

THE COGNITIVE BIOGRAPHIES OF THINGS

David de Léon

Lund University Cognitive Science

Kungshuset, Lundagård

222 22 Lund

E-mail: David.de_Leon@lucs.lu.se

Abstract: In this paper I argue that there is much to gain by constructing “cognitive biographies of things”. These are accounts that detail the history of an artefact and its use, focus on the physical changes undergone by the artefact over time, and draw out the cognitive corollaries of those changes.

There are a number of reasons for why we might want to construct such biographies. If we subscribe to a situated view of cognition, then at least some of our cognitive achievement stem from the physical structures around us. To ignore the genesis, development and appropriation of cognitively significant structures would then be to paint an incomplete and misleading picture of cognition.

Even without commitment to situated cognition, constructing such use-histories may be required if we are to discern the cognitive roles currently being played by some artefact (which may be of interest, for instance, in the process of designing artefacts). By overlaying succeeding phases of an activity with preceding ones, areas of possible cognitive significance can be highlighted and explored.

In this paper I take a shot at constructing a cognitive biography of a large spice shelf that I encountered whilst conducting a study of people cooking. The biography is based on video of a session of cooking as well as a number of interviews. The resulting account spans a period of roughly 30 and details the mutual influence between cognition, activity and changing physical structures. In constructing this biography I hope to show some of the possible difficulties of doing so, as well as some of the benefits.

Keywords: Cognitive biographies, use-histories, artefact evolution, artefact design, cognitive tasks, cognitive congeniality, artefacts, tools, cognition.

INTRODUCTION

We are currently seeing an increasing awareness in the cognitive and mind sciences of the importance of physical structure for cognition. The old view of cognition as something that takes place only in the head has been replaced (or at least tempered) by a view that recognises the roles played by physical and social structures. The environment, it turns out, is not just an arena for action – a playground for problem solving and plan constructing minds – but is intimately implied in many, if not all, cognitive processes.

There are several different ways of advancing this claim, but most would agree that physical structures in the world can, at least, act: as an extension of memory (Hutchins, 1995b; Beach, 1988; Norman, 1988), to simplify choice, perception and internal computation (Kirsh, 1995; Clark, 1997), to constrain and even determine cognitive behaviour (Zhang &

Norman, 1994), and to transform tasks in ways that better harmonise with our cognitive competencies (Hutchins, 1990, 1995a; Norman, 1991).

Once this basic idea has been accepted it should be natural to ask *how* these kinds of physical structures come about. After all, if physical structure can be an intimate and integral part of cognition, more so than previously recognised, then asking questions about the growth, development and appropriation of these structures should be as natural as asking age old questions about learning and development. In fact, both learning and development need to be understood afresh in the light of these emerging insights. The genesis, evolution and adjustment to cognitively significant structure ought to be viewed as an essential aspect of most, if not all, of our cognitive achievements.

Most of the authors cited above *do* acknowledge that there are interesting processes responsible for the build-up of cognitively significant physical structure, but these processes then figure to a negligible extent in their accounts.

Hutchins (1995a), for instance, gives truncated histories of the astrolabe and the compass rose (both ancient navigational instruments that significantly transformed the cognitive task of ship navigation), but then simply concludes that practice can be “crystallised” into things, without discussing the process of crystallisation itself.

Kirsh (1995) acknowledges that the interaction of agent and environment can be studied along different time scales, and does an admirable job of looking at medium and short term mechanisms of how people set up their workplaces for particular tasks. However, the issue of how the workplaces themselves evolve is not addressed.

Bærentsen’s (1989) work on the evolution of the rifle is an inspirational exception which explicitly deals with the interaction of artefacts on the cognitive demands of task performance, and the influence of cognition on artefact development. Although a bold and innovative attempt, Bærentsen’s analysis relies on an unanalysed notion of cognitive processes being built into things (for a critique, see de León, 1999).

Activity theory (the tradition in which Bærentsen’s paper is written) places great emphasis on the historical and cultural foundation of thought and artefacts and would therefore seem to be an ideal place to find the kind of analysis sought for. The activity theoretical concepts of *externalisation* and *historicity* also seem to capture the concerns discussed. However, as Engeström (1999) has noted, there seems to be a general paucity of work in activity theory on these very topics.

Naturally, a part of the reason for this neglect is connected with the difficulty of reconstructing what are primarily historical processes. Unless we limit our interest in the ways in which artefacts and practice co-evolve to very short time scales (for a nice study in this vein see Agre & Shrager, 1990) we have to choose between longitudinal studies and historical reconstructions. Longitudinal studies are in many ways ideal, but the method demands great effort without guaranteeing results (even if we were to choose our sites intelligently). Reconstructions (regardless of the principles that are used to govern the reconstruction) will simply involve too much speculation for some people’s taste.

Despite these concerns we should not be too quick in dismissing these lines of inquiry as each of the approaches has its potential benefits.

In this paper I have opted for an exploration of the reconstructive approach. Of the options presented it is the approach that, at first sight, seems beset by the

most worrisome methodological concerns. However, it is also an approach that has some possible advantages and some unique characteristics. In contrast to more constrained studies of phenomena taking place on a short time-scale it allows for investigation of real-life events spanning changes over long time periods. Although less controlled and more speculative than a longitudinal study might be it permits us to explore sites where the occurrence of artefactual change has already been established.

In this paper I will take a shot at constructing what I like to call a cognitive biography, tracing the life-history of a particular artefact and its use over a period of roughly 30 years, and detailing the mutual influence between cognition, activity and changing physical structures. In contrast to reconstructions of events taking place over several lifetimes (cf. de León, 1999) the present time scale makes ethnographic methods and structured interviews part of the available methodological arsenal.

The artefact in question is an unusually large spice shelf that I encountered whilst conducting a cognitive ethnography (Hutchins, 1995a, 1995b; Lave, Murtaugh & de la Rocha, 1984) of people cooking in their home kitchens (see de León, 2003). Each of the participants of the cooking study was video filmed whilst preparing dinner and later interviewed about the organisation of their kitchens and about the origins of their tools and cooking practices. One of the participants of the study was Robert, a man in his mid-fifties. It is in his home that the shelf described in this paper resides. Based on the interview conducted at the time of the study I have attempted a reconstruction of the genesis and evolution of the shelf and concocted a credible story of the underlying factors behind the various changes to the shelf, as well as their probable cognitive consequences. The reconstruction was continuously checked against the tape I had of Robert cooking and a number of supplementary interviews. The shelf did not always appear as it does now. The collection of spices has been stored in a manner of different ways and the actual shelf makes its appearance fairly late in the story. Although I speak of the evolution of “the shelf” it is really the history of a constellation of artefacts and practices.

This paper is thus an experiment in reconstructive cognitive biography. The result is an unusual hybrid: on some occasions I use data from the case study to make particular claims, at other times I introduce extraneous theories and observations to bear on the case in question and to explain my observations. I hope that the attempt might give some indication of what a cognitive biography might look like, and what sorts of things we might learn by constructing them.

A COGNITIVE BIOGRAPHY OF A SHELF OF SPICES

First I will give a brief description of the shelf and then outline some ways in which its current structure and organisation supports Robert's cognitive activity whilst cooking. This is followed by a reconstruction of the shelf's history.

A Brief Description of the Shelf

Most of the spices in Robert's kitchen are kept on a tall shelf fixed to a wall, a few steps from the stove and workbench were the main activities of cooking take place (see picture 1). The shelf consists of two prefabricated units bought at IKEA (a ubiquitous Swedish furniture store) that have been placed one above the other and glazed in blue to match the other fixtures in the room.



Picture 1. The shelf (to the left of the door), sink and plate rack (far left of picture) and corner of fridge (far right side of picture). Part of the dining room can be seen through the kitchen door.

Each plane of the shelf is just deep enough to accommodate one spice jar and wide enough to accommodate a row of about ten jars. All jars have been labelled with embossed plastic strips and are neatly aligned along the shelving; almost all are of identical size. Row upon row of yellow plastic lids divulge their origins as reused Coleman's mustard jars. Dispersed among these are a couple of tins, a few brand name spice jars and two pepper mills of disparate design. Through the clear glass of the jars various dry powders, seeds, flakes and roots can be seen, their colours ranging from beige to brown.

In the narrow space between the two units that make up the shelf – too narrow to accommodate an additional row of jars – lies a bulldog clip, some rubber bands, a small pile of paper twist ties, and a paper packet of black pepper. Along one side of the shelf hangs a decimated garlic braid.

In all, almost exactly one hundred jars and containers are kept here. By any measure this constitutes an unusually large and impressive collection.

The Organisation of the Shelf

Robert's cooking encompasses Western as well as more exotic cuisines. About a third of the spices found on the shelf (the lower three planes) are endemic to French and Italian cooking, the remaining shelves being devoted to spices used in Indian, Middle Eastern, Chinese, Japanese, Indonesian and Thai dishes.

The spices are organised into categories according to a number different principles (see figure 1 below for the basic categorisation of the shelf).¹ The top shelf, for instance, contains various hot spices, such as chilli and cayenne. Here it is taste and function that determines placement.

Another section contains different kinds of dry leaves used in South and East Asian cooking, and is thus loosely organised by the *form* in which the spices are found. A less obvious category is the group of spices placed together because of their modest application, being dubbed "by-the-pinch spices" by Robert; the principle governing this particular categorisation being the manner in which they are applied. There are also several sections in which the spices are grouped together because they are used together in a particular style of cooking. There are prominent sections with spices used in, for instance, Indian and Chinese cooking.

In those cases in which a particular spice is found in more than one form (e.g. whole and ground) these are placed adjacent to one another.

The bottom three shelves are home to more familiar spices used in Western cooking. This is the largest regional section and has been arrayed alphabetically. The spices kept here are shared by Robert and his wife. Since his wife lacks his penchant for spicy and exotic food this is the only part of the shelf that she ever uses. As she is also substantially shorter than her husband the placement of the spices, in this mutually accessible region, is particularly felicitous. The reason Robert gives for the alphabetical ordering of these shelves is that it was the only obvious categorisation to present itself that would serve two people. It is instructive to note that the only region of the shelf that is used by more than one person relies on a culturally conventional system of categorisation. Alphabetisation ensures a clear, mutually intelligible, and maintainable order.

¹ The categories in figure 1, and in the text that follows, are Robert's own and were taken from a picture of the shelf which he had annotated. In the interview Robert also explicated some of the uses to which he put the spices.

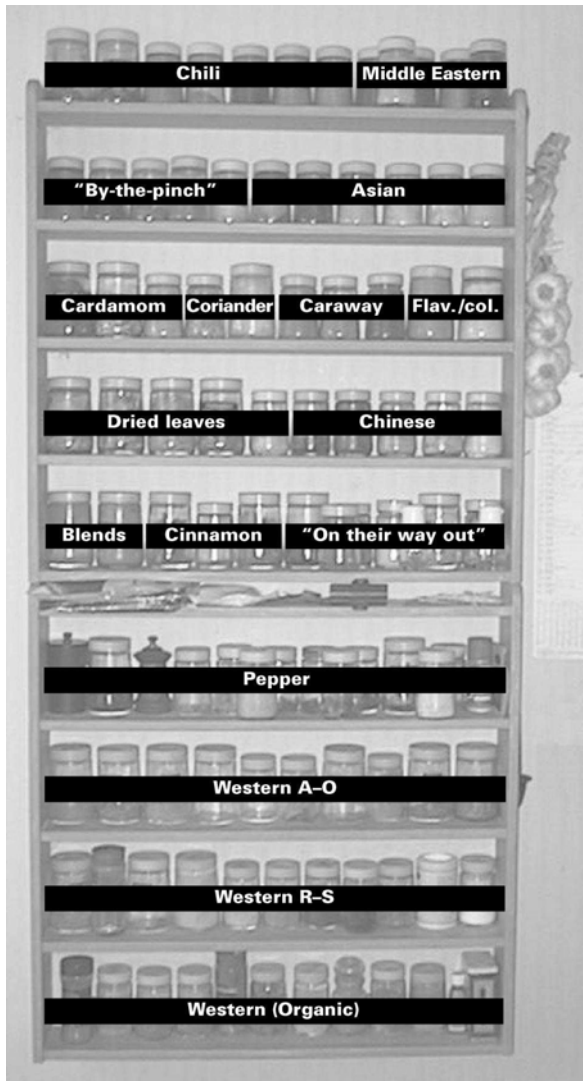


Figure 1. Basic categorisation of the shelf.²

There is also a small section of spices that are “on their way out”. According to Robert these are spices that will be sacrificed as space is required. Some of these are spices that Robert once bought out of curiosity, or that he has finished experimenting with, or for which he has recently found better alternatives (for instance, access to fresh spices that were only previously available in desiccated form).

Some Ways in Which the Shelf Currently Supports Cognition

Since each plane of the shelf is only deep enough for one jar, almost all the jars can be seen at any given time; of the roughly one hundred jars that stand here only a handful are blocked, or partially obscured,

² The fastidious reader might note a slight discrepancy between the labels in the picture and the description of the categories given in the text. The figure is based on a picture taken a year after the original study and in the interim the organisation of the shelf changed somewhat (more on this below).

from sight. The jars are labelled and their contents can be clearly seen through the glass: label and content mutually contributing to the ease of identification of a particular spice. We might think of the shelf as a kind of conceptual model, a physical structure embodying the basic spice combinations of some of the most common, Asian and Western dishes, as well as certain aspects of Robert’s cooking practice and his personal way of conceptualising cooking.

We should be cautious, however, lest we view the shelf simply as reflection, projection, or externalisation of Robert’s inner representations of spices and cooking. For one, the genesis of the shelf belies such an interpretation. As we shall see in the following, there are several determinants of the shelf’s structure and organisation that are incidental, rather than intentional. Moreover, to whatever extent (and in whatever form) the structure and content of the shelf is actually represented by Robert, this will have been repeatedly shaped by the presence of the shelf itself.

The visible thematic spice groups arguably function to support Robert’s memory in a number of different ways. Assuming that he knows what spice he is looking for, a problem then facing him is locating the appropriate jar on the shelf. Instead of having to scan the entire shelf for the spice in question, the thematic groups focus his search to a particular area (obviating the need for knowing the exact location of every spice). For example, just knowing that a spice is, or is not, used in Western cooking removes a large part of the shelf from consideration. That the organisation of the shelf is consonant with his own idiosyncratic categorisations, conceptualisations and habits of cooking also makes the regions more easy to locate.

Even the relationship between the form of his body and the position and organisation of the shelf comes into play here. The spices that are most frequently used (the Indian spices, according to Robert) are within easy reach, whereas slightly less frequently used spices (such as the Middle Eastern spices) require him to stretch upwards, or (in the case of Western cooking) to bend down. The placement of the various groups of spices is not only a question of physical effort and comfort, but ensures that the customary position of Robert’s body when facing the shelf presents him with the most regularly used sections of the shelf. The same holds true for Robert’s wife, whose length constrains which shelves she has easy access to. This is a very straightforward and clear example of the role of embodiment for cognition (for a critical review of the concept of embodiment see Clark, 1999).

These, then, are some ways in which the shelf can support the task of locating a particular spice. When cooking a dish from memory an occasional problem is actually remembering which spices to look for in the first place. In such a case, all Robert needs to know is what *kind* of spices he is searching for. Looking at the

appropriate area of the shelf he need then only recognise the spices required – a far easier task than recalling them (for a primer on recognition and recall see Baddeley, 1997).

The co-location of spices that are commonly used together also serves as a reminder, throughout the cooking session, of spices still to be applied. Anytime a spice jar is replaced on its shelf, neighbouring jars can jog Robert's memory.

There is also an interesting structural feature of the shelf that supports the replacement of spice jars. Since the spices are stored on the shelf one jar deep, and each plane is full to the breadth, the removal of any jar leaves a clearly visible gap. This gap can then function as a perceptual place marker. Again, this saves Robert from having to remember the exact locations of where particular spices are stored: he has only to look for a break in the array to know where to replace a jar. Of course, should Robert pick out several jars together, he would be left with the problem of pairing the correct jars with the appropriate gaps when time comes to replace them. This is not an insurmountable problem and would still be easier than having to remember the exact locations. However, as seen on the video of him cooking, Robert only picks out and uses one jar at a time, replacing it before picking out the next one, thus ensuring that there is no confusion as to which jars belong in which gaps. There are several ways in which the shelf could potentially be used, but significantly, Robert has settled on a strategy that *permits* the physical structure to simplify the cognitive demands of correctly replacing used jars. It is well to point out that it is the *combination* of techniques, procedures and/or habits, with particular artefacts and task environments, in relation to specific tasks, that determines the cognitive congeniality³ of an activity.

THE HISTORY OF THE SHELF

If we want to understand how the shelf came to have its present structure and use, we must go back in time to the late sixties, to the spice shelf in one of Robert's previous homes, and then trace the development of the shelf back to the present. And this is what I will attempt next, reconstructing the genealogy of the shelf with Robert's help.⁴

³Kirsh (1996) calls the measure of how cognitively hospitable an environment is its "cognitive congeniality". A cognitively congenial environment is one that reduces "the number and cost of mental operations needed for task success," "reduces cognitive load on working memory" and increases "the speed, accuracy or robustness of performance" (Kirsh, 1996). The use of the term is extended here (for reasons outlined in the above paragraph) to cover activities as well as environments.

⁴I have taken some liberties in truncating the history of the shelf and excising portions that add little, from the point of view of the reader.

In the first kitchen that Robert remembers having (in a flat in Stockholm, Sweden) the spices were kept – in no determinate order – on a single shelf next to a stove (see step 1 of figure 2). At that time his collection was considerably smaller, consisting of only a few conventional Western spices, and could fit snugly on a single plane. Robert had yet to develop the intense, and broad, interest in cooking that he has today, and exotic food was still something that was only occasionally sampled in one of Stockholm's few Chinese restaurants (in the late sixties Stockholm had only two, or possibly three, of these).

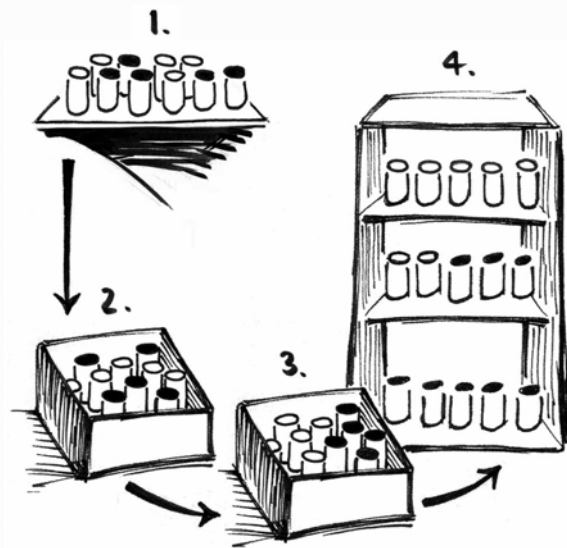


Figure 2. A schematic history of the shelf.

Although there was no intentional order to the arrangement of the jars at that time we can speculate that there may have been some incidental grouping resulting from the handling of the jars. In the kind of arrangement described, spices that are often used together will tend to gravitate towards each other. There are several ways in which they may do this. If all, or some, of the spices used in a particular dish are taken off the shelf and put back at the end of a session of cooking, spices that often occur together will tend to end up in close proximity. Or, if spices are placed at the front of the shelf immediately after use, more commonly used spices will be found near the front, whilst spices in less demand will be gradually pushed towards the back wall. Needless to say, this kind of grouping would have aided the location of common, and even uncommon, spices. With just a few spices in the collection there would have been little incentive to organise them further.

These kinds of processes, in which the repeated performance of an activity shapes the environment in

which that activity takes place, are an important source of supportive structure.⁵ The spatial redistribution of artefacts is one basic mechanism which we have already encountered. In the same way that spice jars can come to be functionally grouped through their use, so may other artefacts employed in the kitchen. During my study of cooking (de Léon, 2003), from which this case is taken, I noticed several of the participants making frequent trips to the plate rack in order to fetch common objects. Implements that are routinely required are likely to have been recently used and cleaned. The plate rack is therefore the most probable place to find them. In addition, the rack is also conveniently placed in most kitchens and its contents visible. The processes of using and cleaning kitchen implements, therefore, sorts out, and makes readily available the most frequently used implements.

Note that this particular use of the rack also conserves effort, the effort of emptying the rack and replacing the things kept there. The rack is cleared almost as a by-product of the activity of cooking.⁶ Much of human activity is like this, with actions having multiple reasons and serving multiple simultaneous purposes (cf. Wertsch, 1998).

Basic wear and tear is another mechanism that can generate supportive structure. For example, think of a footpath kept clear through use (see Barker, 1968), or the growth of meaningful pathways between buildings (see Ribeiro, 1996). Or, consider how repeatedly opening the phone book to the same section (for instance, the pages containing your local pizzerias) can weaken the spine of the book making it easier to locate those numbers in the future.⁷ In a similar manner, tools and implements that are stored in designated locations (for instance, around the walls of a workshop) can discolour, or otherwise mark, those places, thus facilitating their correct replacement.

In these examples activity results in some cognitively congenial change to the environment. The natural response to such change is compliance; the net effect is beneficial and we probably do not pay it much attention. However, it is more common for activity to have the opposite effect, creating clutter and disorder, rather than order. One possible way to respond to encroaching entropy is to actively counteract it, a

strategy which Hammond (1990) calls enforcement.⁸ For example, in the video of Robert cooking there is a slight lull in the session which he spends meticulously straightening his spice jars, making sure that all “misaligned” labels face to the front. As the shelf is subject to rather heavy use (in the session filmed a total of 18 different spices were taken down and replaced) this kind of upkeep becomes a natural part of activity, ensuring that the shelf can continue to function as it does. Of course, it could also be argued that the episode simply reflects an aesthetic preference or ideal, rather than maintenance of cognitively significant structure (although neither interpretation invalidates the other). The physical properties of the shelf and jars also help to keep entropy at bay. The width of the shelf, for instance, greatly limits the ways in which the jars can shift about on the shelf, and the gaps left by jars that have been removed facilitate their correct replacement.⁹

The Collection Grows

Towards the beginning of the seventies Robert starts to experiment with Chinese food in an attempt to recreate some of his favourite restaurant meals. There are, as yet, no Chinese cook books available in Swedish (and books in English are still hard to come by). However, the Swedish-Chinese Association publishes a small pamphlet that Robert procures. Through an acquaintance (a supplier to some of Stockholm’s delicatessens) Robert buys exotic spices in small yellow stackable tins. Throughout the seventies Robert’s spice collection grows, in concert with his steadily increasing knowledge and interest in cooking. Robert and his family move a couple of times and at some point Indonesian dishes are added to the repertoire. The small yellow tins are gradually abandoned as spices become more readily available from other sources. The spices, that are now bought by weight, are transferred to recycled Coleman’s mustard jars (these are the jars that can be seen in picture 1 and figure 1).

⁵Barker (1968) calls this kind of relation between behaviour and environment “behaviour-milieu synomorphs”.

⁶Reading an earlier draft of this paper one of my colleagues pointed out an important exception to this way of using of the plate rack. Although she recognised the use of the rack described here, she mentioned that she will sometimes leave the rack untouched for a period of time after washing up so that the full extent of her domestic efforts might be recognised, and appreciated, by her boyfriend.

⁷This is why your avant-garde books always seem to fall open at the raunchy episodes in the hands of any guest browsing your bookshelves.

⁸Hammond (1990) and Hammond, Converse and Grass (1995) take enforcement to be an *active* strategy of order imposed on the environment. It is interesting to note how, in the present case, enforcement is sometimes *incidental* (recall how clearing the plate rack can be a by-product of other activities).

⁹It would be interesting to analyse and compare the various artefactual and procedural means that have been devised to resist entropy. What technical solutions are there? For what kinds of task is artefactual stability (taken to mean something other than plain robustness) a desiderata? Does stability stand in the way of other functional aspects? If so, what kinds of trade-offs are there (cf. Bleed (1986) on the trade-offs between reliability and maintainability in hunting weapons)? An obvious place to start would be to look at collections and catalogues and how these are used, and how they have evolved. Or what about surgical instruments, how are these handled and cared for?

Spices in a Box

In 1979 Robert and his family move from Sweden to England. An extended period followed in which they lived in a succession of more temporary settings: a van, a trailer, a couple of rented apartments. During this transitional period Robert kept his spices in a low box (see step 2 of figure 2).

Looking down into the open box only the lids of the spice jars could now be seen, the many identical lids exacerbating the difficulty of distinguishing one spice jar from another. To find a particular spice, Robert had to rely on his memory and/or make an educated guess. Whether or not the jar selected was the one actually sought for he would have to lift it above its neighbours to be certain of its identity. Some of the incidental ordering on the shelf may have survived the transfer to the box, but may also have been broken up. Assuming that at least some of the ordering of the spices made it into the box an incorrect guess might give a clue to whether he was searching in the right area of the box. Again, just using the box may have brought some gradual ordering to the spices.

The temporary solution, as so often is the case, turned out to be less temporary than initially expected. Eventually tiring of the impracticalities of the arrangement Robert decided to order the spices into thematic groups (see step 3 of figure 2). To locate a jar he would still have to rely on memory. Nevertheless, the organised box was an improvement over the earlier, mostly haphazard, distribution.

This is the first full and deliberate ordering of the spices undertaken. If there was already some order in place, as I have suggested, we can speculate that that order may have influenced the subsequent intentional organisation, perhaps serving as a rough guide. Any ordering that is conserved through this kind of process corresponds nicely with the way that the spices are used.

From Box to Shelf

In England Robert discovers Indian cooking. For obvious reasons to do with the country's colonial past, Indian cook books, restaurants and spices were all readily available. More spices were brought and Robert's collection started to spill over into various drawers in his kitchen.

In 1982 the family buy a house and Robert purchases a small shelf for the new kitchen. The jars in the box were transferred to the shelf and placed in the thematic categories that had crystallised over the years (see step 4 of figure 2). Although this particular shelf is not the same shelf as the one described earlier in the paper (that one still being many years, and many meals, away) it can be assumed that it supported Robert's cooking in ways similar to the present day shelf.

In the transition from box to shelf there is a noteworthy qualitative shift that occurs. Whereas the chief function of the categories in the box was to aid Robert in locating specific spice jars (remember, only the top of the lids could be seen when the jars were in the box), the visibility afforded the jars when placed on the shelf gave rise to new, unplanned for, and unanticipated functionality, in addition to a general improvement of the previous functionality.¹⁰

Let me briefly outline some of the consequences of combining the categories of the box with the structural features of the shelf (the main differences between using the box and the shelf are also summarised in table 1).

Remembering which spices to use
A cursory scan of the shelf can trigger memory of the spices included in a particular dish. When taking or replacing a jar on the shelf during cooking, adjacent jars may serve as reminders of spices still to be applied. In contrast, the content and labels of the jars kept in the box are not visible.
Finding a sought for spice jar
A guessed at location of a particular spice is easier to confirm using the shelf, since feedback is instantaneous and category boundaries more distinct. Erroneous guesses are more costly using the box.
Correct replacement of spice jars
Gaps are easier to spot and fill on the shelf and neighbouring jars also help to establish correct replacement. In the box there is a greater risk that jars will shift about, breaking up thematic groups.

Table 1. Summary of main cognitive differences between using the box and using the shelf.

Finding a sought for spice on the shelf has some similarity to finding it in the box: in both cases Robert is required to know the relevant category to which the spice belongs as well as the rough whereabouts of that category. One of the things that differentiate the two cases, however, is the ease with which the supposed location of the spice is then confirmed. On the shelf, feedback is almost instantaneous, the jars are stored one jar deep and can be easily scanned (compare this with the shelf in his first kitchen which was just a single plane). In the box, a jar has to be lifted before its identity can be confirmed. Not only is it easier to locate a particular jar on the shelf, but the cost of a faulty guess is much less compared with the extra effort incurred when picking out the wrong spice from

¹⁰Those with a fondness for evolutionary metaphors of artefact development (see e.g. Basalla, 1988; Ziman, 2000) might like to think of this event as a case of exaptation (Gould & Vrba, 1982). That is, as a feature which currently enhances fitness (i.e. cognitive congeniality), but which was not originally built for the role it now plays.

the box. The categories in the box also have looser boundaries and are harder to pinpoint than the more rigid categories on the shelf. From just looking at the box the various thematic groups are not readily apparent and there is the constant risk that the location of particular jars will shift about during prolonged use of the box.

The removal of a jar from either box or shelf leaves a gap that can later aid in the replacement of the jar. On the shelf the gap is easy to spot and fill, and the visible identity of adjacent jars can confirm a correct replacement. In addition, adjacent spices can serve as reminders of spices still to be applied. In the box the identity of neighbouring jars can only be established by lifting them up above the level of the box.

Earlier in the paper it was noted that the vertical positioning of the shelf (in relation to Robert's body) also contributes to the ease with which particular spice jars are found and retrieved.

Reaping the Benefits

The ways in which the shelf supports cognition is a, mostly, unanticipated result of the combination of the categorisation of the spices contained in the box with the structural properties of the shelf. The claim made here is that the improved cognitive congeniality of the shelf is partly accidental, and historically contingent. However, the new ways of working afforded by the shelf are not automatically achieved. Although there are cases where a change in the material means of an activity entail a concomitant change in procedure, in this instance some adjustment had to be made before the benefits of the new set-up could be reaped. There may be many ways in which the shelf could potentially be used, but only some of these are an improvement over the previous use of the box. It is by using the shelf in particular kinds of ways that it is able to scaffold cognition. An example given earlier in the paper is a good illustration of this. You might recall how Robert's strategy (or habit) of taking down and replacing spice jars one at a time permitted the shelf to simplify the cognitive demands of the task. If several jars were instead taken down together, then Robert would be faced with the additional chore of pairing each of the jars with the appropriate gap.

The transition from spices kept in a box to having them arrayed on a shelf, the adjustments to, and appropriation of the resulting structure by Robert, is an interesting case in which an artefact (or artefactual complex) grows and develops in cognitive congenial ways. Needless to say, all artefactual change does not lead to improved functionality or to cognitive congeniality. Nevertheless, the process described may have greater generality than this single case.

Similar mechanisms can be found in, for instance, the gradual co-evolution of the form of books and bookcases (Petroski, 1999). Before the advent of the print-

ing press books were rare and expensive luxuries, either locked up or chained to their bookcases. As they became more numerous, vertical partitions were introduced to the then standard bookcase design in order to prevent the shelves from sagging. Although the motivation for these partitions was originally structural the partitions later came to play an important role in locating books. Catalogues, usually posted on the end of a bookcase, grouped the books in accordance with the partitions that contained them. Even as late as 1749 catalogues were still not alphabetical, but based on these tables of contents.¹¹

Concluding the Story

In 1988 Robert and his family moved back to Sweden. During the summer of their return they lived in a caravan and a selection of the spices were again back in a box. Later, when Robert and his wife moved into a flat, Robert put in an order for a new shelf. In 1990 they finally bought a house and the two IKEA shelves, described at the beginning of the paper, were purchased.

At present almost all spices have been transferred to recycled Coleman's mustard jars. One could argue, from a cognitive standpoint, that a mix of jars, of varying appearance, would have been better (providing redundant cues as to identity), but here Robert prefers to let aesthetic concerns take precedence. Cognitive congeniality is, after all, but *one* factor that governs the shaping of our environment.

Today Robert has set a self-imposed limit on the continued growth of the shelf. He confesses to having been "a bit of a collector" in the past, buying spices in order to learn about them. Now he knows more about his needs and there is also a greater pressure on available space with Japanese and Thai cooking having been recently added to his repertoire.

Since the time of the original study, and the last and most recent interview with Robert, the shelf has undergone further change and is still in flux. Since the initial study was conducted Robert's wife has converted to using organically grown spices. As a consequence the bottommost shelf has been cleared for that use (as seen in figure 1). The two shelves above it now house Western spices used by Robert alone. However, a short while after Robert's wife converted to organically grown spices many shops in Sweden ceased stocking them and they have become increasingly difficult to buy. Robert's wife confesses to now using the ordinary spices on the shelves above hers to "top up" her own jars.

Will the organisation of the bottommost shelf persist, as a vestige of an ephemeral fad, or will the organisa-

¹¹For some other interesting types of interactions and exchanges between co-located artefacts see de Wit et al. (2002).

tion of the shelf eventually return to the one described in the text? One thing is certain, the present shape and organisation of the shelf is unlikely to end here and will undoubtedly continue to change, in concert with Robert's unabated interest in cooking and in response to ever changing circumstances.

DISCUSSION

The story told here is a reconstruction of events taking place during a period of roughly thirty years. As we have seen, the evolution of the shelf is intimately tied to the changing circumstances of Robert and his wife, Robert's intensified interest and growing knowledge of cooking, and even to changes at a societal scale in eating habits. The biography of the shelf and its use has allowed us to glimpse some interesting things, a few of which I think bear repeating.

One important insight is the realisation that much of the structure that supports cognitive activity may have partially *non-cognitive origins*. At least some structure seems to be the result of chance, circumstance, compromise, surrounding agents, and the shaping force of repetition. Perhaps the most significant moment in the present case study is the emergence of new and unanticipated functionality from the combination of previously unrelated structures.

I believe that insufficient attention has been paid to these sorts of processes and their impact on tasks and task environments. We need to continue to explore and expand our catalogue of these phenomena, but more pressing, perhaps, is the work of disentangling and understanding their interplay with other, more purposeful and intentional, processes. Some changes to an artefact or task environment can impact the cognitive ease with which a task is performed without any major changes in procedures or techniques, whereas other changes are accompanied by a concomitant transformation in the way a task is carried out. How people adapt to new structure, and appropriate and incorporate it into more congenial forms of a task, is a key part that needs to be properly worked out.

A better understanding of these phenomena may also serve as an important corrective to theories of design, production and artefact functionality, that are excessively intentional.

Another important and related point is the significance of use. One thing that has been demonstrated in this paper is that the cognitive congeniality of an environment is as much a function of an agent's particular use of that environment as it is a function of the environment itself. It is the particular ways in which things are used that *permits* them to contribute in cognitively beneficial ways. Cognitive congeniality is a relational property, and cognitive biographies must include both the changing forms and shifting uses of things.

As was noted in the introduction, the reconstructive nature of cognitive biographies may be the cause of some concern. The way that the present biography was created, for instance, was through repeated interviews coupled with study of the contemporary form of the artefact and associated activities. The biography is, by necessity, constructed after the fact; consequently there are aspects of it that are based on conjecture. Though cognitive biographies have some distinct advantages they also open the doors to speculation and presupposition.

This problem, however, is not unique to the present endeavour. There are a number of related enterprises that have learned to deal with similar issues. There is much that we may learn, for instance, from the history of technology (for reviews see Staudenmaier, 1984, 1990), the anthropology of technology (e.g. Lemonnier, 1986, 1992; Pfaffenberger, 1988, 1992), social construction of technology studies and actor-network theory (for a review of both see Bijker, 1994), as well as the diverse and numerous branches of archaeology. None of these disciplines (and there are more than those listed here) are specifically focused on cognition, but all are concerned with the processes behind changes in material culture. These areas may provide us with supporting evidence, complementary perspectives and methodological innovations and insights.

Recent focus on cultural biographies of objects (e.g. Appadurai, 1986; Kopytoff, 1986; Gosden & Marshall, 1999) is an interesting example, not only for the partial neologistic parallelism, but because of shared methodological issues. Both kinds of biographies seek to retrace sequences of relations between people and things. In the case of cultural biographies of objects it is a sequence of shifting meanings that is the elusive quarry, in the present case it is a sequence of uses and cognitions that needs to be reconstructed. Each quarry is as intangible and ephemeral as the other and we might find that there are methodological solutions to be shared.

Although interpretative science is difficult there are some potential rewards to be had. Cognitive biographies allow us, for instance, to explore real life events and changes spanning long time periods. And they allow us to concentrate our efforts on sites where significant change has already been established. But there is a further, fundamental reason for constructing cognitive biographies of things.

Tracing the history of a thing and its use can help us understand the present use of that thing. A cognitive biography allows us to better discern the cognitive roles currently being played by an artefact. Against the backdrop of earlier incarnations of an activity, and previous forms of an artefact, the cognitive functions of a thing are able to stand out in relief. For example: a feature of an artefact may be the result of a response or adjustment to problems inherent in previous versions of the task. Knowing about these earlier phases,

enables us to discern (or, at least, to explore) the roles being played by this feature. Overlaying succeeding phases of an activity with preceding ones can often point us to possible areas of cognitive significance.

A disregard for the developmental trajectories of environments, tasks and people, will therefore lack some of the essential ingredients necessary for a genuine understanding of the cognition of task performance.

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