

Projected Plans and Situated Activity: Inventory of Objects and Workspace

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Introduction

One consideration about embodied action is that the world can serve as a (then external) model. This has led to the definition of behavior-based architectures without (or with very few) internal states using simple mechanisms of coupling.

However, the question remains: how creatures use this external model to act in the world? Skilled activities in a world shaped by artefacts require both local and global coordinations. And global coordinations imply interaction between internal and external representations (Hutchins 1995). Under these assumptions, we argue that the "no internal states" principle must be attenuated and transformed to "no internal states for selection of action": we want to suggest that everyday activity with manipulated objects imply a projection mechanism of internal models in the world in order to shape the world as a model of *control*. The shaping of the workspace thus reflecting this ongoing *control* of activity¹.

The role of projection will be emphasized in the context of everyday activities with everyday objects (grocery shopping and cooking). Two examples of projection will be presented to illustrate how projection of plans in an equipped space (*arena*) play a role of action control.

Because the example involves objects and their manipulations, the study of spatial mechanisms for control shall be emphasized.

A projection of a list of items in the space

Lave, Murtaugh and de la Rocha (1984) present the example of the arrangement of products in the shelves of a supermarket.

¹ One must note that this has a dramatic effect on the study of such activities (i.e. manipulation tasks): the study of the object placements reflects the control of the placement itself. This may seem a trivial conclusion. However, that spatial arrangements must only be analyzed in terms of control (and not with the usual action representation — i.e. since object placement is an action, one is tempted to introduce hierarchies of action: epistemic actions, iconic manipulation, etc. Moreover, computational approaches have had the same tendencies of behavior-based, i.e. action-based, architectures whereas in this paper we suggest that they should be control-based) is a novel approach.

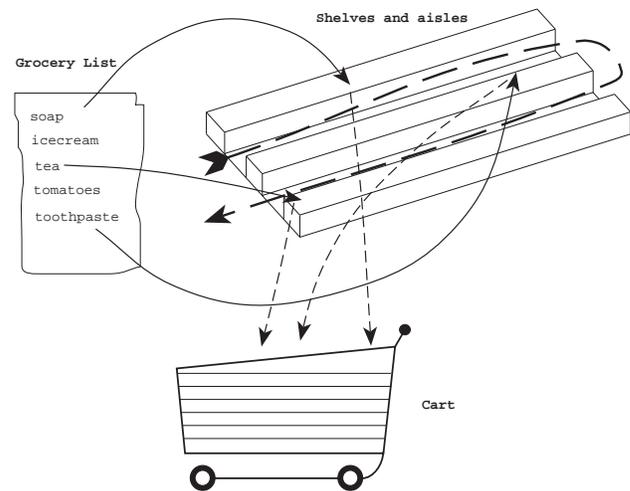
This example can be redescribed in terms of spatial projection and concerns the navigation of a shopper in a supermarket. Lave studied shopping activities in order to demonstrate that, in that context, it is not the grocery list that guides the shopper when he collects the items in the shelves but the spatial arrangement of the products.

For Lave, the world of the supermarket is made of several layers of external pre-representations² formatted as a list of items :

(1) the shopper's list (list 1) which contains the items that are to be bought,

(2) the supermarket as a list (list 2) which is that of the arrangement of the items on the shelves.

In this paper, we shall also consider a third list (list 3): the objects in the cart, which acts as a retrospective plan reflecting the temporal order of the collect of items.



If the supermarket as an arena must be treated as a list (list2) that "is filled with partially ordered sequences of independently obtainable objects" (see Lave, Murtaugh and de la Rocha, 1984), it is mainly because, for Lave, the internal structure of the shopper's plan is partially projected

² A *pre-representation* is an external representation which exists prior to the activity itself; for instance, a shopping list, a check-list, an assembly plan, etc. are pre-representations. An agent using a pre-representation can be seen as stateless, the external representation then acting as the agent's external state. The idea in this paper is to show that an agent projects a pre-representation in its environment in the form of (external) control structures to guide its activity.

in the environment. It is the projection of the shopper's list (list1) in the spatial arrangement (list 2) that permits, without prior plan's effects, specific explorations and routes in the grocery store as the search of items is achieved by following the order of items located in the spatial arrangement.

To navigate through the aisles, the customer is treating the arena as a structure of control as the plan is projected in the world. This mechanism of projection can be described as a mapping between two external representational structures: one without control structure and one with a control structure.

Discussion

Lave's viewpoint is such that list1 only contains specifications for actions, as each item appeared as a shorthand for actions. So the problem is just to provide enough control for the shopper to act in real-time. As the control structure is not provided by list1 (under the assumption that lists are just pre-representations), list2 provides it. How? The object locations in the shelves allows the sequential collect : the locations store control informations.

However Lave does not take into account the possibility that list 1 can have the same content than list 2. In this case, not only the objects are the same but they also appear in the same order. In this latter case, both aisles navigation and objects tracking do not appear: indeed the equivalent order of the objects in the cart makes as if the objects appear in the same order during navigation (although they may not). Objects then can refer, as a short-hand, to the actions: navigation to the first object, picking the first object and placing it in the cart, and so on for the remaining objects. Consequently the temporal ordering just refers to the control structure made by the successive appearance of the objects. What is the process which gives rise to this control? Obviously, it lies somewhere between the interactions of the lists. And, in particular, we claim it lies in the spatial configurations of the lists.

Lave's argument is not explicitly oriented towards the spatial arrangement of the shelves and its effects on the equality of list1 and list2. A second example will provide a better outline the spatial mechanisms that intervene during a course of an ongoing activity.

A projection of a dynamic list in the space

Other spatial projections appeared with manipulated objects when a user, as a cook in a kitchen, rearranges the space within the course of action to set priorities. In that case, the user becomes a partial designer of the spatial structure.

In this section, list1 and list2 have the same meaning than in the previous section.

We studied the cooking activity by videorecording several times a cook in its home kitchen. In this activity, the recipe is as a pre-representation, such as Lave's list1.

But now, the spatial arrangement of the items is shaped online (i.e. along with the making of the dough, the cook places objects in certain location to realize the dough). Therefore, the spatial distribution of objects into different areas now determine the content of list2.

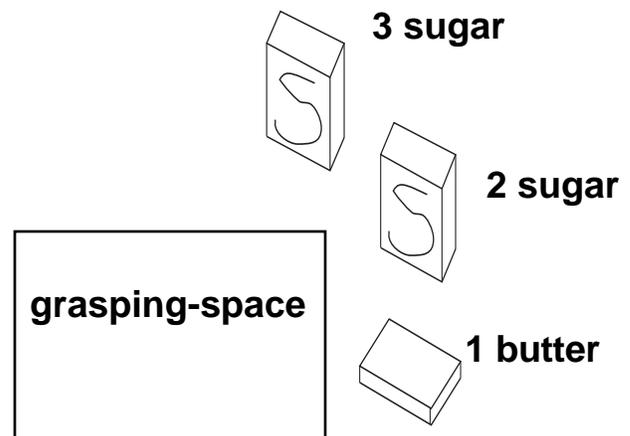
Indeed cooking-tasks imply the identification of the search space. Its characterization can be done on the workspace itself by partitioning the search space into configurations and areas that are clearly or partially bounded. Two main areas can be observed:

- (i) a *grasping-space*, that was called by Mead (1980) the manipulatory area, where the objects are close (both seen and graspable) and ready at hand for immediate use;
- (ii) a *safe-space*, as an extension of the grasping-space, where objects are placed at hands-reach for further use:



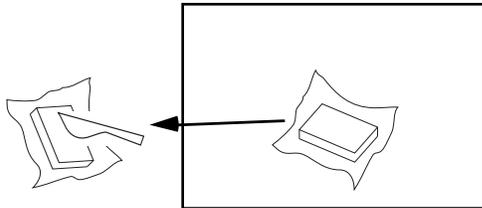
Together with the definition of spatial regions, a close study of the cooks' activities (Conein & Jacopin 1993) reveals different spatial arrangements of manipulated objects, which facilitate the flow (i.e. control) of execution:

1- Object alignment. A set of objects are aligned in the safe-space in respect with their future use by presenting a temporal order:



2- Object gathering. Objects that will be used at the same time in the same action sequence are grouped together in the safe-space, distinctively of the others.

3- Object combination. Objects can be assembled as a tool-kit. This is a special case of object gathering and is better understood as an icon. For instance, the construction of both a knife and the butter, one above the other, and the knife aligned with the body of the cook, placed aside of the workplace just before their use:



These three kinds of spatial construction made of objects must be linked the process of spatial configuration of regions and areas with partial boundaries. Certain spatial regions, as the safe-space, act as a reservoir and denote a suspension of an action and in certain cases a transformation of a plan.

Discussion

We start with the hypothesis that an inventory of objects, by being placed in an equipped space, plays the role of a control structure.

Whereas Agre and & Horswill (1992) attach states to objects in term of cleanliness, we propose spatial "states" instead. Object alignment corresponds to the usual queue (First-In First-Out) data structure and consequently evokes a sequential organization of activity. An inventory of objects as they are arranged in certain regions in the workspace can act as a projection of a plan. A projected plan is not made of action representations but acts as a control structure that sets agenda and priorities.

Object gathering prepares the involvement of objects in the same activity; for instance, the cook places the flour and the sugar packages nearby because they are to be mixed at the same time later on. The control thus is to be understood in terms of constraints on execution : the iteration (picking-up, mixing, ranging) that would range over all the needed objects now only concerns the mixing. That is, it concerns the crucial action towards the achievement of the dough making goal: control contraction by object grouping. Object combination could be interpreted in terms of representation and information cueing (Kirsh 1995): an icon appears on the workspace to remind the agent when to use the objects inside the display. In terms of control, the action is suspended and to be resumed later.

This latter interpretation presents two advantages over the former. First, it avoids climbing the hierarchies of representations and second it uses the spatial placement for shaping a visual display by assembling two related objects. Indeed, the suspension of action comes together with a displacement of the objects: they are let aside of the workplace during the suspension of the action.

Consequently, the spatial placement reinforces the information about the suspension, something that the iconic interpretation would not do: icons can be found anywhere.

If a workspace can be used as an informational display, then everyday objects as a source of informations for action serve as contingent cognitive artefacts (Norman 1991). So the proliferation of cognitive artefacts in our world of technology can be viewed as a specialization of simple mechanisms of objects use in action.

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