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Title: Specific characteristics of innovative design in agriculture: a distributed design of biotechnical objects

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Theoretical work about innovative design has been originally based on the industrial sector. Innovative design has been opposed to classic engineering situation. It opens the door for new thinking about R&D management. A unified formal framework for design has been proposed by Hatchuel and Weil (i.e. 2009) based on the definition of two spaces that interplay, the space of concepts and the space of knowledge. This theory, mostly developed from and confronted to industrial case studies, opens up new perspective to “creative rationality” (Hatchuel 2002) and expands Simon’s proposal of a bounded rationality. This theory is now challenged by its use for designing a large range of objects and its relevance is discussed to give account or support design processes in more open and distributed design contexts (Gasser et al., 2003; Detienne et al., 2012). As Kazakçi (2005) has underlined it, this theory partly ignores how the design process is situated, i.e., how the environment of designers and their situated nature should be taken into account. In this paper (ibid), he has argued that an environment space E should be introduced to the theory. Cerf et al. (2012) have proposed to add a U space to conceptualize the materiality of use, the feed-back of the situation as developed by Schön (1994) and how it interplays with the space of concept and knowledge (and vice versa).

In this communication, we propose to revisit this proposal of a U space in the light of innovative design in the primary industry (agriculture). We will firstly develop why innovative design is required since agricultural processes are no longer designed to increase the artificiality of the natural environments by the use of pesticides, fertilizers and mechanization in order to maximize the productivity of the crops but rather designed to enhance the existing ecological regulations within the agroecosystems (Meynard et al., 2006, Meynard et al., 2012). Secondly, resting on our experience in designing decision tools, agricultural production process or collective organizations, we will discuss the need to reconsider the way CK theory takes the design situation into consideration. More precisely, we will address this from a double perspective:

- The first one points the need to consider the properties of the objects in design and their contexts of use. Biological objects can indeed change in unforeseeable directions due to short regulation loops or long term responses to given actions. This high adaptability of biological objects (plants, animals, landscape, etc.) makes their monitoring quite difficult and highly dependent on the extreme variability of the conditions (soil and climatic ones for example) in which they fit. As far as the design of agricultural processes aims at promoting biological regulations, this adaptability, which the former “artificialization” of cropping situations had partially erased, becomes more crucial. It becomes more difficult to clearly separate the monitoring of the object and its non-deliberate changes under unforeseeable climatic conditions or evolution of its biotic environment. Therefore, design has to be achieved in highly uncertain environments and there is a need to embark the adaptation and the feed-back loops which can hardly be revealed *in silico* and will be revealed through *in situ* tests.
- The second angle emerges thanks to some specific organizational characteristics of the agricultural sector. Design takes place in quite open and distributed networks crossing various organizations. To a certain extent, they can be compared to some open and distributed design communities as observed in the OSS ones as described by Détienne

et al. (2012). Indeed, we speak of open and distributed design to recognize the design activity of various players, among which farmers are important ones. We do not only call for the recognition that the users continue design in use and that design can be seen as a developmental process as suggested by Cerf and Béguin (2004) for example. We also wish to better capture the processes which support radical innovation in the primary industry. For example, a farmer might design a new cropping system by combining species and techniques in such a way that it finally results in a radical innovation (combination of different species and no-tillage and local fertilization techniques, etc.). But this can be the result of a “bricolage” which is highly linked with the feed-back he gets from the cropping situation at different time spans (from infra-year to multi-years) in some very specific conditions (soil, surrounding of the farm, etc.). This invites the farmer to constantly design new adjustments over the year. Radical innovations likely to contribute to a transition towards sustainable agriculture can emerge in a step-by-step process while fitting better to some specific conditions. In this process, concepts are not necessarily made explicit, and the value of making them explicit can be discussed. The radical innovation emerges from a step-by-step process in which there is a need to support the “dance” between knowledge creation and use situation. It is even more crucial when the design process aims at creating new spatial distribution of cropping systems and of cropping management practices in order to manage water quality in water catchment as the collective dimension (coordination amongst farmers and other stakeholders) has to be taken on board.

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