An Anthropological Move Towards Tangible Interaction Design

ABSTRACT

User interaction design has for many years been concerned with the skills required in operating computers and machines. For keyboard and mouse operated, screen-based user interfaces the main focus has been on the cognitive skills of humans.

This paper takes as a basic preamble that a shift from keyboards to tangible interaction design requires one to study the skills built through bodily movement. The emerging field of Anthropology of Movement can help in studying and understanding human movement.

With inspiration from anthropology, philosophy and sociology, I have analyzed a short video sequence of a plant operator operating very tangible machinery. Tangible interaction can be regarded as a series of discrete actions, but based on the analysis I will argue that the movements in between the hands-on actions are crucial to understanding skilled user interaction. Possibly designing with respect to the in-betweens - when the body adjusts towards the next action - holds great promise for making tangible interaction design a success.

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INTRODUCTION

Keyboards and computer mice may be adequate user interfaces when interacting with laptop or desktop computers, but the fact that computers are moving away from desktops and becoming embedded in artefacts and environments calls for a revision of the way we as designers look at interaction. In our group at the Mads Clausen Institute we have developed a deep interest in human movement and how movement relates to interaction. We are intrigued by the way that the acquisition of skills through movement can make interaction second nature, and lured by the idea of transferring such qualities into design of tangible interaction.

The body has generally been neglected in interaction design. Until recently, the dominating focus has been on cognition, with only little regard of the dexterity with which people can manipulate objects.

To deepen our understanding of human movements and to find inspiration for novel interaction we have made extensive use of video as a rich source of information. Though Gibson [5] is talking about movies, I think it is also true for video that the use of filmed material will give us a fair chance to empathize with what we see: 'We are onlookers in the situation, to be sure, not participants, but we are in it, we are oriented to it, and we can adopt points of observation within its space.' [5, p. 298] Digging into the details of movements we have been able to describe them, express qualities and create rich metaphors that can be used to inform and inspire the design process. In previous work we have focused on single movements of hands in the (maybe naïve) belief that all we need are richer movements to replace the trivial button pushing of current user interfaces. [1]

The goal of this paper is to expand *this* view of interaction to look at more complex sequences of movements, and at human skill building as an important building block for enjoyable tangible interaction. For this we need a slightly different approach to video analysis than we have used so far. From looking at qualities in discrete movements [1], we now need to broaden our view; what are the implications of movements, what leads from one action to the next, can we make sense of it?

This paper is based on the analysis of a 19 sec. video sequence showing a skilled brewery operator performing a sequence of very physical actions when interacting with a machine in the brewery. Noting the details of the single movements helps defining the sequence as a whole, but a detailed analysis of the entire flow of movements is necessary to get closer to an understanding of what is actually going on and how that knowledge can be used to inform the design of tangible interaction.

The introduction to the work of Tim Ingold and his essay 'Up, Across and Along' [8], provides a clue to possible ways of gaining further insight. In particular the metaphor of the wayfarer helps to shed a new light on the video clip. This insight is discussed with Suchman's notion of situated actions

[12], followed by a delegation of the work, between human and non-human actors in the video clip, in order to bring the analysis further. Strauss's theory of action [11] has proven to be valuable to deepen the understanding of movement and to inspire principles for tangible interaction design. The paper will close with a discussion that seeks to identify possible design principles.

WHAT IS A MOVEMENT?

'We come into the world moving; moving and feeling moved to move are what are gone when we die.' [10, p. 275] In this short sentence Sheets-Johnstone states her understanding of movement. This statement differs from the understanding presented in philosophy, namely that movement is something that is forced upon the body and action is what the body is able to by itself. Throughout this paper, my understanding of movement will be closer to the first rather than to the second. Reading this paper one should think of movement not simply as mechanical displacements of the body and limbs, rather that movement is from the body, that movement is emotion and movement is expression.

MAKING SENSE OF MOVEMENTS

In previous work we have used what we call the 'Video Action Wall' [1, p 189] to make sense of the quality of movements and transform this understanding into new design principles. With a foundation in video of skilled crafts people, the video action wall allows designers to assemble video clips of particular movements and place them on a large screen, much like post-its. By shifting around the looped video clips it is possible to compare, group and characterize human movements, and designers can take inspiration for designing novel interface devices We have used part of Laban's 'Effort – Shape Description' [6] as a starting point for discussing how we experience different qualities of human movements and then moved to rich metaphoric descriptions. He distinguishes four basic components in the effort of movement. (See Figure 1)

1. The management of weight (force) - is it firm or light.
2. The flow of movement - is it free or bound?
3. The use of space (focus) – is the movement direct or indirect?
4. The use of timing – is the movement sustained or sudden?

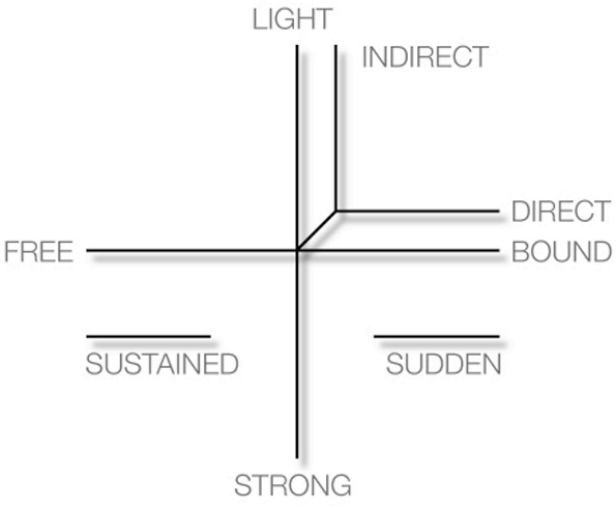

Figure 1: The Complete Effort- Graph [6, p 509]

In this way we have been able to extract qualities from the short video clips with discrete actions, and to introduce these qualities in new interaction designs. However, we have come to realize that the video action wall with its emphasis on discrete actions - when people actually 'do something' to the machine - may limit our chance to understand the full flow of interaction. This is the motivation for the present work.

MOVEMENT AND ANTHROPOLOGY

With an interest in human movements and roots in a tradition of user centred design with strong links to anthropology, we have looked towards the anthropology of movement to find an alternative angle for analyzing movements caught on video. Farnell discusses the emergence of a holistic 'anthropology of human movement' and how this nondualistic (non-Cartesian) approach has challenged researchers, not only in ways of thinking, but also in the use of new methods and tools: 'The current challenge for anthropology is to develop modes of registration and specification that will facilitate the learning and analysis of action, allow records of visual-kinaesthetic action – alongside records of speech – to become a normal part of fieldwork practice, and so lead to the presence of enacted forms of knowledge in ethnographic accounts.' [4, p. 354] Farnell proposes the use of video and a transcription system, emphasizing the qualities of the notation system developed by Rudolph Laban

Movement and Labanotation. Labanotation is a system for recording and analysing human movement, first published in 1928. Rudolph Laban based his system on natural human movement and not on a particular kind of dance, as most other movement notation systems are. The system allows the notator to choose among three different notation descriptions:

1. Motif Description
2. Effort – Shape Description
3. Structural Description

Motif writing provides means to describe a theme or the most significant features, as well as the motivation of a movement. 'Effort Observation and Analysis' is used to describe the dynamic content of a movement; the use of energy and the shape of the movement, and together they provide valuable description of the quality and expression of a movement. This is rather in opposition to the structural description, which describes in clearly defined and measurable terms; the specific body parts, the space occupied, time and dynamics. [6, p. 11]

Making sense of Laban. Hutchinson claims that 'The scientist would be lost without his symbols by which he can communicate his ideas objectively to his colleagues everywhere' [6, p. 9] In my case, I would be lost *with* the symbols and I guess most of my colleagues too, since the system consists of hundreds and hundreds of symbols that can be combined in innumerable ways. Hutchinson also stresses that the system can be used at any level and combination according to one's field and momentary needs. One can start on a simple level and expand as the need for more details grows. What is very important is how it can work as an eye-opener and a sensitizing tool in the training of movement observation. This has been my prime angle on Labanotation; a heightened sensitivity towards movement, in combination with terms expressed in a natural language. In the current project I have mainly benefited from the former, the heightened sensitivity, due to the explorative approach. As my research will come further, I can take up parts of the system to fill my needs, but for now the categories and the grammar seems the most valuable.

Movement and embodiment

The non-dualistic approach to understanding people in their world is in the centre of Dourish's 'Where the Action Is' [2].

Figure 2: The 5 points of interaction at the water station

Drawing on the work of a number of phenomenologists, Dourish stresses our embodiment in the world as the core element in understanding and making sense of interaction. 'If we are all embodied, and our actions are all embodied, then isn't the term, embodied interaction, in the danger of being meaningless? How after all, could there be any sort of interaction that was not embodied? What I am claiming for 'embodied interaction' is not simply that it is a form of interaction that is embodied, rather that it is an approach to the design and analysis of interaction that takes embodiment to be central to, even constitutive of, the whole phenomenon. This is certainly a departure from the traditional approaches to HCI design.' [2, p.102] This is the approach I will take as I make my way into the brewery video.

VIDEO AND TRANSCRIPTION

In the video sequence the camera follows the process operator Trevor in a brewery with the environment dominated by pipes and machinery in stainless steel. He is walking down an aisle with machinery on both sides with his attention directed towards the water station to his left, a small cluster of machinery, approximately 1 meter deep and 1,5 meter wide. The water station is a collection of pipes, valves and a filter tank. The function of the water station is to dilute the beer to the correct alcohol content and it is the last step in the filtration process, before the beer ends up in the beer cellars.

The video shows the third step in a procedure of four steps. Between each new batch of beer Trevor must flush pipes and filters and the filter of the water station. The pipes and filters are flushed first with hot water, then with 'caustic', then again hot water and finally cold water. In the clip we see how Trevor is flushing with hot water after the caustic, a procedure similar but not quite identical to, the preceding and the following steps.

Interacting with the water station

Standing in front of the water station with his left hand resting on a handle, Trevor now leans forward to close a valve with his right hand (Figure 2.a). Then he reaches up with his right to flip a second valve on top of the filter tank (Figure 2.b), moves it to a third valve under his left hand. He pulls the handle upwards (Figure 2.c) and moves the hand to assist the left hand closing a fourth valve (Figure 2.d). He then moves his left hand to open a fifth valve on the left side (Figure 2.e) and steps back. In this sequence he operates 5 out of 8 valves on the water station.

What is not visible in the video is the fact that Trevor 'pushes' the caustic out of the pipes with the hot water; he does not open a valve until enough pressure has built up in front of it to provide an efficient push.

At this point I have to say that what Trevor can do and what actions he can take are naturally restricted by the fact that it is a brewery he is working in, and that the design for the layout of pipes and valves has been made as it has. What he makes is beer, but what he does is basically to move fluids from one place to another in a particular succession. To enable him to do that he has a number of pumps, pipes and valves at his disposition and though he is rarely in actual contact with the product as such, the quality of the beer is still influenced by the way that he interacts with the afore mentioned objects. The social aspect also has implications; I guess there is a limit to how flamboyant and expressive he can be in his actions, according to local 'rules' governing in the brewery and the fact that he is acting in front of a camera. Nevertheless it is my conviction that Trevor, within those limits, can develop his practice to a point of perfection, and it is within those limits I will do my findings.

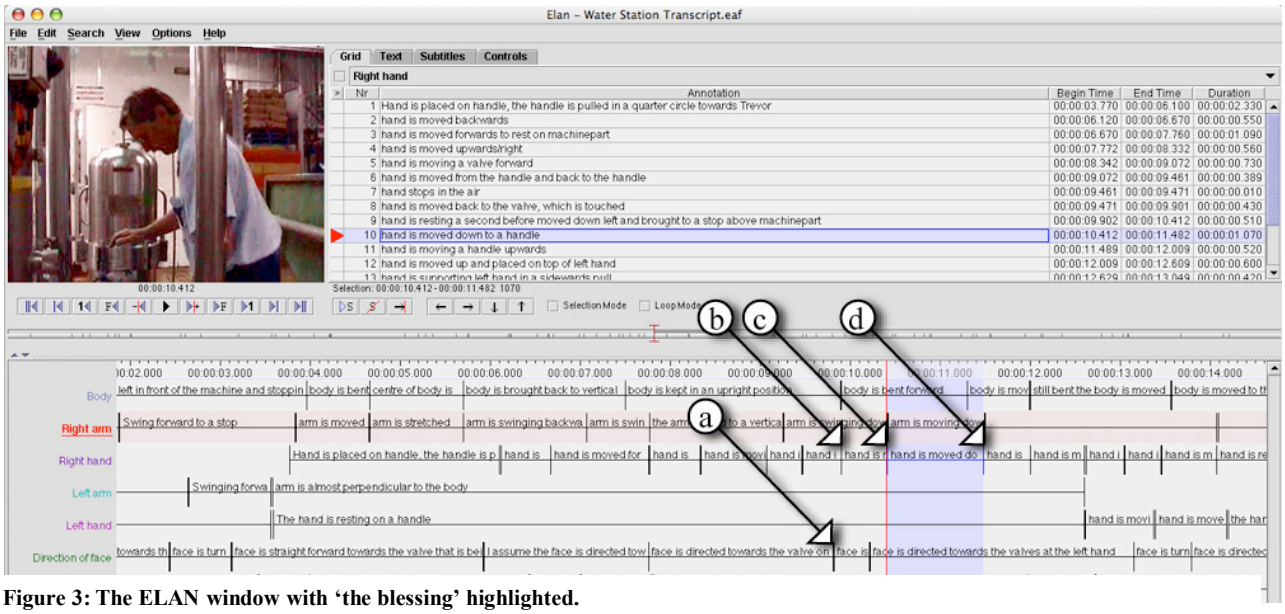

Figure 3: The ELAN window with 'the blessing' highlighted.

Video transcription

To analyze the movements I first made a transcription of the 19 sec. video using the linguistic annotation tool, Elan [3], to meticulously pin out every position and movement of limbs and body. This helped me reveal details about timing, the succession in which the different body parts were brought into use, and to making an accurate description of the sequence as a whole. I will describe two situations from the video and discuss the implications of my findings. Now, written language without the possibility of showing the video is severely limiting for describing physical movements, but please bear with me. It is a comfort to me that Sheets-Johnstone comments on the same problem saying: 'Languaging the dynamics of movement is a challenging task, perhaps so more than languaging any other phenomenon one investigates phenomenologically.' [10, p. 268 fn] In the following I will give a little illustration of an outcome of the transcription, an example I will also come back to later.

'Blessing' the gauge

At Figure 3.a Trevor starts turning his head away from the valve he just closed and at Figure 3.b he starts moving his hand downwards. At Figure 3.c, which is where the cursor is, he holds his hand in the air above a gauge 'blessing' it, as it can be seen in the window. He continues to move the hand downwards until he grasps a handle at Figure 3.d. This could be seen as simple displacement of the hand from A to B, but the fluency with which the action is performed, as well as the timed adjustment of the body posture, tells me that this is indeed a skilled practice. Before this little section, moving his hand to the valve first referred to, Trevor briefly touched the gauge that he later 'blessed', but the little stop in the air above the gauge convinces me that this is a reflection and adjustment to his movements in the action. I am here dealing with a skilled person acting in the environment in which those skills were incorporated. What at a first glance could look like a sequence of programmed actions is indeed a fluent succession of continual adjustment to the situation.

MOVEMENT AS SKILL BUILDING

Ingold advocates five qualities of human skill, which can help, elicit the elements of skill and skill building in the video sequence:

1. Hands, eyes, tools are not used; rather they are brought into use through patterns of dextrous activity.
2. Skill is a property not simply of the human body, but of the total field of body, mind, and richly structured environment.
3. Skilled practice is not just the application of mechanical force to exterior objects, but entails qualities of care, judgement, and dexterity.
4. Skilled practice is learned through introduction into contexts that afford selected opportunities for perception and action, and through scaffolding, rather than through representations and schemas.
5. Making arises within the process of use – the creative process of environmentally situated and perceptually engaged activity – rather than in the design that precedes it. [7, p. 353]

Looking at the video from this angle, what strikes me first is the framework created by the layout of pipes and valves and how this together with, what seems to be, a natural sequence of actions, supports the process operator in his work. The second thing that strikes me is how the different valves are dealt with, it seems that each valve has its own character and hence requires different handling. I do not see a simple application of mechanical force, but rather a reflection on the state of the system, an adjustment of the action as a feedback to the situation.

WAYFARING AND TRANSPORT

At a seminar at the university of Southern Denmark, Tim Ingold introduced us to his fascination of the line. [8] He discusses relations between the line and three different fields, namely movement, knowledge and description. Ingold contrasts the movement *along a line* with movement *from point to point* across a surface and uses the term 'wayfaring' for the first, and 'transport' for the latter. (See figure 4). He uses a similar dichotomy for knowledge and description, namely that knowledge used to be thought of as *growing along a line*, but now seems to be thought of as something that is as *being built up in a spot[8, p. 7]*.

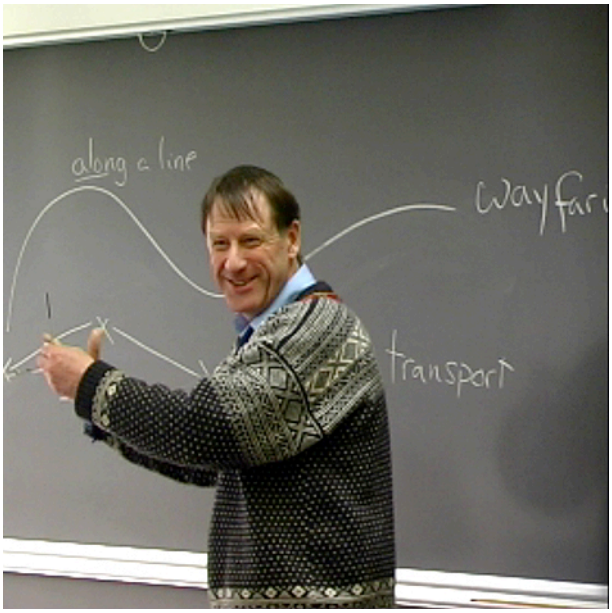

Figure 4: Tim Ingold is presenting 'wayfaring' and 'transport'

Wayfarer and tourist

To illustrate the idea of wayfaring, Ingold introduced the line in Figure 5.a. The wayfarer walks along, comes to a place and hangs around, walks to another place and hangs around there for a while. The little knots represent the rests on the way, but the wayfarer is in constant motion, the movement never really stops. Where the wayfarer rests is where the tourist jumps into action. As in Figure 5.b he jumps from place to place but unlike the wayfarer who is constantly adjusting his locomotion to the perception of his environment, for the tourist the bond between locomotion and perception is broken.

Having looked at the actions in the video sequence very much as point-to-point or as 'transport' with little 'somethings' in between, it now made sense to look at it as wayfaring and in this way give equal weight, and thereby full justice, to the in-betweens.

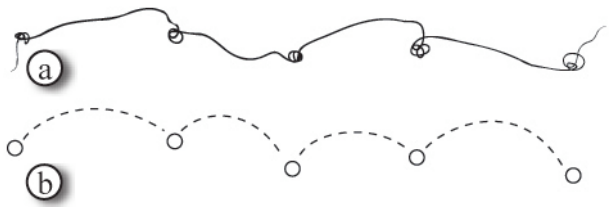

Figure 5: The 'wayfarer' and the 'tourist'

Figure 6: The interaction sequence viewed as wayfaring.

Movement as Wayfaring

Looking at Trevor, or maybe rather his hands, from a wayfaring point of view, I will regard the places in which he interacts with the system as the 'rests'. See figure 6. In those spots, I will be able to explain what he is doing without much discussion, namely that he is opening or closing valves by either turning them clock- or counter clockwise, up or down etc. The in-betweens on the contrary are a challenge.

Blessing the Gauge. This example has been thoroughly described earlier in this paper to emphasize the skills aspect, but is mentioned here to highlight the challenge of the in-betweens. (See Figure 7)

Figure 7: Blessing the gauge

Between Two Valves. In one instance Trevor closes a valve, moves his hand but returns it to the valve, he returns to the valve to make sure that it is properly closed; he needs the feedback from the handle to make sure that the system is in the desired state before proceeding to the next valve. Figure 8 shows where Trevor is making sure the valve is closed, but with his attention turned towards the next valve.

Figure 8: Between two valves

Resting the Hand. Since Trevor approached the water station, his left hand has been resting on a valve as it can be seen in Figure 9, and it remains there until he has to open the valve. To open the valve he needs support from his right hand since the valve is tight (eventually see Figure 2.d.) Trevor gradually loosens the grip of the right hand as the valve opens and the need for support decreases. Trevor moves his left hand to the next valve, and his right hand rests on the valve for the remaining time of the sequence. There is a good reason for holding the hand there; the pipes are very hot since the water is 80°.

Figure 9: Resting the hand

MOVEMENT AS SITUATED ACTION

Suchman has used the example of the Trukese and the European navigator to represent two different views on human intelligence and directed action. The European navigator begins with a plan and carries through with his journey by executing every step of the plan. Should he run into trouble, he would have to alter the plan before he can continue. The Trukese navigator in contrast, sets off with an objective and responds to the conditions as they occur; his actions are situated. In this line of thought I could say that Trevor acts like the Trukese, that his actions are situated; meaning that they are 'taken in the context of particular, concrete circumstances.' [12, p.vii] If I asked Trevor what he was doing I am pretty sure that he would describe his course of interactions as I did in the beginning of this paper, maybe with some details about the purpose of the individual valve or handle, but still as the European, as a plan with clearly defined steps. In that case I could confront him with my observations; ask him whether he had planned to 'bless' the gauge or double-check the valve as mentioned earlier, I would expect a 'no', and I assume that he would prove me right, that he was adjusting his movement to the situation.

NON-HUMAN ACTORS

In the brewery different fluids are transported from place to place via a vast system of pipes. One could choose to see Trevor surrounded by pipes, valves and machinery, but with the words of Latour: 'I do not hold this bias but see only actors - some human, some nonhuman, some skilled, some unskilled - that exchange their properties.' [9] The work that is executed in the brewery is delegated among several actors, some human and some non-human. In this instance, part of the work has been delegated to actors of a more technical origin, namely valves; they are responsible for directing and controlling the beer, as well as hot water and etching fluids. The human actor has a line of colleagues with 'whom' he needs to interact. Those colleagues/actors are illiterate and deaf, and the interaction with them is rather physical, tangible. They respond only to touch, and their feedback is haptic and visual, perhaps also auditory.

Following this line of thought, I can make my way into Strauss [11] and a pragmatist/interactionist approach to interaction.

MOVEMENT AS TRAJECTORY

Trajectory is the word Strauss uses for 'The course of any experienced phenomenon as it evolves over time and (...) the actions and interactions contributing to its evolution.' [11, p.53] Viewing the water station sequence as a trajectory, Strauss's 'Basic Assumptions of a Theory of Action' provides another possible angle that can deepen the understanding of actions and interaction, and inform design of tangible interaction. Regarding the valves, that Trevor interacts with in the video clip, as his colleagues, I will highlight assumptions, discuss and reflect on my observations in the following.

Valves and assumption no. 15

'15: The several or many participants in an interactional course necessitates what Blumer termed the 'alignment' (or 'articulation') of their respective actions.' [11, p. 40]

The actors have to align, they need to find a level at which they can interact, a coherent language that both understand. Suchman points towards this view on that matter: 'A more profound basis for the relative sociability of computerbased artefacts, however, is the fact that the means for controlling computing machines and the behaviour that results are increasingly linguistic, rather than mechanistic. That is to say, machine operation becomes less a matter of pushing buttons or pulling levers with some physical result, and more a matter of specifying operations and assessing their effect through the use of a common language.' [12, p. 11] From a tangible interaction point of view, that common language should be rather the opposite of linguistic, namely a physical language: The valve responds only to direct manipulation, but in return it can physically show its current state, the level of open- or closedness, and supported by the friction felt through the handle, and sound and vibration it might indicate the amount of fluid passing through the valve. The human actor is in fact quite competent in this relatively simple, but still sophisticated language and the valve can reveal an impressive range of information that only needs little or no translation. Information about state, temperature, wear, flow, need for maintenance etc. would call for a fair amount of translation, had it been displayed through a computer screen. One cannot really hold the valve itself responsible for the way it acts in the world, rather the designer of the valve, the person or team behind the choice of delegation of work, materials and shape.

Valves and assumption no. 7

'7: Actions are not necessarily rational. Many are nonrational or, in common parlance 'irrational' Yet rational action can be mistakenly perceived as not so by other actors.' [11 p.30]

Watching Trevor 'blessing' the gauge could lead the uninitiated to the misconception that he was suffering from involuntary hand movements, where in fact he was adjusting the movement of his hand to the situation. As mentioned earlier, this is the second of four 'flushings' and in the first one; Trevor actually touches the gauge, feeling how hot it is. This movement has been incorporated into his modus operandi and the 'blessing' indicates that Trevor is in the same place at different times, performing different tasks. 'If, as history, the past lies behind us, as memory it remains with us, not only in words but also in our neuromuscular patterning and kinaesthetic memories—the way in which specific experiences and concepts of time/space are built into our bodily modus operandi' [Behar in 4, p.353]

CONCLUSION

'Why do this?' asks Dourish 'The intuitive behind tangible computing is that, because we have developed skills for physical interaction with objects in the world—skills of exploring, sensing, assessing, manipulating, and navigating—we can make interaction easier by building interfaces that exploit these skills.' [2, p. 206] Harnessing these skills could be the way to make interaction easier, but the question is whether interaction should be, at any price, *easier*? Maybe easier to *learn* would be more valuable? Designing interfaces that would require the acquisition of *new* skills could make the *learning* easier and more intuitive.

In this paper four different perspectives have been brought to an interaction sequence, to investigate how the understanding of skilled actions might support tangible interaction design.

Ingold's distinction between wayfaring and transport draws attention to the in-betweens, to the movements between the points of interaction. In our quest for finding ways to design engaging tangible interaction, we must consider the entire sequence of movements, not just the contact points. This is where time becomes an issue; operations with technology should not be considered in isolation, but in the stream of activities in which they will be part.

Suchman's notion of situated action puts a focus on the vital role of the situation when looking at action. To accurately understand Trevor's sequence of actions we cannot use them to reconstruct a plan, rather see that the equipment provides him with (in this case at least) practical and appropriate actions, actions that are made relevant in the context of 'flushing the pipes', or 'diluting the beer'.

Latour's non-human actors remind us that the technology takes part in the work, rather than just being tools for the activity of work. Work has been delegated to them, skills—to greater or lesser degrees—have been incorporated in them and they are interacted with.

Finally, Strauss´ interactionism highlight that there is an alignment required between operators and equipment (particularly so as we move to intelligent systems that occupy Suchman, and the humanness of non-human actors that Latour discusses). This alignment, I have proposed, needs to be achieved through a physical language if we are concerned with embodied interaction and skill building through action. Furthermore, the rhythmic quality of the activity provides us our familiarity with the ways of working 'alongly' (rather than 'building up'). This suggests that the rationality of action is only really understandable from within it . . .

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