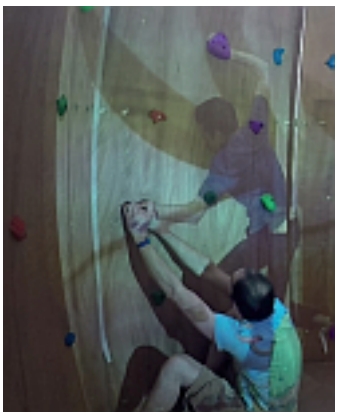
Framing of ideas

Creation of opposing frames of reference, both "grounded" and "philosophical", to encourage "projection" of design ideas.

IMITATION GAMES OVERVIEW

sourcing of materials

Transparent walls already made....

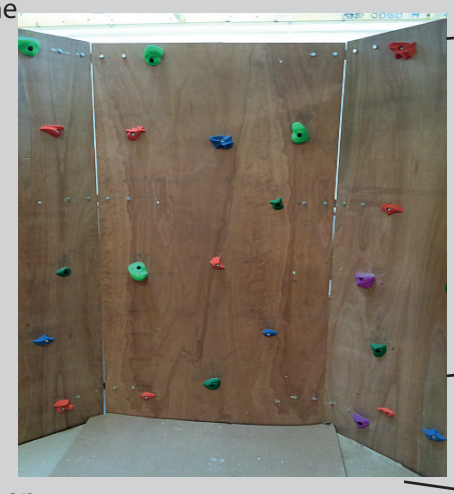


Video projection on to walls is effective, though technical and user interface development would be required It's good for showing differences in how people move.

A circular form like a roundel is self-supporting and accomodating mirrored and cyclical motion

The roundel climbing system is novel, pleasing and could be developed. It allows for circular training. People respond well to it.

The human body and video are the best forms of kinaesthetic representation available for the least effort



Imitation is a potentially rich motif for future design work, especially when it allows for iterative variation and improvement.

"pursuit" climbing is fun and encourages instinctive climbing

Imitation based on synchronous motion from martial arts and dance could be used in climbing

Angles of vision are difficult at times in mirrored climbing, which works best below climbers' limits

IDEATION

PROTOTYPE CONSTRUCTION

TESTING

WRITE UP

Experimentation

Creation of an physical "experimental system " to test ideas and generate unexpected ideas

Conclusions

Creation of an physical "experimental system " to test ideas and generate unexpected ideas

Justification

That the question of design through imitation in climbing is worth asking is demonstrated by recent literature on climbing training. Dave MacLeod, one of the UK's leading climbers, suggests that learning based on (carefully directed) imitation is now considered an effective and desirable means of imparting movement technique:

> "Most climbers these days understand that their climbing would improve and they would get more out of their present level of strength and fitness if they learned to move better and more efficiently on the rock. In the past few years the sport has really started to accept that to achieve this, *climbers need to pay attention to good examples and influences from which to copy good movement technique*. Good examples might be climbing coaches, or just good climbers you can watch in the flesh or on videos." (MacLeod 2009 p32, emphasis added).

Such imitative techniques are used and described by climbers, as described in this example (see figure 1):

> "There's a cluster of [yellow] volumes [...] up the top there. The next hold is quite far away. Trying to work that out took me the first time about four or five tries [1], of just trying and falling, trying and falling. So in the end I had no clue what I did and I reached up and finished it. It's taken watching someone else do it and me doing it a second time [2] to work out what the move actually was." (Harris 2015)

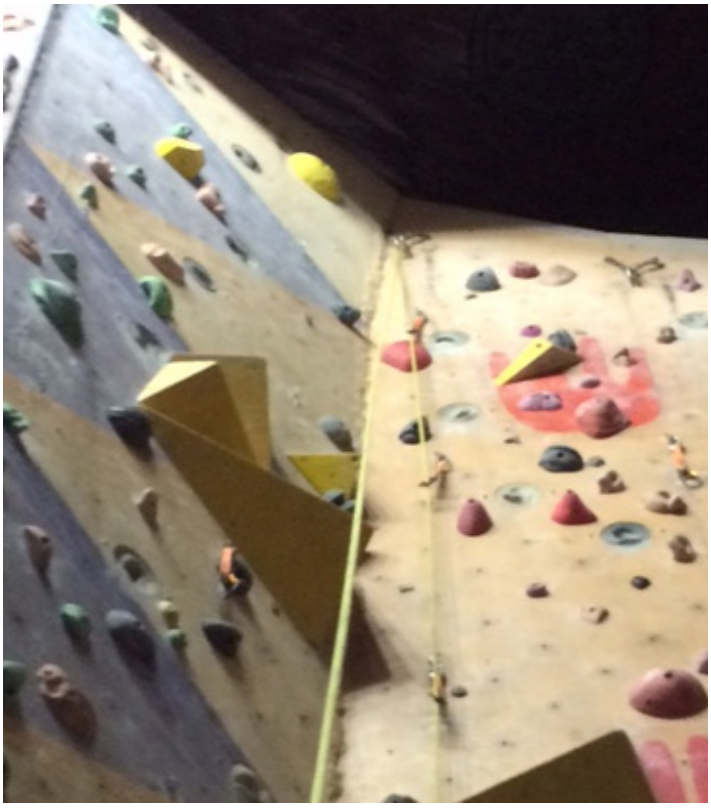


Figure 2. Section of indoor climbing route described by Tom Harris, showing cluster of yellow volumes (centre left) and the "next hold" (upper left), the movement between which is difficult.

Here both iteration (1) and imitation (2) can be seen at work as codification processes for embodied (climbing) knowledge[1]: seeing someone else climb route resolved the disjunct between the climber's demonstrated capability of completing the route and his remembering how to do it.

It is notable though that such imitation is rarely used *systematically* in climbing training, in contrasts with other sports. MacLeod comments:

> "The problem is that climbing moves are comparatively undefined compared to something like a golf swing, which has a consistent ideal movement to perfect, or tennis which has a cadre of shots to give structure to practice. Climbing moves are much more varied than this, but not so much that we can't define certain key moves such as twisting to extend the shoulder and reach, rockovers, drop-knees etc." (MacLeod 2009 p25)

There appears to be wider failure to understand that one can drill technique (as one might in say, martial arts, dance or swimming classes), suggesting a design opportunity:

> "When the idea of doing technique drills is suggested to climbers, it is met with confusion or

1 The climbing concept of *beta*, or verbal advice given before undertaking a route, could be understood as a linguistic imitative process, but imitation is a broader and generally sub-linguistic process.

indifference [...] They think 'What exactly would that entail? When would you actually do it? I've never heard of other climbers doing it...'" (ibid., p35)

The question of *how* to move also has received little attention in recent climbing related design work, which has concentrated on more obvious and tractable themes, perhaps because movement itself is a complex and non-linear process, hard to design for and measure.

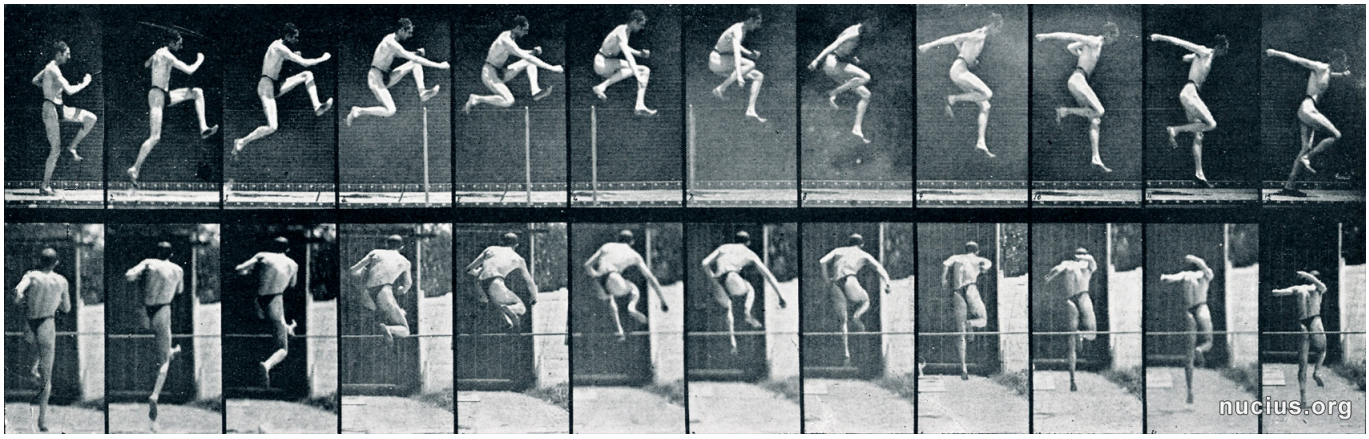


Figure 3. Eadweard Muybridge's late 19th century chronophotographs, here of a man performing a straight high jump, demonstrate the complexities of human motion. These difficulties present themselves in the present century: see for example Andrienko et al. (2013) on the "Visual Analysis of Movement".

"Climbax" is a recent such project which measures performance attributes of climbers such as power and speed, using wrist mounted accelerometers, in order to promote improvement, especially where human coaching is not feasible (Ladha et al. 2013). It is not clear that such measurements, even if they correlate demonstrably to ability, will improve technique, and indeed they may encourage "performance statistic chasing" at the expense of understanding and efficiency.[2]

"Augmented Climbing" is an augmented reality project which uses a projector and a depth sensing camera to track and suggest next holds to climbers (Kajastila, Hämäläinen 2014). While effective, this still focuses on the question of *where* to move next rather than *how* to execute the movement (indeed several test climbers are reported as saying that it would be great to be able to compare different climbers' approaches). An emphasis on which hold to use next can highlight difficulty rather than encourage experimentation and practice.

The lack of similar design work focussing on movement technique suggests an opportunity.

2 In climbing good technique often allows less power to be used. See MacLeod (2009) pp50-51 for further discussion.

Motivations

This project was motivated initially by my interest in the complex relationship between perception and execution of human movement: when one practises an activity like dance or rock climbing, one's ability to perceive finer distinctions in movement grows along with one's ability to execute these movements: the feeling is one of more meaning coming out of one's perceptions of movement. Also interesting is a sensory asymmetry: motion of others is (generally) perceived with the eyes, yet "first person" information on execution comes from the sense of proprioception (and from the eyes in some cases). Both of these relationships involve complex feedback mechanisms, fertile terrain for design.

I have previous examined the graphic representation of improvised dance composition in tango (Hughson 2014) motivated by a desire to visualise and record what is otherwise transient. This notion of representation of movement was the starting point for this project.

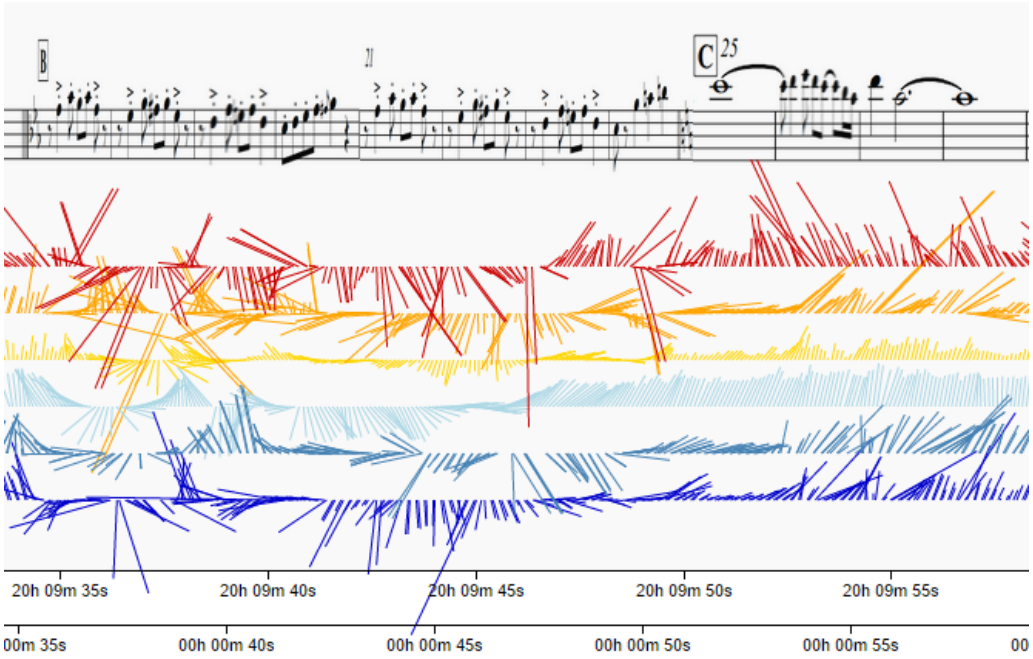


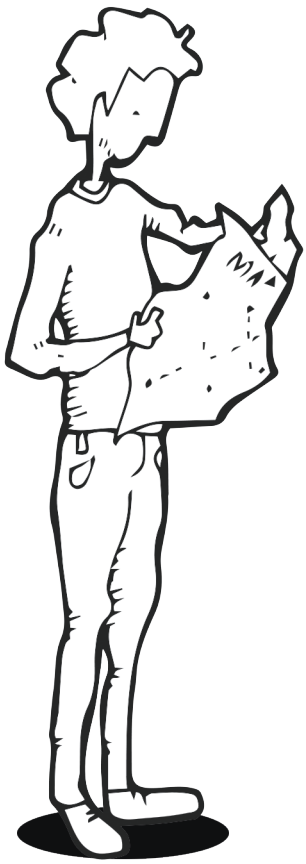
Figure 4. An extract of output from "Patagraphy" (Hughson 2014). The graphing of dance movement worked - but would such graphics have any meaningful effect in the world?

My decision to focus on rock climbing was in part based on my familiarity with it and with differences in training approaches between it and other sports. This experience has influenced this project. In climbing and dance I have been interested in how (internal, mental) visualisation and images can be used to improve performance and reduce tension.[1]

Methodologically, I was motivated to explore the tension between rational processes in research and the often intuitive nature of creative work (or "artistic design"). In previous projects (e.g. Hughson 2015) I felt that an intuitive decision making process was rationalised "post-hoc" to make it fit a desired research model, which seemed like intellectually dishonest shaping of praxis into desired representations of research. I wanted to investigate alternative research models which better represent my own experiences of design process. Hearing Steven Scrivener speak on the "production of unexpected events" at the 2015 Creativity and Cognition conference had a major influence on me, giving me a conceptual model to understand the questions I had been asking.

1 See for example Franklin (1996) for background on the role of imagery in sport and movement

During the same project I was interested by **constructivist** accounts of knowledge, where knowledge is viewed as consisting in (social) relationships, a conception under which design activity can considered as an adjunct to such relationships. My decision to design for “kinaesthetic knowledge transfer” reflects this idea.[2]



2 We could also give constructivist accounts of sports training, in which relationships with others are considered the key determining factors in performance - or at least the key factors to design for. This might be contrasted with a positivist approach, which might emphasise the acquisition of training and performance data, suggesting designs such as “Fitbit” or the previously mentions “Climbax”. Doubtless both aspects are important to optimal performance, and professionals attend to both, but there remains an empirical question as to which is more important for the time-pressed amateur. Dave MacLeod (2009 p17) comments: “If you spend all your time climbing with good climbers (good in some respect, not necessarily grade, maybe just effort level) it rubs off on your without you even knowing it. It’s quite a marvellous feeling when it happens.”. From my experience, the best thing I ever did for my running *speed* was to join a running club, where associating with others who were in the habit of running quickly radically improved my speed - because I saw first-hand that it was possible.

Conceptual background

Movement physiology & kinaesthetic learning

In simple terms, movement in animals is carried out by muscle cells, which contract and expand when stimulated by motor neurons, which relay signals from the brain (although reflex actions may be mediated through the spinal cord). A separate system of nerves monitors the spatial position of the body, creating our sense of "proprioception". The interaction of these two systems of nerves, combined with input from other senses such as vision, creates a complex system of feedback (or sense-action cycle) which allows for complicated patterns of movement and response,[1] the great majority of which is subconscious, although in sports training we may deliberately direct attention towards it.

While changes in strength and range of movement can relate to changes in muscles and other mechanical tissues, changes in control (and to some extent strength) are related to changes in the strength of connections (synapses) between nerve cells (neurons) and the frequency and strength of signals between neurons. These changes generally happen in response to repeated stimulus or use (the most basic expression of this is the principle that "neurons that fire together wire together", also known as Hebbian learning. Training in movement technique therefore can be understood as acting upon the "wiring" of neurons, which can be viewed as encoding behavioural information[2].

By extension, kinaesthetic learning through imitation could be understood as the transfer of information coded in one person's nervous system to another person, mediated by the senses and reinforced by repeated practice.

Basics of rock climbing

Rock climbing is a sport where people climb steep rocks, cliffs or artificial climbing walls, generally aiming to climb to the top of a "route" using the efforts of their own body only, with ropes and other safety equipment used only to provide safety. Roped climbing is normally done in pairs, with one person climbing and the other "belaying" (managing the rope for the safety of the climber) at any given time.

Bouldering, also practised inside and outside, is a low level form where mattresses and "spotters" (other climbers who direct fallers towards safe landings) provide safety. In both cases, "routes" and "problems" are grade in terms of difficulty using a wide range of systems: thus focus on "grade" can be significant amongst rock climbers.[3]

Climbing on artificial walls, often located indoors in major centres of population, has developed significantly in the past 30 years, to the extent that it represents many people's only experience of climbing. By allowing good conditions for regular training, artificial walls have led to an increase in technical climbing standards. The use of adjustable artificial holds also allows for the creation of more varied climbing routes than might be possible at a single outdoor location.

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1 Most the "output" of human beings can be considered as movement on one level or another: language production as movements of the tongue, mouth and vocal tract - or fingers, emotions as complex preparations for motion,

2 It has been suggested that one feature that distinguishes human beings from the great apes is our capacity for fine motor control, evidenced by the higher density of nerves which control our muscles compared to theirs (Walker 2009). What we lose in capacity for expressing brute force (perhaps because it is harder to fire many neurons in synchrony than few, martial arts training aside), we gain in capacity for activities which require greater motor control, such as endurance running, hunting with tools, playing the piano, or gossiping about our fellow homonids' movements.

3 See http://www.rockfax.com/publications/grades/ for some details. "Sport" grades are also referred to as "French"

Rock climbing technique

For Dave MacLeod (2009 pp28-92), there are four key elements to climbing training: movement technique, finger strength, endurance and body mass. The notion of learning through imitation explored in this project is concerned primarily with the first, although it is arguable that finger strength and endurance training can also be facilitated by imitation.

The learning of technique in climbing can be likened to the process of language and vocabulary acquisition: a basic and intuitive set of movements can be used to cover most circumstances in lower levels of difficulty, with the most basic motion being similar to climbing a vertical step ladder. Harder routes and more efficient technique require a wider range of movements and awareness of balance, momentum and power. There are also discrete techniques which can be identified, such as "flagging" of legs to one side to create balance, or "drop knees" (see Hague, Hunter 2006, especially chapters 4 to 6, for further details).

More abstract notions of speed, control of momentum and fluidity can also be considered as movement technique.

Imitation and kinaesthetic empathy

School teachers will know that human beings have a significant capacity for imitation. Decety & Meltzoff (2011) state that "human infants are the most imitative creatures in the world. Although scattered imitation has been documented in other species, *homo sapiens* imitate a larger range of behaviours than any other species, and they do so spontaneously, without any special training."

Imitation has been described as taking place on three levels: (1) imitation perceived stimulus, such as a body movement seen; (2) imitation of the function or goal of an action (e.g. picking an apple up to eat it) or (3) imitation of the "presumed internal state of the partner" (Demiris 1999 p10). The difference between the first two is important if we are concerned to communicate quality of movement as well as purpose (e.g. the distinction between how one climbs technically and which holds one uses). The last of these can be understood as being a basis for human capacities such as empathy.

Kinaesthetic empathy is an "elusive" concept with "problematic definitions" (Reynolds, Reason 2012), but broadly speaking it refers to the human capacity to feel, understand or replicate another's situation through proprioception and perception of the other's body. Mimicry in dance would be one example. Research into so-called "mirror neurons", brain cells which activate identically when a person performs an action and when that person perceives another performing that same action, has done much to provide a neurological basis for this capacity.

The notion of *assisted imitation* has been suggested as a method by which infants learn of the possibilities of their environment (*affordances*) and of their bodies (*effectivities*) from a care-giver who helps to direct the infant's attention towards relevant or interesting things (Zukow-Goldring, Arbib 2007).

Imitative techniques are also increasingly used in artificial intelligence and robotic applications: sometimes it is easier and more flexible to teach an artificial agent to imitate another rather than to define behaviours more explicitly (Demiris 1999). This lack of need for formal rules is a significant advantage for the designer of such systems: there is no need to codify, and therefore (potentially) limit, the behaviours in a given interactive system.

Theoretical framework and methodology

Four key design theoretical ideas underpinning this project are described here, followed by details of their application.

Key theoretical ideas

The first notion is that ideas are "made true by events" (James 2004 p2), following the pragmatist tradition. William James suggests that Truth [...] is a property of certain of our ideas. It means their agreement, as falsity means their disagreement, with reality" (ibid.). In design research terms, this favours the building and testing of prototypes of design ideas to test their validity, rather than the testing of their congruence with existing theory or a hypothetical desired future only.[1]

Secondly is the idea that contemporary user-centred and participatory design methods generally produce incremental (rather than "radical") design ideas. It follows that if we hope for more substantive innovation we should use further methods (see Norman & Verganti 2014).

Following on from this is the idea that "Projection" (or transfer of ideas) between heterogeneous domains is a good method of producing more radical "meaning" based innovation (Chow & Jonas 2010). In practice this means seeking to oppose frames of reference: this is the key idea behind the ideation process in this project.

Finally, is the idea suggested by Stephen Scrivener (2013) that (design) knowledge is created by "epistemic artefacts", generally identified as a result of surprising or "unexpected events" in empirical work ("felt difficulty" in pragmatist terms : a divergence between our expectations based on our models of the world and events). "Experimental systems" designed should be to be rich enough to generate these. This favours working from curiosity or loosely defined topics rather than from a critique of the present state of the (artefactual) world[2] (ibid.). This notion is preferred because of its congruence with pragmatist notions of truth and because it allows the generation of a richer range of outcomes, including unexpected outcomes, rather than requiring the satisfaction of pre-conceived (by designer, user or other stakeholder) desiderata.[3]

Methodological application

(This section should be read with reference to the overview diagram).

Given the broad starting interest in representation of human motion, a philosophical rather than grounded approach (Zimmerman, Forlizzi 2008), a research question was defined by asking and answering a series of initial questions. In each a case a list of answers was created, and the most interesting or appealing answer was chosen, favouring answers which suggested systems of feedback, low design effort, gaps in existing design work and fields in which the author has knowledge. Evidence for these answers was collected from comparison of case studies, interviews and observation.

Following the definition of the question, a system of opposing frames of reference was set up. Rock climbing was contrasted with other sports, principally dance, martial arts and swimming, to encourage projection of ideas. Theoretical ideas from the academic fields of psychology and ethology were con-

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1 Especially if the results of such testing make (or can be foreseen to make) no "concrete difference [...] in any one's actual life" (James 2004 p2). That an idea's truth or utility cannot be foreseen is not a reason not to investigate it: the objection is to truth being ascribed to ideas that do not affect reality on some level.

2 To paraphrase crudely, we should seek to make the world more interesting rather than necessarily to make it a better place (by designing to remove some recognised problem).

3 A possibility of failure also follows from this.

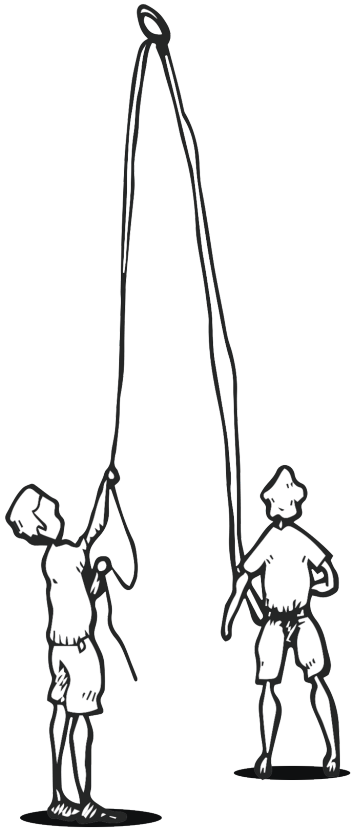
trasted with existing design practice. Ethology[4] was chosen because of the focus on movement, something common to all animals. A third axis of contrast between new technology and tradition also became evident. These axes were explored through a combination comparison of case studies, interviews, participant observation, "desk research" (or reading) and some practical experiments. The data from these were synthesised to form "insights" to provide reference points for design ideas. Random input from museum and art gallery visits was used to assist in the ideation process.[5]

Ideas were then selected for prototyping and testing, with the aim of creating a rich "experimental system". Factors considered were generative potential (or richness), degree of novelty, cost, ease of construction and realisation, aesthetic appeal, practicability of testing and variety of experiments possible.

Following pragmatist ideas, construction of prototypes and experimentation with technology was considered an active part of the research process. Gaining familiarity with technology as well as materials and physical processes such as welding helped considerably with understanding possibilities and limitations. Workshop staff proved very helpful in suggesting ideas: especially the notion that circular forms are self-supporting.

A range of participants with differing climbing abilities was identified for these experiments. Evidence was collecting using video recordings, conversation and observation. Quantitative and extended testing, of the kind necessary to demonstrate changing in sporting ability, were not attempted due of a lack of time and resources.

Conclusions and ideas for further work were drawn from this. In the spirit of an experimental system, ideas not related to the original research question were not excluded from consideration.



4 The science of animal behaviour. See Sapolsky [no date] for an introduction to its application to human beings.

5 See Dingli (2008), which examines Edward de Bono's ideas of lateral thinking, for background on the value of this technique

Design data collection

Interviews

Semi-structured interviews were carried out with the five rock climbers: Darren, Tom, Rusty, Simon and Marc. These focused on techniques and circumstances used to improve technique and ability.

Similar interviews were carried out with five professionals involved in other sports: Denry Aal, a swimming coach and trainee outdoor instructor; Lucy Wild, a contemporary dance teacher; Maite Delafin, a contemporary dance performer and teacher and a student of dance science; Enid Still, a former manager of Kattaikkuttu performing arts school[1] in India; and Damian Thompson, an Argentine tango teacher with extensive experience of martial arts.

Further details of these are given in appendix C and in the following synthesis section.

Case studies

The exhibition and paper session on movement at the 2015 "Creativity & Cognition" conference held at the Glasgow School of Art[2] provided a range of examples, which were supplemented with internet based research.

Climbax and the augmented climbing wall are described in the introduction. Other significant case studies are covered in the synthesis section below.

Participant observation

I followed elementary classes in contemporary dance for two months during this project to gain experience of teaching methods used. I also continued to practice rock climbing with some regularity, and with particular attention paid to the behaviour of other climbers.

Figure 5. Imitation is common is dance classes. Here participants video the teachers for future reference

An exercise in mirroring of movement in pairs done during an ethics training class at the Gloasgw was also significant: it made the initial link between movement awareness and empathic responses.

1 See http://www.kattaikkuttu.org/
2 See http://cc15.cityofglasgowcollege.ac.uk/

Desk / academic research

An additional interview was carried with Arthur Still, a psychologist with interests in ecological psychology, imitation and creative feedback (see Still, Inverno 2014). This focussed on psychological ideas relating to imitation and creative output. (See section two for an overview of some of this).

Ideas from the field of ethology were based initially on informal conversations with a scientist working in the field at the Glasgow Climbing Centre, followed by readings from textbooks on animal behaviour and cognition (see Wynne, Udell 2013 and Reznikova 2007). This reading influenced this project towards simple and non-verbal means of communication.

Experimentation

Several short technical tests were performed early in the project to gain some technical exposure.

The performance of the Microsoft Kinect[3] product in tracking parts of a climber's body was tested on a bouldering wall at the Glasgow Climbing Centre. It was found to be broadly effective in tracking the location of the body of a climber, but it some common climbing situations, such as with raised feet, or hands obscured by the body, it struggled to accurately plot body position (see screen shot below). Such technologies seem best suited to tracking the location of a climber on the wall, as suggested by Kajastila & Hämäläinen (2014).

Figure 6. Screenshot showing the difficulties a Kinect camera has in tracking the motion of a climber. Note that the left leg and arm are incorrectly positioned on the yellow skeletal frame generated by the Kinect camera

Experiments were also carried out using body mounted accelerometers. An initial test using the same procedure as in Hughson (2014) found that body rotation could be easily tracked and plotted. However it was not clear that such representations are any more informative than video. The idea of trying to using graphic output as a means of imitation seemed like an unnecessary abstraction: video output, combined with a trained eye, seems more effective. Three dimensional plots could be used to handle the high dimensionality of motion data, but again finding a representation that is better than a (video of a) human body seemed difficult.

3 A depth tracking camera with specialised software for tracking the human body. See https://www.microsoft.com/en-us/kinectforwindows/

Synthesis

The “design data” collected were synthesised into a series of ideas, the most interesting of which are detailed below, in order to help shape ideas.

Representations of human movement can be internal or external

Internal representations include things like reflexes and habits of motion, but also internal use of language, visualisation or kinaesthetic imagination. Damian Thompson suggested that which one of these is used depends on the person, although he considered visualisation faster than linguistic representations.

External representations offer more scope for design, as patterns of use In different sports vary. In dance classes, mirrors are used for immediate visual feedback. This does not happen in climbing. Could we design to make it possible? Similarly Denry Aal mentioned that swimmers leave trails of turbulence in the water which give an impression of their movement. Could climbers similarly leave trails?

The human body is its own best representation

This idea follows the example of Express It!: a system for visualising the gestures of conductors (Lee et al. 2015). It seemed unnecessary and inefficient to re-represent the motion of person. It seems easier to learn to read the person, as Maite Delafin said dancers do.

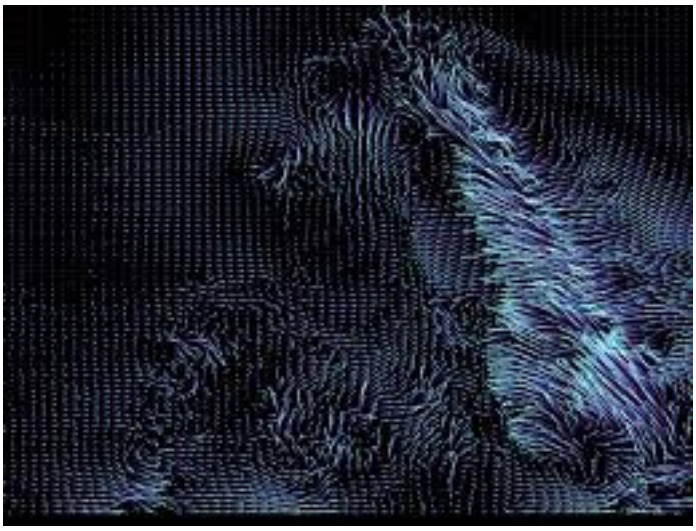


Figure 8. Express It! visualises the movement of conductors. Is this conterproductive?

Imitation can be immediate or delayed

In most dance classes, students move simultaneously with the teacher. In contrast, in bouldering climbers take turns to try routes, as there is only one of each route. Could we make climbers climb simultaneously on identical routes?

Enid Still mentioned that performing arts students would often practise in their free time after teachers had left, in particular using a circular follow-my-leader arrangement. All climbers mentioned that climbing with better or different climbing partners was good for their ability. Could we make it such practices easier?

Social context can both inhibit and facilitate performance

Darren (a climber) mentioned that he did not climb as well when with climbers better than him; he felt socially inhibited owing to competition. This contrasts with the idea of assisted imitation offered by Arthur Still, where infants are "suggested" towards interested objects in their environment by nurturing caregivers.

Imitation is more interesting if it is iterative and generative

Two exhibits from the Creativity and Cognition exhibition demonstrated this idea. Beverley Hood's "Glitching" (n.d.) demanded exact replication of dance moves displayed on a screen. A neighbouring exhibit used the same hardware but was far more interesting: a figure was generated that approximated the movement of the viewer, with some time delay, creating a sense of engagement and absorption.

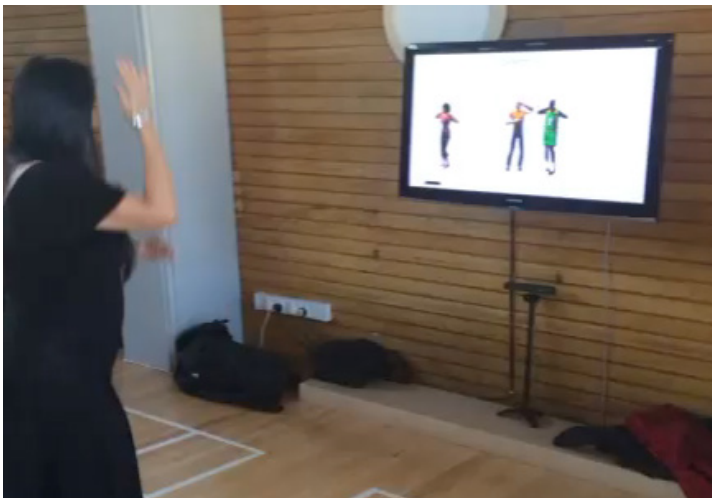


Figure 9. "Glitching" by Beverley Hood

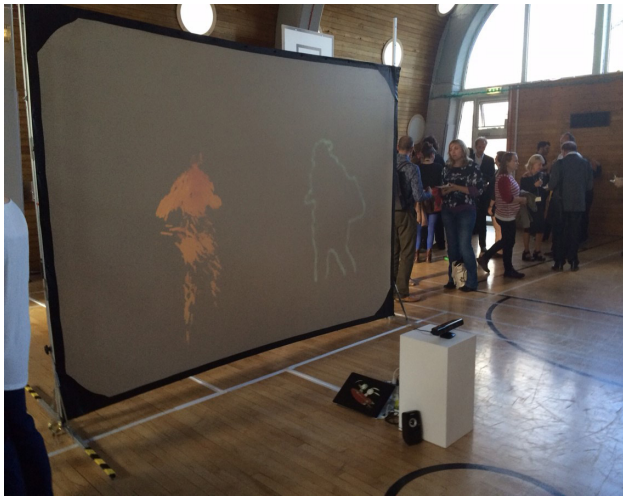


Figure 10. A more engaging neighbouring exhibit

A similar contrast can be made between declarative "Labanotion", which few dancers use, and the approximate scores used in dance improvisation.

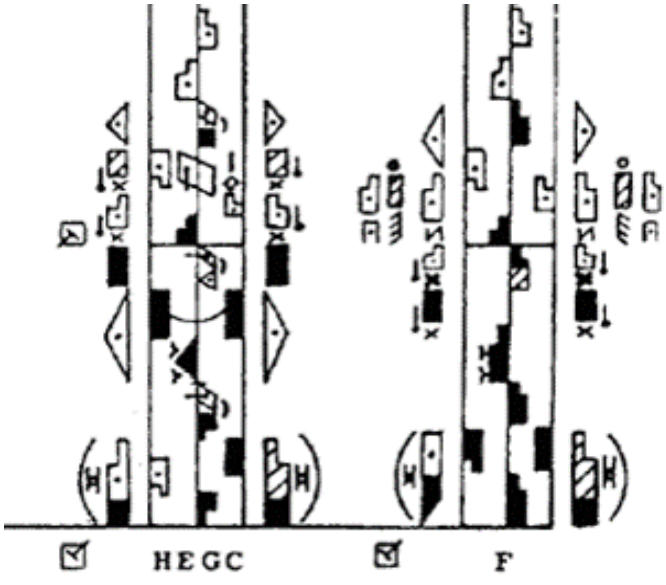


Figure 11. Labanotation is a complicated declarative score for movement

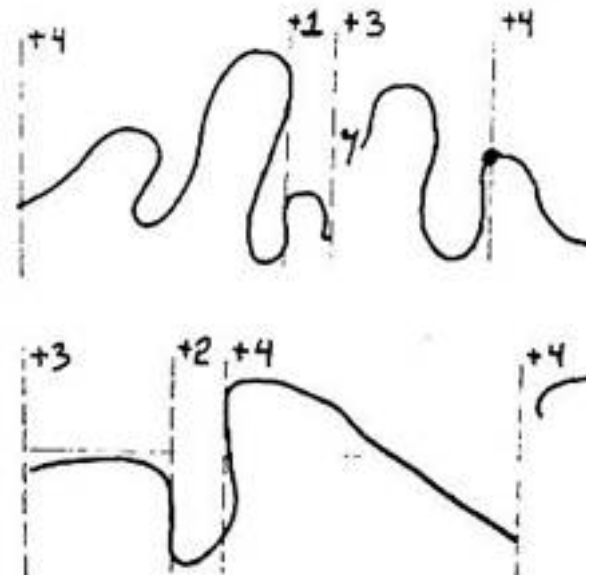


Figure 12. A sample of a score used in dance improvisation

Geometric arrangements for learning vary

Rusty explained that martial arts are taught in rows, with the teacher at the front and students arranged by ability so that each can see somebody more able. Enid Still explained that circles were used for teaching of performing arts, with a guru as the focal point. Also students practised dance in circles, each one copying a neighbour. Could climbers be encouraged to learn in circles?

Good aids to kinaesthetic learning draw attention to human motion and sensation

There have been rapid recent development in motion sensing technology, exemplified by Google's "Project Tango" (n.d.) and the Climbax project already discussed. However, design projects that draw users' attention to the movements of other participants seem more likely to support the development of the kinaesthetic empathy useful in many sports. Fogtmann 's (2012) project TacTowers gives a good example of this, using lit towers to create a competitive system of training for handball requiring participants to predict each other's movements.

Could we do something similar for climbing?

Technique development can be inhibited by fear and pursuit of performance

Most of the climbing interviewees mentioned that climbing difficult routes or feeling in danger made it harder to work on technique. Denry Aal said that swimmers who always try to go quickly cannot learn to respond to water properly. Could we reduce fear in climbing by keeping heights to a minimum?

Ideation was an ongoing process through this project. The key ideas occurred during a morning session of the 2015 Creativity & Cognition conference which was concerned with papers on movement. My notes contain this:

> "Idea: mirrored climbing. Make exactly the same moves in mirror image. Larnign scheme. how to get the idea set up. Mirrored climbing. (could also use video / tech to do this.) (link this to an idea of after experiencing the prototype, children are more creative)"

...followed some lines later by:

> "idea: imitation games..... how do we learn from effective people? children learn by copying movement they judge to be effective."

From this it follows that listening to inspiring people talking about a topic of interest is one of the best ways of having ideas.

Nevertheless an ideation method was used (random input from museums and galleries). This did help to develop existing ideas.

Firstly an exhibit in the Bauhaus Archive in Berlin, consisting of light from a source above being scattered by an irregular and rotating metal contraption, suggested the idea of a 360 degree projector system for climbing walls.

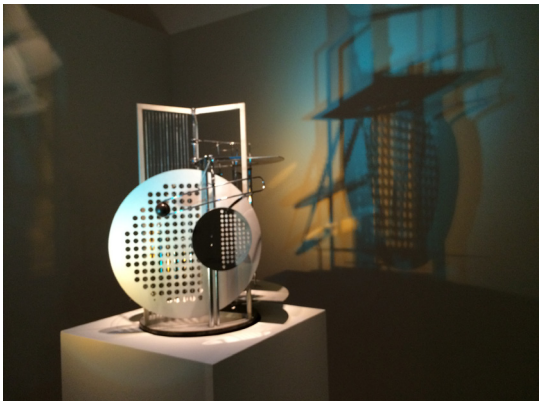


Figure 13. An exhibit from the Bauhaus archive in Berlin

Later in the Bauhaus shop a transparent teapot suggested the idea of a transparent climbing room with holds on either side, allowing climbers to mimic each other through glass.

Figure 14. A glass teapot in the Bauhaus Archive shop

An exhibit of chairs in a design museum suggest the idea of being able to make visual comparisons of different rock climbers' patterns of movement side by side.

Figure 15. A series of chairs in a Berlin Design museum

In London an exhibit of eggs, cameras and televisions suggested the idea of using cameras and projectors from the same point in space to record and replay climbing. This informed experiment D.

Figure 16. Exhibit of eggs, cameras and televisions in the Tate modern

A later exhibit played with perception of depth, or lack of it. This suggested the idea of focussing attention on the hips in climbing, as many climbers are not aware of the position of their hips in relation to the wall, although it has a significant effect on climbing. This became experiment E.

Figure 17. An exhibit at the Tate modern consisting of a black rhombus with steel appendages sticking out. From a distance it appears flat.

Visiting Carsten Holler's exhibition "Decisions" at the Hayward gallery in London and seeing the exit slides suggested the idea of two climbers climbing side by side in parallel or in mirror images:

Figure 18. Carsten Holler's twin slides, which formed the exit from his exhibition "Decisions" at the Hayward gallery in London

Based on these ideas a more or less deductive process was followed to arrive at the decision to build an octagonal roundel.

1) A climbing structure was needed to test these ideas. Local climbing centres would not agree to set custom routes, so one had to be constructed.
2) A transparent cuboid or roundel shaped structure would allow for most of these ideas to be tested.
3) Transparent materials (polycarbonate, structured glass) are expensive. Most of the structure would need to be made from wood.
4) Wood comes in sheets of standard size. Therefore a regular polyhedron would be best
5) An octagon would be roughly the right size, self-supporting and circular enough to allow for continuity of movement. Projectors could be used to project on to two of its panels

Nevertheless this process was supported by looking at street furniture. A metal skip and a wooden barrel provided insight for steps two and five respectively.

Figure 19. A cuboid shaped metal skip outside the Glasgow School of Art

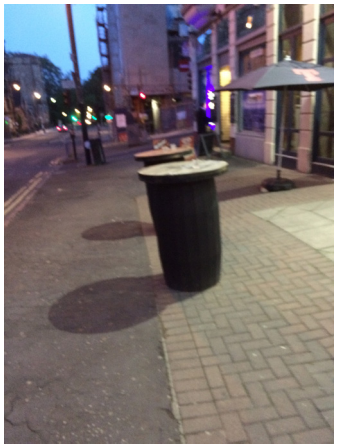


Figure 20. A street table adapted from a barrel in Glasgow

Experiments

For the purposes of experimentation, an octagonal “roundel” was constructed in a studio at the Glasgow School or Art (see appendix A for details of construction). It was not possible to include a transparent section in the roundel as had been hoped. This prevented testing of the transparent climbing wall idea.

Figure 23. The completed prototype ready for testing

Three routes were set:

1) Green, an easy route (French 5 /5+), in mirrored form along the central access of the roundel.
2) Purple, a short mirrored bouldering problem, graded approximately V1 or V2
3) Orange and Blue, a pair of identical routes around the roundel, set two panels apart, to allow one climber to follow another.

Figure 24. A panorama of the inside of the roundel, showing route setting.

These can best be illustrated on a diagram:

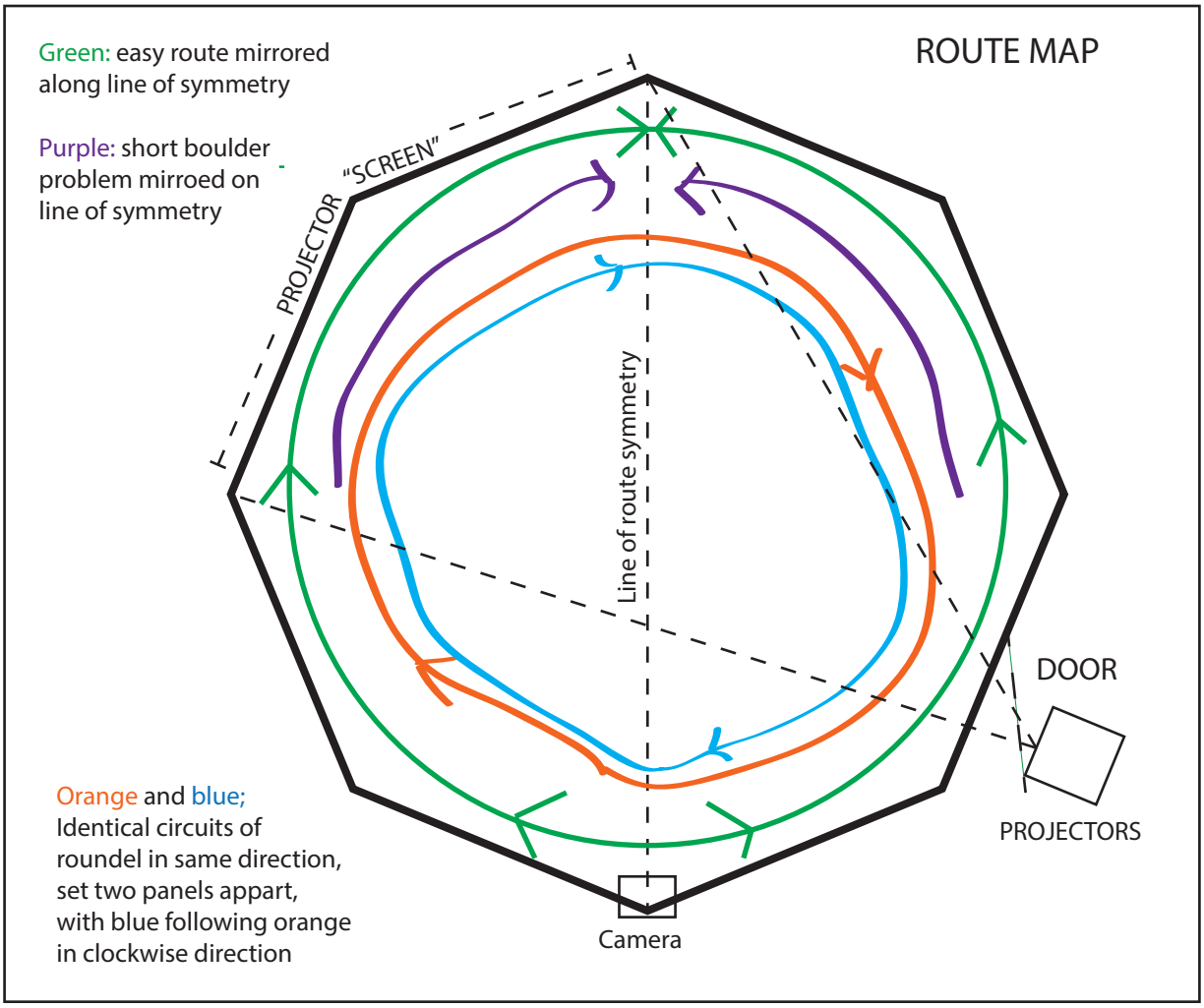


Figure 25. Map of climbing routes on inside of roundel, showing position of door, camera used for recording of experiments and projector and "screen" position.

Seven test subjects were recruited, of varying climbing abilities; DP, a very competent boulderer (V9), TH, a good climber (French 7a+); FU, an experienced climber (French 7a+), accompanied by AS; VL, a complete beginner with experience of dance; ES, an intermediate climber (French 6c), and JL, a relative beginner. These subjects were all members of the Glasgow Climbing Centre and so were aware of the safety implications of climbing. They were briefed verbally on the risks and the experimental procedure.

The following experiments were carried out:

A) Mirrored climbing in opposite directions around roundel on the green route, with one climber leading and one following:

Figure 26. Mirrored climbing on the green route

B) “Follow my leader” climbing around roundel in the same direction on the blue and orange routes, with the following climber imitating the leader.

Figure 27. “Follow my leader” climbing on blue and orange routes.

C) “Pursuit climbing” - starting at opposite sides of the roundel, moving in the same direction and aiming to catch the other climbing, for speed development (with no need to copy movements)

Figure 28. Pursuit climbing on the green route

D) Climbing with previous climber projected on to the wall, mainly using the purple problem. Three variations of this were used:

a) climbing on top of the projected climber
b) climbing on the mirrored holds opposite the projected climber.
c) using the projection as a preview of the route

Figure 29. Climbing on top of a projected climber on the purple holds

E) Musical hips: climbing singly and in pairs with a mobile phone running the “Sound wand” application (see appendix B for details), calibrated to produce musical notes depending on the orientation of the hips. This was intended to encourage awareness of hip movement in climbing, (Good technique often involves orientating the hip before making a movement rather than at the same time).

Results

Experiments A, B, C and D worked well. Experiment E failed: the sound was far too confusing, especially when two people climbed together. A summary of results is given below, containing both my observations of the effectiveness and comments from participants.

Experiment A: Mirrored climbing

DP: “It was hard to keep track of where you were.”
DP: “Good, because it felt awkward, which is actually something I’m trying to. I’m getting some coaching. As a warm up I’ve been told to climb some easy problems and then remove some holds or remove some techniques [...] the point is to make me climb outwith my style. It’s forcing me to try another language.”
TH: “It’s tricky cos you’re fighting yourself [...] because I climb a lot, it’s quite difficult [...] especially if it’s not something you’re really struggling with, I just have the way I’d do it”
TH: “it would be useful to have coloured wrist and ankle bands”
TH: “The angle of view is really good for the first two panels
FU: “It’s difficult to tell which climber is which [...] it would be like tango and you’re back to back and can’t see each other”
ES: “It’s weird because you have to look behind you to see the other person”
ES: “It’s nice to see the other person’s movement. You have much wider foot span than I do, or at least you use a much wider span. It’s not in my climbing. It’s cool to see that”.
JL: “what I found interesting [...] it’s like synchronised swimming, you’re trying to get into the other person’s mindset”
VL: “I’m the wrong person to do this[...] I’m too short

Observations: climbers would sometimes talk to each other to explain what they were doing. There were also clear differences between climber’s abilities to read the bodies of other climbers.

Experiment B: “Follow my leader”

TH: “It’s nice because you’re always looking in the same direction, and you’re copying exactly rather than trying to work out the mirror.”
TH: “That route’s harder. Looking while not falling off is much harder”
FU: “It’s easy cos I can see you right away”
FU: “Since we’re both experienced climbers [...] I basically did it the way I would do it. There were not that many different options”.
AS: “It looked much smoother”
FU: “I do like the concerted movement, because it’s not a way that you climb usually. That’s really nice”
FU: “It’s like in ballet, the worse climber has to follow the better climber.
ES: “It’s ok until it gets too hard, cos then you’re forced to move into what your body wants.”
VL: “there were some things you did that I physically couldn’t do”

Observations: this made sight lines easier. Most people found copying without mirroring easier.

Experiment C: Pursuit climbing

TH: “It’s very dangerous [laughing]. It’s good fun though”
TH: “Very good for endurance training. You just keep going until you catch somebody. You’ve got this real drive”.
TH: “I think you’d want some stouter crash mats, cos you take risks that you wouldn’t if you were trying-to work out the problem”

FU: “Nice, you do things much more naturally. It’s fun”
ES: “I did a few moves that I wouldn’t ever have normally done. Like feet out [off], because it’s so juggy”
ES: “It’s fun to see at what point you get exhausted.”
ES: “It has the feeling [of being] in the flow. It [then] reduces [...] I would try next time to stay focussed”

Observations: this was a very fun exercise, and attracted attention. Among good climbers it was interesting to notice differences in looseness.

Experiment D: Projected climbers

DP: “This would be great for sponsors [...] now if you don’t video something [a problem you complete] it’s like it didn’t happen”.
DP: “It would work well on [training] boards [...] often you look at the instructions for the route but [...] you can’t work out how they’ve done the movements”
TH: “I think if there were some audio accompanying his moves that would help”
TH: “It’s very difficult to climb on top of the projection”
TH: “It needs to be not mirrored” [of climbing beside the projected climber]. “if somebody was stuck on a problem you would never show them the mirror. [...] as soon as your brain gets tired
VL: “It’s difficult [...] I would need to have the time to memorise it.”
VL: “It’s a good idea”
VL: “It’s really hard to see the feet. It works for hands”

Observations: climbing in front of a projected climber is very difficult. The best use for this arrangement seemed to be having somebody climbing with the projection in front of them, and somebody else observing the differences.

Experiment E: Musical hips

TH: “It think it’s more of just a distraction to be honest.”
TH: “I’d imagined [it would be] a particular tone you were trying to get, like when you’re trying to teach somebody an instrument”
TH: “It’s a good idea in theory but it doesn’t work”

This experiment was abandoned for other participants owing to its clear failure.

General reactions to the structure

TH: “you could sell this”
FU: “I like the formal solution”
VL: “In another country you could install this in people’s gardens”

Commentary

Several climbers commented that these exercises encouraged them to consider ways of climbing that they did not normally use; that were not part of their normal vocabulary. This was especially true of DP, who is being coached to seek such behaviour. FU was more conservative about adopting other people’s movements. This suggests that the effectiveness of these methods in transferring kinaesthetic ideas may depend on the disposition of the climber as well as on the nature of the exercise.

It was also very notable that beginners struggled with the routes set, and experienced climbers found imitating harder when they were stretched by the climbing. This agrees with the idea found in research that kinaesthetic learning works best at lower levels of intensity.

Conclusions, limitations and further work

This project has shown that there is potential to create environments to encourage imitative learning in climbing, and that these can been engaging as forms of training, succeeding in exposing climbers to habits of movement beyond their usual repertoire, a common goal in climbing training (MacLeod 2009) It appears that this process works best when climbers are training away from their limits (where focus narrows to the self). The experiments also worked best with more experienced climbers. Beginners tended to be too overwhelmed by focus on climbing to concern themselves with other climbers. In all cases, sight angles sometimes caused problems. Circular imitative and pursuit climbing were found to be able to help increase the intensity of climbing training.

In methodological terms, projection of ideas between domains proved a good method of creating "meaning innovation", in this case by introducing notions on kinaesthetic empathy from other sports into the design of artificial climbing installations. The notion of the "experimental system" proved valuable, and was effective in generating unexpected events and ideas. Some ideas produced by the experimental system did not necessarily relate to imitative learning (see "applications" below). Thus the climbing installation can be reasonably said to embody knowledge beyond the original question: it serves as a novel[1] small scale climbing installation in its own right. To paraphrase William James, it "unstiffened my theories, limbered them up and put them to work." (James 2012 p27).

Limitations

This project was necessarily limited by its short running time and limited empirical evidence. Its conclusions are necessarily probabilistic in nature. More specifically:

1) Cost of materials prevented the testing of some experimental ideas, such as a transparent climbing wall.

2) Lack of time (especially given the time required for construction of the prototype) and technical complexity prevented the testing of side by side or overlain videos[2] to follow up on the projector experiment.

3) Testing was done with a very small sample, and no attempt at quantitative measurement of improvements was made. Reliance on accounts of experience does not necessarily give a good indication of the effectiveness of the methods tested.

4) Repeated testing was not carried out over a period of time, precluding study of adaptation, engagement, skill acquisition and training effects over time.

5) In climbing terms, the test installation was limited to low level "traverse" climbing". Repeated training in this way may have a detrimental effect on "vertical" climbing ability (MacLeod 2009).

Design applications

Two significant design possibilities for climbing have emerged:

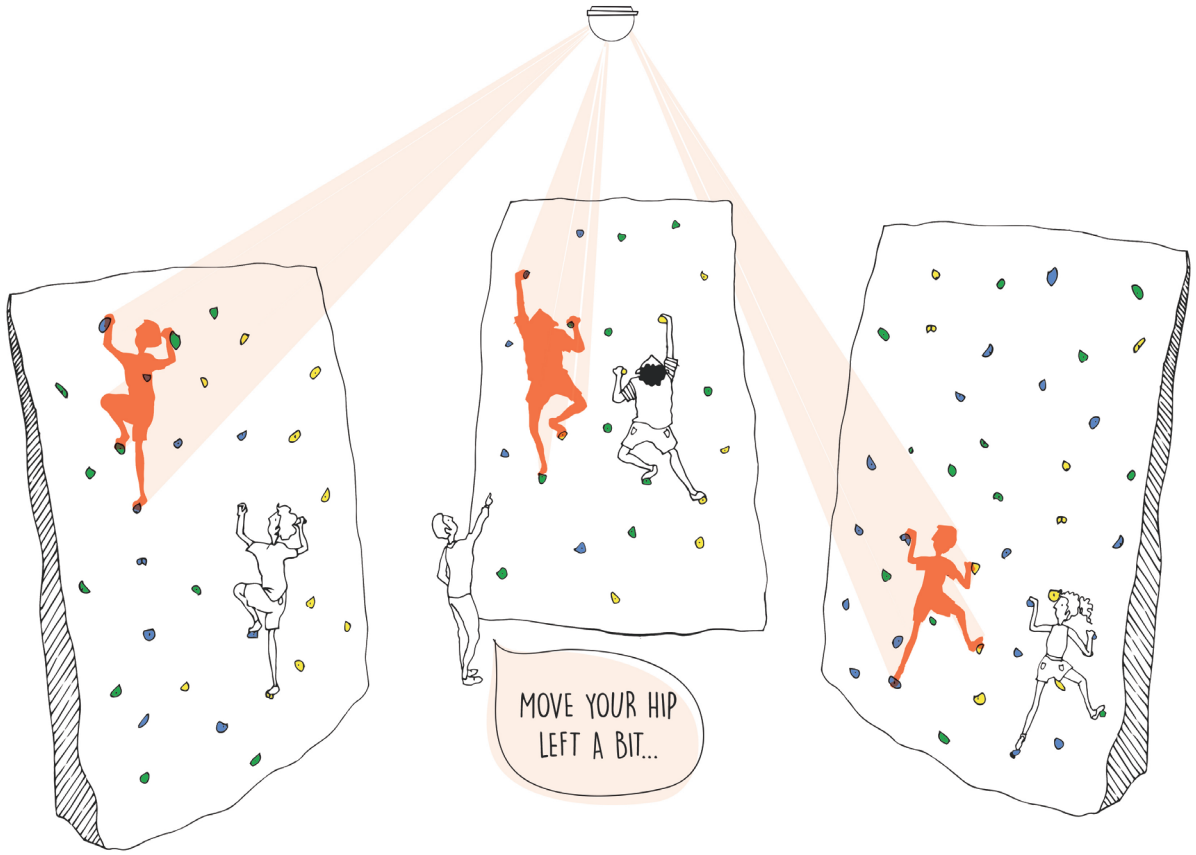
a) A roundel shaped climbing installation is self-supporting and mechanically efficient, and appears to facilitate forms of training not generally practised in existing facilities. This form could be developed in existing climbing centres, or as a stand-alone installation for other contexts (gardens, workplaces). It could be used for both imitative and solo climbing. The concept could be developed by including a "roof" section, or inward sloping panels, allowing for training on overhanging climbs. Mirrors or transpar-

1 Novel, or perhaps innovative, because I can find no reference to such a structure being built before.

2 Although an application for doing this was identified in the form of Hudl Technique (see http://get.hudl.com/products/).

ent walls could provide additional lines of sight.

b) A combined system of video recording and projection could be developed to facilitate climbing training and kinaesthetic learning. Technological advances in fields such as laser projection, combined with the ubiquity of “smart” mobile phones able to connect to local wireless networks, and 360 degree cameras[3] could make this a realistic possibility for existing climbing centres. Such technologies could have significance in an age in which social and sponsor recognition of climbing achievements often requires video evidence. Projection could also be used as a means of improving audience experience as rock climbing seeks wider recognition as a spectator and Olympic sport.



Further research

The notion of kinaesthetic empathy could have interesting applications in fields such as physical rehabilitation, or perhaps in treatment of fear of heights or autism.

Further work on easy to use Video based methods for climbing technique comparison would be worthwhile, including the side-by side projection of different climbers. This idea could also be applied in areas such as dance training.

It would also be appropriate to carry out further testing of the effectiveness of the applications described above, perhaps with the co-operation of an existing climbing centre.

3 E.g. the recently launched Pcuk 360 camera - see http://360puck.com/

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Appendix A: Prototype Construction

The prototype environment was constructed using advice from Robin Smith (2002) published on UK Climbing's website and with help from the Glasgow School of Art's workshop. Construction took place in the department of Sculpture and Environmental Arts' (now former) Haldane building studios, before the structure was relocated to the first floor of the same building for testing.

Materials

8 x exterior plywood sheets (2440 x 1220 x 18mm)
120 x M10 t-nuts
120 x 40mm M10 cap bolts (8mm allen key fitting)
25 x 135 degree angle brackets, made from 50 x 8mm strip steel
100 x M10 nuts and bolts to attached brackets
3 x expanded polystyrene insulation sheets (2440 x 1220 x 50mm, for floor padding)
Corrugated cardboard (top surface for floor padding)
2 x door hinges (for door)
3 x sliding latches (for door)

3 sets of mirrored climbing holds ("Core" range, for mirrored routes, supplied by Core Climbing - see http://www.coreclimbing.co.uk. Mirrored climbing holds are surprisingly hard to obtain.)
2 identical sets of climbing holds (for parallel routes, sourced from eBay)

Construction method

1) 135 degree angle brackets were made in the workshop in a three step process:

a) Strip steel was cut into 25 x 40 cm lengths
b) Four 13mm holes (for M10 bolts) were drilled into each strip
c) Each strip was bent through 45 degrees half way along its length.

2) Plywood sheets were attached together using the 135 angle brackets, three per join (mounted at top, middle and bottom). A wooden crutch was created to maintain the correct angle and support the sheets while bolts the brackets were mounted. Bolts were initially kept loose to accommodate inaccuracy in construction.

Figure 32. Cutting of steel strips to form brackets


Figure 33. Example of steel bracket


Figure 34. Joining of plywood sheets to form octagon

3) Once this process was complete a small door was created, the width of half a sheet and the height of half a sheet, between the lower and middle brackets. The door was outward opening, with chamfered edges to prevent it from opening inward. (Outward opening was favoured to prevent the risk of injury through falling on top of an open door, despite the mechanical disadvantage of this when outward force is applied to the door through feet when climbing). The door was held in place with two large hinges and held closed with three sliding bolt locks mounted on the inside (to prevent use as a prison cell).

Figure 35. Addition of a door to the structure

4) Subsequently holes for more mounting climbing holds were drilled into the panels follow a regular pattern. A cardboard template was used to drill these. Using a good quality drill bit was found to help prevent the plywood from splitting. A symmetrical pattern of holes was used to allow for flexibility in creating mirrored climbing routes. T-nuts were hammered into position in each hole.

5) An experiment with using sheet polycarbonate to create a transparent section of wall proved unsuccessful: The 6mm sheet acquired was mounted but proved too flexible for use.

6) Holds were then fitted to the holes to form routes, attached using 40mm M10 cap bolts with 8mm allen key fittings (using this style of bolt proved essential to make holds grip the plywood. Countersunk bolts did not work).

7) 50mm sheet expanded polystyrene was used to create impact protection on the floor. Corrugated cardboard was laid on top of it to distribute load. This proved a cost-effective means of creating impact protection.

8) Lastly coloured tape was used to mark points of symmetry between the panels and holds.

Figure 36. Roundel structure with t-nuts fitted to allow climbing holds to be added

Figure 37. A polycarbonate sheet fitted to try to create a transparent section of climbing wall

Figure 38. Fitting of polystyrene foam floor covered in cardboard following the fitting of holds

Appendix B: Equipment, software and code

Projected climber prototype

The “projected climber” prototype was set up using two Viewsonic PJD7820 projectors, each capable of producing a light output of 3000 lumens, and each projecting on to a standard 2440x1220mm plywood sheet. This proved adequate in a well-lit studio environment, especially with some shading from direct light, with the projectors placed side by side approximately 4 meters from the wall.

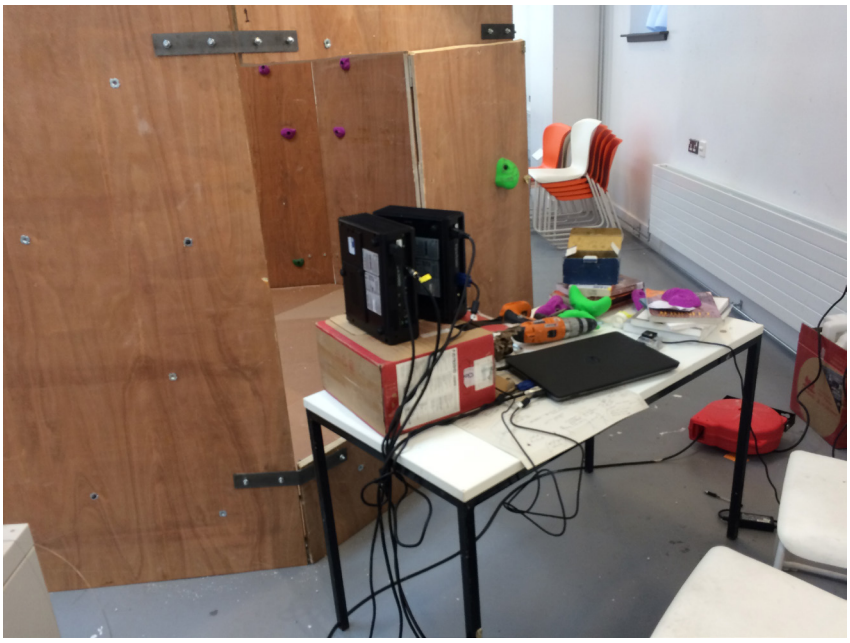

Figure 39. The projectors in position, projecting on to the back wall of the roundel

Climbers were recorded using a GoPro Hero 4 black camera, filming at 30 FPS, 720 pixels wide, on medium field of view setting. The camera was placed directly on top of the projectors.

It was important to keep the projectors and camera fixed in consistent position so that recordings would superimpose on the wall consistently.

Videos were transferred from the camera to a computer via a wifi connection, which proved slow. An alternative model of camera may help here. These were projected using the connected projectors, with Processing (v2.2.1, available at https://processing.org/download/?processing) used to control the video playback. The Keystone library for Processing was used to handle the alignment of the video on the two climbing wall panels. This allows for fine control of the alignment of the projections as well as control of the choice of videos and their speed and transport controls.

It would also allow for bluetooth remote control of the projection (using a mobile phone application), although this was not implemented in practice.

The processing code is available at http://beanbox.org/imitationgames/projection.pde.

Musical hips prototype

An iPhone application called “Sound wand harp” was used for testing (see http://soundwandapp.com/). This was installed on two iPhone 4 mobile phones. The phones had to be orientated horizontally in use, in a seat pocket of the climber’s trousers or shorts, or in a phone holder. The software was set to work in hands free mode. This proved adequate to test the concept, though in practice a more sophisticated controller would be required. The MIDI controller version of Sound Wand might be suitable for this purpose, although it is likely that a smaller “wearable” would be used.

Kinect climbing test

A Microsoft Kinect model 1414 was acquired along with a power supply for connection to a PC. Processing v2.2.1(see above) was used along with the “Kinect4winSDK” library for processing, available at http://www.magicandlove.com/blog/research/kinect-for-processing-library/. The standard sample code available on this site was used for testing.

Accelerometer testing

Accelerometer testing was carried out using iPhones attached to the body using Velcro strapped cases. Data were collected using Sensor log software, and visualisations created using the d3.js library, following the same method described in Hughson (2014). Three dimensional visualisations of accelerometer data were created using the three.js library.[1]

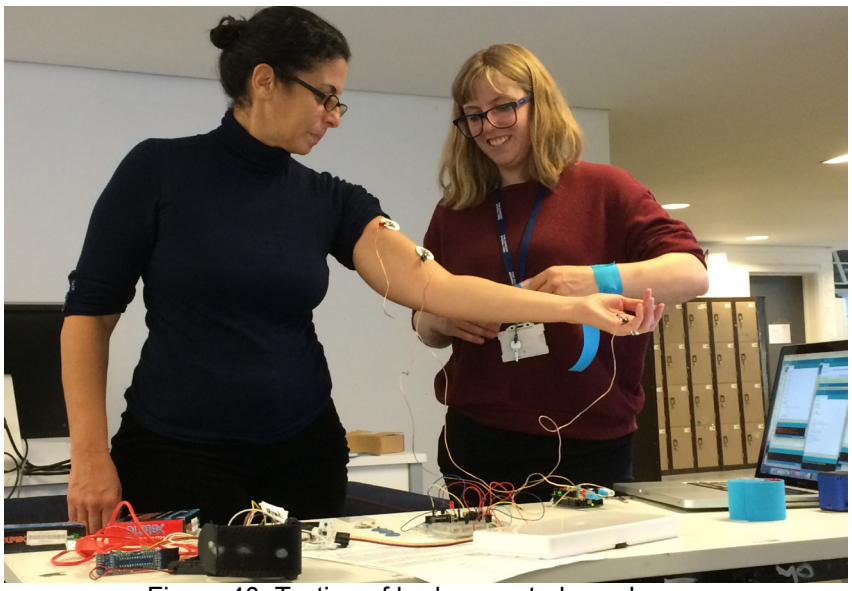

Figure 40. Testing of body mounted accelerometers at an “Art School IO” workshop.

1 See http://threejs.org/.

Appendix C: Details of interviews

Interviews with climbers

The key findings from the interviews with climbers are summarised below. These interviews were semi-structured, and focussed around factors which influenced climbing ability and learning,

Darren is an experienced, committed and highly competent male boulderer[1] (font 7b+), and has recently started a formal training programme with a coach. Key ideas to emerge were that having started work with a coach had forced him to change his habits, making him more structured in his work. He also described that he had started working harder physically because of this: he now sees that he had become "stuck" in a habit of making only a certain level of effort beforehand. He mentioned that the presence of other climbers can be encouraging, particularly when solving a problem together, but also discouraging: he becomes intimidated when climbing with people he knows to be better than him.

Tom is a male regular rock climber (French 7a+). He noted that climbing with people who are better than you is the best way to climb. He said that although his technique is "not the best", he has a relatively fearless approach which helped him out.

Rusty is a male rock climber (French 6c+) who formerly practised martial arts. He climbs because of its sociability and because it is easy to practise with people of differing abilities. Recently he has been trying to challenge his climbing habits by changing venues and partners. He noted that in martial arts training students stand behind people who are better than they are, facilitating imitation.

Simon is an experienced climber and also father of two members of the Scottish youth climbing team. He noted that his children have progressed extremely quickly through training in a team and have easily surpassed his technical ability. He mentioned that their coach has them watch videos of high-level climbers the night before competitions to improve their performance.

Marc is an experienced former climber (French 6b+) with particular experience of guiding beginners. He mentioned that variety of climbing partners is key to progress. In particular he suggested that male climbers could really benefit from climbing with females, who have less strength and therefore use better technique. He said that body awareness was a problem for many climbers. He also mentioned that a "minimum sufficient co-ordination" is necessary for a certain level of climbing.

Interviews with other professionals

Semi-structured interviews were also carried out with people involved in teaching other sports and dance forms. These focussed on methods used to improve awareness and variety of technique in teaching and in practice.

Maite Delafin is a professional contemporary dancer and student of dance science. She described techniques used in dance improvisation to create variety, where the key problem is to break one's habits of behaviour. Techniques used include "Brian Eno cards"[2] to break habits, abstract draws to dictate some feature of an improvisation, such as line to indicate the height of movement without dictating its speed, and observation by partners, often considered more accurate than using one's own eye, which may not perceive the same things.

Enid Still, former manager of a school specialising in performing arts in India, discussed teaching meth-

1 A form of low level rock climbing. See "Basics of rock climbing" in the preceding section.
2 See http://www.rtqe.net/ObliqueStrategies/ for details.

ods used. As performances could be up to eight hours long, narrative was used to assist with memory. Initial teaching was done by a guru with students sat in a circle. Live (oral / visual) transmission is traditionally used (rather than videos or audio recordings). Songs would be taught a line at a time, with students echoing the lines. Dance could also be taught in circles, with students copying the student in front. She also mentioned that children would invent pieces themselves without "expert" assistance from teachers.

Denry Aal is a swimming coach and trainee outdoor instructor. He said that coaching swimming could be difficult if people did not have an awareness of technique, but rather insisted on using power to move. He suggests that removing pressure to perform is important to improving technique. It is necessary to develop an internal representation of the kinaesthetic process, rather than an internal (perhaps visual) one. Mastering balance is important, and this is best done by feeling how movement of body parts affects it. He uses imagery like pendulums and boats to assist this process.

Lucy Wild is a contemporary dance teacher. She said that touching people's bodies is an effective means of teaching them and developing awareness of differences in feeling. Students need to develop control of weight and momentum as well, but this takes time. Partnered work can be very effective. She stressed the importance of appealing to instinct in movement by not giving people time to work things out. Also she suggested that competition could be a useful driver for improvement (e.g. "how few steps can you take to cross the floor?"). Restrictions could also be applied, such as focussing on high, medium or low levels.

Damien Thompson is a professional tango teacher and with extensive prior experience of martial arts[3]. He stressed the idea that mimicry is the essential means of learning, with approval and disapproval coming through body language (and physical contract) as much as words. He stressed that energy comes from the other person in martial arts, and that this idea applies in tango too. He had applied ideas from his martial arts training to his learning of tango, and this greatly improved his technique. Previously he had learnt by watching instructional videos, but this had produced a forced style. Nevertheless he suggested that comparison of videos over time is a great way to observe improvements in technique. He explained that different students had different learning styles: some analytical, some artistic. Some learnt verbally, which is slowest, others visually, which is quickest, and others kinaesthetically.

3 See "Getting to know Damian Thompson" (2012) for some background on Damian.

Appendix D: Personal development

A major difference between this and previous "studio" work undertaken on the course was that this was a solo project. This provided both freedom, in that decisions could be made quickly, but it also removed balancing effects. In particular, while I enjoyed the freedom to explore ideas early in the project, it took me time to find effective means of organising these ideas. Maintain a blog with details of progress helped, but I would still benefit from keeping more organised written records. While our studio's culture over the summer could have been stronger, relationships with co-students were still a significant help.

Timekeeping proved to be a significant problem, especially early on in the project. On one occasion I was late for an interview, which meant it did not go ahead. I became better at managing my time as the project progressed. Another problem was producing good illustrations and graphic design work. I sought to remedy this to some extent by trading my ability to code for Ottavia Pasta's excellent drawing skills.

I gained satisfaction from the construction of the prototype, and noticed that practical work had a considerable effect on the ideas that I produced. For example, I did workshop training in metalwork and welding over Easter, thinking it would merely be for personal interest, but found myself using these skills during the construction of prototypes. Moreover, having such competence made it easier for me to put myself in a "making" environment, where exposure to the ideas of staff and other students was often inspiring: an example perhaps of a constructivist approach at work. Equally the feeling of permission and legitimacy engendered by the sculpture and environmental art department's lending me of studio space was liberating.

I also now have a stronger belief in the value of artefacts as carriers of embodied knowledge - or perhaps as epistemic objects. This is perhaps a useful counterpoint to the excessive focus on ideas that I had early in the project.

Attending an academic conference (Creativity and Cognition 2015) early in the project was also a key moment. It gave me increased confidence in my critical thinking and abilities, insofar as I was able to analyse ideas presented and understand why I liked some and not others, irrespective the formal academic presentation. This exposure to a wide range of thinking really helped my creative thinking: solipsism is a bad thing for designing.

A parallel can be drawn here with the ingredients for good climbing: there appears to be parallel between good kinaesthetic thinking and design thinking, in that both benefit from exposure to the ideas of (selected) others as well as from focussed work. While my climbing abilities may have suffered through lack of practice during this project, I hope there have been some compensations.