# Renewing collaborative design in the management of animal genetic resources

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**Abstract:** *In French agriculture, the dominant mode of animal genetic resources management relies on cooperation between scientists and farmers. The latter take part in the definition of breeding objectives and in the production of genetic data via on-farm milk recordings. This mode of collaborative design is currently being called into question by cooperative failures and criticisms from farmers about the mode of knowledge production involved. We review the literature of present theories and methods of collaborative and participatory design, and then use an intervention-research project to analyse the way two initiatives of new modes of collaborative design can renew collective capacities for the management of local genetic resources.*

***Keywords:*** *participatory management of natural resources, collaborative design, design regime, innovative design, animal genetic resources, milk sheep industry*

## Introduction

The design of sustainable farming systems is based on sustainable management of the resources that they mobilize. For example, genetic resources are crucial to the sustainability of these systems. Their management faces various challenges, between the pressure of globalization and liberalization, and the emergence of more participative approaches of agrobiodiversity (Bonneuil *et al*, 2006; Labatut, 2009; Vanloqueren and Baret, 2009). Managing the genetic resources mobilizes farming systems entails a collective scale of design and management where cooperation between different actors (farmers, scientists, managers) and user participation are essential. Except with a few cases[1], breeding activities need certain types of cooperation: for plants breeding, cooperation between seed companies and the farmers who test and produce seeds; for animal breeding, cooperation between cooperatives/breeding centres and breeders. In addition genetic resources are common goods their management and preservation are based on the communities to which they belong[2]. Within this structure, farming systems, and thus the arrangements that design and produce the resources that they use, face multiplying challenges. Our research question is: how is the collaborative design of agricultural genetic resources evolving to adapt to new objectives of sustainable development, and which new collaborative design approaches are implemented?

In France, collective management of animal genetic resources for food and agriculture has, at least for ruminant species, been based since the 1960s on principles of participation by breed users. Animal geneticists and farmers are engaged in a collaborative process that aims at improving breed performance and producing scientific knowledge: it requires the active participation of farmers in the production of information on animals. This is done through artificial insemination, on-farm milk recording, the production and morphological qualification of breeding animals, and the choice of breeding objectives. The French national research and development system processes the information gathered on-farm to give each animal a breeding value. Thanks to this structure of

[1] Cases of largest industrial farming systems which have a sufficient number of animals, capital resources and competences (large farms run by veterinarians for example) to manage autonomously their breeding activities.
[2] Even if latest evolutions according to intellectual property rights, patents and biotechnologies tend to reduce this specificity of genetic resources.

cooperation both specialized and local breeds have improved their productivity, quality and health. Yet it is currently being called into question by cooperative failures and unexpected consequences. Breeding objectives and the erosion of variability and biodiversity are put into question, supported by scientific controversies (Hansen, 2000). There is also criticism of the mode of knowledge production involved, in particular about the relevance of scientific theory to producing sustainable breeds and the modes of intervention of geneticists. Moreover, breeding organisations are in an environment where uncertainties are manifold and various, where breeds compete against each other, and where public support is in decline. Breeding objectives cannot be defined *a priori* any more: increasing the productivity of a breed is no longer sufficient to ensure its sustainability. Objectives, values and collectives need to be redefined. All these reasons call for changes in the way objectives and knowledge for the production of genetic resources are constructed. A "top-down" vision of innovation is no longer sufficient, nor is a separate view of design and use. This is why we argue that drawing on design theories is fruitful for analysing and possibly redefining the process of innovation involved in the collective and participative production of genetic resources.

Our subject topic here is the management of animal genetic resources (i.e. breeds used in livestock farming systems) in agriculture, in particular for animal breeding activities. Even though they have a "biological" dimension, resources used in these activities are not given, but designed (Labatut, 2009). In a paradigm where genetic resources were seen as stocks, the term of design has not until now had a place in their management. Yet we consider that they have always been the result of a collective design process. By "design" we generally refer to *"collective efforts destined to create objects, equipment, techniques, even social systems, that are at the same time original and in keeping with the values or desires of the time"* (Hatchuel and Weil, 2008). These activities entail design processes because their object is to design the type of animal and the performance desired from it. A breed is not already there but results from a technical and social construction on the long run. So do the farming systems using the breed. The object is also to design the instruments and organisations, the collectives that make it possible to reach these objectives. As Hanna and Unceasing (1995) emphasized, *"one of the central difficulties in the use of natural resources is the design of management systems that are effective, equitable, and efficient"*.

We aim hereto understand why this collaborative design process of animal genetic resources used in agriculture (i.e. breeds) has difficulties to adapt to new objectives of sustainable development and to investigate and analyze the actual changes in design process. We aim at identifying new modes of knowledge production and new types of collaborative practices in order to favour innovation.

## Theoretical framework

A large body of sociological work has developed the analysis of increasing participatory approaches in Science and Technology, what Jasanoff (2003) called the "*participatory turn"* of science studies. It has sought to categorize participatory situations along a continuum of degrees of participation, showing that in agricultural research the participation of non-experts usually centres on the consequences rather than on the design of science and technology (Bonneuil *et al*, 2008), while in medical and biomedical science patients' organisations are engaged in the research process (Callon et al, 2001). Others have considered new regimes/modes of knowledge production ((Nowotny H. et al, 2001; Pestre, 2006) in which scientific research would be more socially embedded. However, this body of literature has mainly focused on the external analysis of participatory science, analysing the difficulties of implementing the "*alluring calls for democratizing science and technology under the present social, economic, and political circumstances*", and the problems and limitations of participatory approaches (Lengwiller, 2008). The starting point for these studies is science, and the way "lay citizens" take part, to varying degrees, in the production of science. Our perspective here is slightly different:

- First, we start from detailed analysis of the actual design processes involved in the production of a specific resource (here, animal genetic resources), trying to avoid the opposition between what is science and what is not, between scientists and "lay citizens".

What we address here is the production of a common good (a breed) for which scientists do not have the monopoly of production (it is almost impossible to produce it without involving the actual owners of the breed, the farmers).

- Second, our perspective is both theoretical and managerial: our aim is to analyse the actual changes in processes of design, but also to question the existing theory of design developed in hierarchical, well defined context of firms to the specificities of distributed and democratic context of the production of common goods in agriculture.

These are the reasons why we draw on design theories from a number of fields. More precisely, we have identified various areas of theory in which scholars have developed different types of approach to participatory design and co-innovation. They have common source in seminal authors such as Simon (Simon H.A., 1991; Simon H.A., 1995), who defines design thinking as *"a process for practical, creative resolution of problems or issues that looks for an improved future result"* (Simon, 1969).

Historically, computer sciences and cybernetics (for instance artificial intelligence and its applications in expert systems (Winston, 1984)) were born as design sciences. They were used in many domains to design new tools in "*engineering, medicine, business, architecture and painting [which] are concerned not with the necessary but with the contingent - not with how things are but with how they might be - in short, with design*" (Simon, 1969). At the crossroads between computer science and ergonomics, there is work on the design of new tools (Zacklad, 2003; Zouinar M. et Salembier P., 2000) within Computer Supported Collective Work (CSCW) (Redmiles D., 2002). Research in these scientific domains has ultimately focused on designing new tools to facilitate collective work, while leaving socio-organisational issues aside. In parallel, some cognitive ergonomics work has developed a conceptual framework with numerous empirical studies on how design occurs in a collective work setting (for the French school of ergonomics: Cahour B., 2002; Darses F. and Falzon P., 1996; De Terssac G., 1996; De Terssac G. and Friedberg, 1996; Theureau J. and Filippi G., 1994; Visser W. and Falzon P., 1992), within micro-level investigations of specific situations showing a single space/time unit.

Another body of work, referring to the sociology of design, has studied design processes through the objects and tools used by participants in the collaborative process of design (Jeantet *et al*, 1996; Jeantet, 1998; Star S.L. and Griesemer J.R., 1989; Vinck D. et al, 1999; Vinck, 2004). Scholars consider these "intermediary objects" as "*analysers that allow access to the reality of the actual processes of design"* (Jeantet, 1998). While these approaches describe the work of designers and their use of intermediary objects very precisely, they mainly describe design with a comprehensive position and do not propose a theory and methodology of design which could be used to renew design processes. Their approaches do not provide frameworks to analyse historical evolutions of design processes.

The third body of literature we have identified is linked to organisational studies and management sciences, where a huge amount of research has been done on innovation and its management (Callon, 1986; Whitley, 1999; Argyris C. et Schön D.A., 1996; Nonaka, 1991). Proposing the concept of socio-technical regime, Kemp (1994), Geels (2005; 2007; 2004), had taken into account in the analysis of technological trajectories, not only the activities of engineers but also the roles of scientists, politics, users and stakeholders in the evolutions of technological development. While the distinction between "innovation" and "design" is sometimes implicit, some scholars argue that the innovative capacities of an organisation rely on the management of design activities and competences (Hatchuel, 2002).

These approaches have rarely been mobilized in connection with natural/agricultural resources design and agricultural innovations. For example, much NRM research to date sought to integrate knowledge about a domain problem and make it available for policy development and the decision-making process. Some has tried to include the knowledge of stakeholders and build a "shared view of the problem" in participatory modelling processes (i.e. "Integrated Assessment", (Pahl-Wostl C., 2005)). In this work research, Natural Resources that must be managed are considered as given objects where "problems" must be solved. We argue here that it is more fruitful to define precisely the long-term evolution of collaborative design rather than to consider participatory research as

something "new" in natural resources management, the "solution for better management".

Our proposition is that organisation and management sciences offer methods and theories that are pertinent to the analysis and support of design processes relating to natural resources, and to genetic resources. In particular we propose to draw on research which deals with the necessity to manage design processes rather than just knowledge or learning in innovation situations. More specifically, we will mobilize research by Hatchuel, Le Masson and Weil (Hatchuel 1996b; Hatchuel and Weil 1999; Weil 1999) on the processes and methods of innovating design, for a number of reasons. First, this approach can characterize different systems of design over the long term, notably the cycles between systematic and innovating design. This theory can thus help us qualify the dominant system of design in the management of animal genetic resources, its crisis factors and the ways that it evolves. Second, this approach offers a theorization of the collective process of design, on the scale of organisations, not of the individual or of the designers alone. The theory may thus have an application outside the conventional business framework, in pluralist situations (Denis *et al*, 2007) such as ours where there is no unity of time or space, where power is distributed, where the organisation's frontiers are blurred and it consists more on networks of actors. Last, this theory directly offers a managerial perspective because it proposes a method to accompany the design processes (Le Masson et al., 2006), described and piloted through two facets: existing knowledge and concepts currently specified. For these authors, "*the running of the design process consists in taking an interest in the way these two facets exchange: how the necessity to specify abstract concepts leads to the activation of knowledge, and how knowledge enables to specify the concepts"* (Le Masson, 2000). This design theory is formalized through the C-K model that distinguishes between two expansible spaces that co-evolve during the design process: the space C for Concepts (which does not exist yet) and the space K for knowledge (what is already known or must be explored). Concepts can be "a feminine car", that we could translate, in our domain, by "an animal adapted to mountain breeding", or "a sustainable cow". A concept *«does not represent a reality but a potential for expansion"* (Le Masson et al., 2006).

How we use this framework is first to analyse the evolution of collaborative design in the management of animal genetic resources. Within these two dimensions, these scholars identified two types of design processes (systematic design, innovative design) that define the modes of knowledge production in the process of innovation, and the links between research, innovation and design. Systematic design occurs when the process of design can be broken up into separated stages, and when it is possible to design in one stage regardless of the following ones. In this process, the product of the design can be defined through several functions which can improve separately (for example the various breeding criteria for an animal: milk production, milk quality, udder morphology…). The value of the products, the business model, and the relation with the market are stabilised (for example: a high level of milk production to supply a cheese processing industry), which stabilizes the nature of the product performance (high level of animal individual performance). The competences needed for design process are well defined and structured into separate trades: design process can be divided between firms and the trades in each one (for example, work division between scientists who work out the animal performance, breeding centres which organise the production and the mating of breeding animals, and farmers who provide the breeding scheme, with data on offspring performances). The expansion in this systematic design regime is limited to a family of products predetermined by the generative model.

Confronted with the expansion of the objectives of design and an unstable economy, these systematic design processes must be renewed. Asaro (2000) indicates that *"the current heterogeneous field of participatory design claims the twin goals of increasing efficiency (of both technical experts and users) and increasing democracy (primarily for users)"*. This is why authors such as Hatchuel, Le Masson and Weil (2008) consider that a design system is emerging, the innovative design regime. Innovative design is a process *"where the target is not stable and where value criteria are changing or can be discovered on the way"* (Hatchuel *et al*, 2008). It does not separate design and use, but integrates the use into the design. "*We no longer need to just conceive the means for our ends. We are now enjoined to conceive the very ends that our societies must choose if they want to*

*save their life structure"* (Hatchuel and Weil, 2008).

We mobilize here this typology of the design regimes that Le Masson *et al* proposed to qualify more precisely a situation of collaborative design of genetic resources and try to understand its crises and evolution paths. We argue in particular that to say that a natural resources management setting is "participatory" is not sufficient to ensure its sustainability and legitimacy.

## Empirical case and method

Most of the research on collaborative design in the domain of natural resources was written in developing countries. Keeping these resources is also an important challenge in industrialized country. This is why we studied the case of the sheep milk and cheese industry in the Western-Pyrenees, South-West of France, and more specifically the improvement and management of the three local breeds used to produce the milk: the Manech Red Face, the Manech Black Face, the Basco-Bearnaise. Thanks to the research done by INRA for the Lacaune breed in the Roquefort region, were breeding innovations for sheep have been designed, and to the active participation of local breeders, a breeding centre and three breeding schemes were implemented in Western-Pyrenees to increase the efficiency of the breeds and as a result the farmers' income. Genetic improvement has been a success, but cooperation between farmers and R&D organisations is still difficult (Labatut et al., 2007).

For three years we conducted an in-depth longitudinal field study with open interviews, participant observations and archival research. We studied local practices and the organisation of breeding in the Western-Pyrenees, as well as the practices, discourses and theories of the animal genetics scientists involved in the improvement of the three Western-Pyrenees breeds. We realized interviews with two types of actors: (i) designers of the breeding technologies, mainly scientists; (ii) participants who perform, daily, the breeding activities; (iii) stakeholders concerned with the local breeds and actors from different functional areas (cheese processing industries, professional organizations, local governments). We conducted, recorded and transcribe fifty-two semi-structured interviews. These interviews usually lasted between one and four hours. We used direct observations to gather data on the collective sequences of design activities, and to follow performances in situation, which at the same time was a second occasion to ask people what they do, how they do it and why they do it the way they do it. We attended every important meeting of the breeding center, and followed the various stages of the breeding activities, both on farm and at the breeding centre (milk-recording on farms, artificial insemination, animal certification, etc). Our objective was to understand how knowledge and innovation were produced, by which dynamic, and the underlying participative model; the exact part breed users (direct users such as breeders, but also actors of the industry and territorial collectivities) play in the production of knowledge, the design of the animals to select, and the instruments and mechanisms to make this selection. We also did intervention research in addition to this observation and data collection research. For two years we animated and took part actively in the design of selection and industry indicators so as to place these activities among the 5 scenarios of a previous prospective study. Thanks to this we could analyse «from the inside» a new form of collaborative design.

Our goal here is to understand why this collaborative design process is facing a cooperation crisis as well as criticisms, and to investigate ways to re-shape this process with new modes of knowledge production and new types of collaborative practices.

We'll take three steps: first, we describe the type of collaborative design system observed in the Western-Pyrenees since the late 1970s, identify the criticisms/failures in this system, and diagnose those failures. Second, we analyse how the collaborative design has recently evolved (and is still currently evolving), introducing a new design regime. To confront these failures two methods of collaborative design, one completed and the other at its beginning, are detailed and analysed to understand how these two initiatives can help change the "design regime", promote and include previously excluded perspectives (farmers outside the breeding schemes, territorial actors, etc.), through cooperation and collective learning cycles. Third: we discuss the collaborative design

theories with the help of these ongoing experiments.

## Results

### A historical participation of used in design processes

In France, animal genetic selection is based on particular coupling forms between the State, public research and the industry (breeders and national or regional professional organisations). Some authors described them "socioeconomic, neocorporative orders" (Aggeri and Hatchuel, 2003). In a period of Colbertist State intervention, since the Breeding Law in 1966, public research (through the INRA) was strongly committed to organise the improvement of the productivity of French livestock. A breeding regime was set up based on cooperative organizations where breeders were administrators. UPRAs (Union for the Promotion and Selection of Breeds), whose members were also breeders, were commissioned to define the breeding objectives of the breed in their care. In the Western-Pyrenees, one selection centre (le Centre Départemental de l'Elevage Ovin/ County Centre for sheep breeding) and one UPRA were thus created at the end of the 1970s to organize the selection of the three local breeds of the county. These two places design the breeds in defining their performance objectives and managing the flockbook. Thus a certain type of users (the breeders) takes part in this design through Board meeting and General Assemblies. When breeders ask for evolutions to be implemented in breeding schemes, for example a new breeding criterion such as milk quality, the INRA scientists come to present different breeding scenarios, depending on the weight given to this new criterion and on the state of scientific knowledge. Breeders who are board members then collectively decide, helped by the managers of the breeding centre, of the weight that should be given to the chosen criterion. Some of the breeders there are also in charge of other organisations of the sector, such as the association of PDO Ossau Iraty, cheese made from the milk of the three local breeds, and the Interprofession Laitière/Milk Intertrade.

But the boards of administrators of these organisations are not the only way for breeders to take part in the breed design process. They also take part in two other stages of knowledge design and production on these animals. On the one hand, they are involved in the production of information needed for the selection through milk recording. This concerns all the breeders (20% of the farmers population), and not only those who are members of the board. On the other hand, breeders also take part in animals qualification, where one can assess animals according to the morphological criteria defining the breed. Breeders taking part in this stage are also breeders who were asked by the breeding centre to join. These two activities are also two stages of the design of an efficient animal.

### Limits of participatory design systems

The breeders thus intervene at the same time in the definition of the production objectives, in the production of the information needed to reach them, and in the definition of the outlines of the object that must be designed, through the checking of the appropriateness of the animals to the breed standards. Yet in spite of these different places of collaboration in the design process, some groups of breeders criticized the way selection schemes work, are governed and their objectives. Some consider that "the administrative people are those who decide", others that "the schemes just follow the Lacaune model", others yet that "breeders should be more taken into account", among others when animals are assessed. Sometimes criticisms are directed towards the scientific knowledge used in these breeding schemes, and the models designed in other contexts (such as the Rayon de Roquefort) that are seen as something imposed and not as the local construction of specific breeding schemes. Surprisingly, some breeders who were previously milk controllers for the breeding schemes (thus perfectly knowing the way they work), do not subscribe to these collective schemes when they set themselves up. Scientists do not think these criticisms are justified considering the breeders participated in various spaces in scheme design. There is also the fact that animals are assessed on-farm, in their specific breeding context. These two elements should guarantee the

specificity and the appropriateness of the schemes vis-à-vis the Western-Pyrenees territory.

We could notice discrepancies between this theoretical model and the observed design processes. Until the 2000s, the dynamic of breeding scheme design corresponded to a systematic design regime, according to Hatchuel *et al* (2006) definition. During the twenty first years of the breeding schemes, the "identity of the objects" that were designed stayed stable: the criteria of animal performance was defined by an increase in individual performance, even if the criteria were not only milk production but also milk quality. The choice of criteria in the Western-Pyrenees followed the same path as in the Roquefort region, for the Lacaune breed. The choices offered to the breeders in the Western-Pyrenees are not, as designers often think, only driven by farmers demand. It is also defined and oriented by several factors:

- The availability of the scientific knowledge needed for the integration of a new criterion ;
- The technical feasibility and the economic cost that this integration generates. The criteria with a low marginal cost of integration were privileged in comparison with those that would have required to veer from the trajectory already taken in the Rayon de Roquefort and to create new knowledge.

A strong path dependence comes indeed from the technical and economic difficulties stemming from new experiments or new measures at the level of several hundreds of farms. The criterion of sanitary quality of milk (the cell level in the milk) illustrates the effect of these constraints. After the settlement of milk quality and milk quantity, there were two "available" criteria to be implemented next (those already implemented in the Roquefort region, where knowledge, genetic modelling and the measure methods are already designed and tested): the sanitary quality of milk or the morphology of the udder. On one side, the morphology of the udder was a criterion quite costly to implement (an heavy measuring device as it requires a complex procedure of visual evaluation of the udder, the standardization of the judges, etc.). On the other side, the data already existed on the cells. As a result, the criterion of milk sanitarian quality was chosen. These elements reveal that the design process of the breeding strategy (choosing the breeding objectives and integrating new criteria) was based on a principle of systematic design (Le Masson P. *et al*, 2006): little new knowledge is created compared to those produced in the Rayon de Roquefort, and the performance criteria stay the same in both areas.

Yet this regime of design was shaken by an external factor. The mad cow disease at the end of the 1990s forced those in charge of the sheep breeding schemes and the scientists of INRA to quickly find a solution to prevent scrapie disease, in particular in the Western Pyrenees where the risks were the highest. An experimentation of genetic selection for scrapie resistance was led in a number of farms, and the results were quickly put in practice on all the schemes, including in Roquefort. In this case we can talk of an innovating regime of design because the nature of the performance changed: the goal was no longer to improve the individual productivity of animals but to guard collective action against sanitary risks. The nature of the means implemented in the design process changed too. Means that should be implemented were unknown: prophylactic means? Genetic ones? Genetic means were finally implemented, but a method radically different from the selection that had been realized for the last twenty years was used: performance (resistance against the disease) was not evaluated by the observation of the phenotype (they would have to get the animals sick!) but directly on the DNA genotyping of the animals in order to identify those who possessed alleles of resistance against the disease.

These changes only partly modified the regime of design. The mode of participation of breeders in the various places previously cited did not changed. They kept not being directly engaged very much in the production of knowledge on the resistance against scrapie. This confirms the argument that to recognize a design process as a participative one is not enough to ensure its legitimacy, since there are still criticisms and breeders leaving the breeding schemes. Various elements can be put forward to explain this phenomenon: the composition of the board of both the breeding centre and the breeding organism: only a fraction of the breeders were represented, mainly coming from 20% of the direct users of the breeds (and genetic gain producers). One of the three breeds, the Manech Tete Noire, was also very poorly represented (only one or two breeders who used this breed were present

for each meeting), and its breeding scheme was the flimsiest in terms of cooperation (from 63 Manech Black Face breeders in 2000 to 52 in 2009, and from 18269 ewes to 14509 in 2009). Regarding the participation of the users in the design process, the choices available were also strictly defined: the identity of the objects to be designed stayed centred on the animal and its performances that can be separated into different factors that can be improved independently. In terms of experimental protocols and evaluation criteria of results, the choices still belonged to breeds managers and scientists. They collaborated with farmers to provide the animals, directly in the farms, for the experiments, and afterwards to produce the information required for the routine genetic calculations. Thus in this regime the state of scientific knowledge inevitably defines the design process: the extension of the knowledge space (according to the C-K theory) is collaborative between breeding scheme managers and scientists (the genetics engineer from the breeding centre took an active part in the experimental protocols ) but hardly beyond, for example when it must involve breeders and/or the more indirect users of the breeds (the industry and territory actors).

The emerging criticisms and the difficulties, particularly the financial ones, that breeding schemes are facing with the State currently withdrawing from breeding activities, combined with the multiplication of the objectives allocated to agricultural activities, reveal the instability of the identity of the objects to be designed. The identity of local breeds seems currently challenged: should competitive local breeds be selected, rather than using more specialized ones? Should the breeds that convey and support the image and culture of a territory be chosen? What is the value that the industry created (territorial development, economic development, etc.)? It seems that the known ends are no longer sufficient or legitimate now (the orientation of genetic breeding is not unanimously shared), no more than the ways to reach them (the legitimacy of scientific knowledge is sometimes challenged). The « dominant design » (Le Masson and Weil, 2008) at work does not thus seem to redefine the goals of collective action. As Callon (2004) tells us though, *"to design new technologies, new goods and new services, is not just a question of satisfying needs or demands expressed by well-identified human beings. It is also and mainly shaping new forms of human agencies and consequently constructing new types of collective life"* (Callon, 2004). As Hatchuel *et al* argue, this situation raises what is no longer a knowledge "transfer" question, but one about *"management of the reciprocal learning vital to the collective production of knowledge. This management presupposes new types of organization described as "design-oriented"; as these encourage cycles of collective learning, they make possible the simultaneous regeneration of objects, skills and professions".* In this context (cf tensions between liberalization and territorialization), performance and evaluation criteria are not known and must be designed. A review of the evaluation criteria does not only imply to design new dimensions of the performance, though, but to question as well the existing performances. This can turn out to be very tricky, particularly when the "dominant design" is strong (Elmquist and Segrestin, 2008). It seems necessary, then, to revive the capacities for innovation, the "*collective abilities to re-create on a permanent and simultaneous basis new sources of value (products, concepts, patents, environmental values, etc.) as well as skills (knowledge, know-how, trades, etc.)»* (Elmquist and Segrestin, 2008). It is necessary for this to stop viewing collective action and its trajectory through the decision theories, and adopt the perspective offered by the theory of design. Thanks to the latter we can, while objects have an unstable identity, consider that the possible alternatives to the "dominant design" are not pre existing but must be created (Elmquist and Segrestin, 2008; Hatchuel A., 1996; Hatchuel A., 2001b; Hatchuel A. and Weil B., 1999; Le Masson P. *et al*, 2006) : rationality (the appropriateness between means and ends) must be expansionary. What was before considered given must now be designed.

To confront these new challenges, breeding schemes managers and scientists began various steps to support and favour innovating conception processes and new forms of collaborative design. Two of them are analysed more thoroughly here, revealing the emergence of a new design regime.

## A participatory forward study and a set of indicators to share knowledge among a

## fragmented industry

In 2003, breeding schemes managers took the initiative to implement a "prospective genetic study" to identify the various scenarios of evolution of the local breeds and of the dairy ewe industry in the Western-Pyrenees. They also constituted a Groupement d'Intérêt Scientifique (Scientific Interest Group) which gathers all industry actors as well as many scientists. They claimed that this approach, voluntarily collaborative, will help them counter their current difficulty: *"The difficulty comes now from some breeders calling into question the main lines of the selection, but mainly by the growing difficulties to finance our breeding actions, in particular by territorial collectivities, as our grant applications are in competition with others. Under these conditions it becomes more and more urgent to reformulate a breeding project that is really shared by all the producers, and put back in the European economic context."* (mail from a person in charge of economic forecasting to a scientist, July 15, 2003). This approach mobilized 40 people: breeders, those in charge of the industry's organisations (PDO association -guarantee of origin-, joint-trade organisation), managers of the selection schemes, scientists… to build five prospective scenarios. It is important to observe that the actors implicated in this approach were not only those usually implicated in the process of designing breeding schemes, the members of the board. There were also breeders "from the outside" and industry actors other than the directors (technicians, the prime movers behind the organisations of the industry etc.).

This approach widened the sphere of knowledge and the sphere of the concepts that could be invested during the design process: possibilities that where unthinkable before such as "the restriction of the IA linked to the interdiction of the hormonal synchronization, possible in this strong "societal" pressure context; what can we do without the IA ?" "do we have to work on the hardiness?" "do we have to implement different criteria for each of the three local breeds*?"*. This work also put forward the fact that innovation, to ensure the sustainability of the industry, cannot be just technical. It has to be social and interorganisational: the commitment of all the occupational families, the support of the territorial collectivities, etc.

Once the scenarios were constructed and shared, those in charge of the prospective approach were facing the expectations of stakeholders such as territorial collectivities: how to use these scenarios for public decision making? They decided to continue with the collaborative approach and build indicators to follow the evolution of the industry. Theses indicators had two objectives:

- At first, make it possible to regularly identify in which scenario(s) of the forecast the industry was, and make that a subject of debate inside the industry ;
- A second objective then appeared : to be used as a "tableau de bord" (Bourguignon *et al*, 2004) that help the actors of the industry in its strategic piloting.

Because the agricultural sector does not have the unified and hierarchic structure of an organisation or of a company, the absence of one organ in charge of its orientation makes design work difficult. Mutual knowledge of the activities of the various actors of the industry is also difficult to attain. The building of a collective instrument of knowledge of the industry's evolution was thus a challenge to favour these strategic piloting, an aid to long-term decision in a very unstable context. It also was an answer to the expectations of actors such as territorial collectivities. This "tableau de bord" could help them determine their degree of commitment and the amount of money granted to the industry.

Different works showed how indicators are not an end in itself, but above all a medium for learning and cooperation (Bernard, 2008; Bourguignon *et al*, 2004; Moisdon, 1997; Moisdon, 2005). If the indicators are sometimes recognized to just slightly influence management practices, they allow the "enrolment of actors". B. Bernard (2009) indicates that "*around these tools, these actors join forces, confront each other and find ways to cooperate"*. What is important here is thus to see (though the reasoning is still in its infancy) how these performance indicators become a tool for cooperation and negotiation between actors, which favours information feedback and a more horizontal capitalisation (Moisdon, 1997). This work mobilized the actors of the industry and made them realize the importance of a collective tool of strategy: *« The concrete question we must ask now is : "why do we now have to search for data that everyone keeps to himself even though it concerns the whole*

*sector? […] Within the framework of this tool, data comparison could be done by sending of a card that gives an overall picture with the indicators filled in to a centralising organisation – the GIS – or even better, via an online database. This would render the access easier, above all everyone could be informed of a sector data that he does not directly have»* (person in charge of AOC Ossau Iraty).

Thanks to this forecasting approach the nature of the actors implicated in the design process of genetic strategy evolved. It also widened both the space of concepts and of knowledge when it revealed unexpected possibilities (impossibility to use the IA, sanitary crisis, etc.) and shared information that was scatter between various actors in the industry. But though this collaborative method widened the "visual field" of those in charge of the selection, it did not really make it possible to design concrete proposals to develop the way breeding schemes function. It remained at the level of the definition of a collective goal (one scenario among the five got the votes of the shareholders), but did not provided the tools to fulfil this goal. To design organizational, technical, genetic or systemic innovations to achieve this goal, a second step has been proposed, but is still in its early stages.

## An innovative design workshop to explore new innovation paths?

The "innovative design workshop" method is a second path of collaborative and innovative design. It stems from the works on design theory we brought up in the first part. This workshop proposal is based on a method called K-C-P which takes up the principles of the design theory proposed by these authors. It implies the organisation of three types of workshop, the order is chosen on the way: a workshop to share knowledge (K), another to explore concepts (C), and a third to structure proposals (P). Here we bring up the first insights of how this method, created in the classic business world of large firms, could be adapted to a distributed situation such as breeding activities, and the questions that remain open.

- The aim of the first phase (K) is to share intensively knowledge: participants meet to exchange their knowledge on predefined themes. Experts can then be asked to intervene : the objective is to make an «inventory » of the existing knowledge. What is important then is to limit the leadership risks from a participant or an expert to the detriment of the others, to avoid all forms of intellectual tyranny and critical and non constructive interventions. It is a collaborative participation process, where different actors collaborate and are put on an equal footing. It emphasises linkage through the exchange of knowledge, different contributions and the sharing of decision-making power during the innovation process (Probst and Hagmann, 2003). In the Western Pyrenees, breeders, geneticists, experts in other management devices of local breeds (Aubrac, Alpes du Nord, Roquefort, Corse) or in other domains (territorial development) could intervene and see to it that everyone's knowledge is equally taken into account. It is important to mix the various trades. This phase of knowledge mutualisation is all the more important for this fragmented industry in the Western Pyrenees. Depending on the theme that is chosen the various points of view on this question could come out during this phase[3].

- The goal of the second workshop (C), is to bring out these concepts that should be kept and to work on both the definition of the knowledge that will be needed and on the feasibility of these innovative concepts. The methodology stresses the importance of encouraging participants to use roundabout means rather than their habitual reasoning, what they usually do in their work. In our case, performance criteria other than the productivity per animal should for example be imagined, but also

[3] One of the themes brought up with professionals during the first stages of this reasoning was hardiness – the genotype/environment interaction. This theme was raised because it is highly controversial in the Western-Pyrenees and one of the reasons given by some farmers for not using breeding technologies: a loss of the breeds' hardiness. For geneticists, hardiness is linked to the genotype/environment interaction, which is, in their opinion, low enough in the Western-Pyrenees to not be taken into account. This theme, and the concepts which could rise from it, might challenge traditional thinking of both farmers and geneticists. This theme raises broader questions than just the animal as such, as also the farming practices and farming system, through the use of mountain pastures for summer grazing or not, and market structure, through the economic value of a cheese produced with hardy animals in tough environment such as mountain.

concepts linked to more organizational innovations, or innovations on how animals are raised, used and broader farming systems. Hence the importance of the reasoning in C: if we only work on knowledge, tensions between the various logics of selection can continue to appear. Rather, the alternatives that could come out of these workshops are not mutually exclusive.

- The third phase (P) is the synthesis of the previous ones. It allows the identification of a new strategic space and of new performance criteria. It should help determine the actions to implement. For example to favour breeders to take part in the elaboration of the experiment protocols. It is indeed important that they are collectively validated so that the knowledge that is produced during these experiments is more easily legitimated. There are no projects to realize, but knowledge and concepts to explore in a near future. Participants must then think about new performance measures, outlines of solutions ; new skills to implement.

## Concluding remarks

The implementation of this method is still in its early stages. A lot of questions remain open: how to choose the concept C? How to make sure that traditional thinking will be left aside during the process? "Who is involved?". Designers are easily identifiable (research department for example) in "classical" firms, but adapting this method to a collaborative design process in such a fragmented situation requires the identification of the actors relevant and necessary to this reasoning. As Callon puts it, "*it is important for the design work to include all those who are going to be concerned by the innovation, and why it must be as open as possible*" (Callon, 2004). Oft-ignored actors should be mobilized, as "*participatory work should be proactively inclusive with practitioners actively attempting to include and seek out people who are often ignored or do not take part in community development or research processes*"[4]. We started to identify those actors and their mobilization has just started: farmers who were in the breeding scheme and had very good results but left the breeding scheme a few years ago; actors from new local organizations such as the association for transhumant sheepherders, etc.

"Innovative design" is not a goal by itself but a way to regenerate the collective capacities to manage local genetic resources in order to ensure their sustainability and to put the challenges of competences and social organisation forward. Design process is more important than the concrete systems/technologies that can be designed *in fine:* it allows learning cycles and new relations between participants, the building of a common culture and the identification of new paths of innovation and concepts. Yet several questions remain unanswered. First of all, how can we define the link between the collaborative design of genetic resources and the farming systems design? Can we transfer these methods to the level of the farming systems design? Second of all, it is important to avoid an hegemonic discourse on participatory/collaborative design and co-innovation. Several authors emphasized the "tyranny" of participation, thus we showed that there is an essential co-existence and a cycle between the different modes/regimes of design. Finally, how can we ensure the collaborative process in the innovative design workshop, i.e. the equal participation of every actor in the process? How can we minimize asymmetries and controversies on what is known? We will have to carefully take this into account during the process.

## References

Argyris C. and D.A. Schön (1996) *Apprentissage organisationnel. Théorie, méthode, pratique,* De Boeck Université.

Asaro P.M. (2000) "Transforming society by transforming technology: the science and politics of participatory design", *Accting.Management and Information Technology*, vol. 10, pp. 257-290.

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Bernard B. (2008) "Itinéraire d'un indicateur forestier, De l'émergence et de l'enrôlement", *Revue française de gestion*, vol. 2, n°181, pp. 97-110.

Bonneuil C., Demeulenaere E., Thomas F., Joly P.-B., Allaire G. and I. Goldringer (2006) "Innover autrement? La recherche face à l'avènement d'un nouveau régime de production et de régulation des savoirs en génétique végétale" in *Quelles variétés et semences pour des agricultures paysannes durables ?* (Dir.Gasselin P. et Clément O.),

Bonneuil C., Joly P.-B. and C. Marris (2008) "Disentrenching experiment: the construction of GM crop field trials as a social problem", *Science Technology Human Values*, vol. 33, n°2, pp. 201-229.

Bourguignon A., Malleret V. and H. Nerreklit (2004) "The American balanced scorecard versus the French tableau de bord: the ideological dimension", *Management Accounting Research*, vol. 15, n°2, pp. 107-134.

Cahour B. (2002) "Décalages socio-cognitifs en réunions de conception participative", *Le travail humain*, vol. 65, n°4, pp. 315-337.

Callon M. (1986) "Eléments pour une sociologie de la traduction. La domestication des coquilles Saint-Jacques et des marins-pêcheurs de la baie de Saint-Brieuc", *L'Année Sociologique*, vol. *Numéro spécial La sociologie des Sciences et des Techniques*, n°36, pp. 169-208.

Callon M., Lascoumes P. et Y. Barthe (2001) *Agir dans un monde incertain,* Editions du Seuil, Paris.

Callon M. (2004) "The role of hybrid communities and socio-technical arrangements in the participatory design", *Journal of the center for information studies*, vol. 5, pp. 3-10.

Darses F. et P. Falzon (1996) "La conception collective : une approche de l'ergonomie cognitive" in *Coopération et conception* (Dir.De Terssac G. et Friedberg), Octarès Editions, Toulouse.

De Terssac G. (1996) "Le travail de conception : de quoi parle-t-on ?" in *Coopération et conception* (Dir.De Terssac G. et Friedberg), Octarès Editions,

De Terssac G. and C. Friedberg (1996) *Coopération et conception,* Octarès Editions, Toulouse.

Elmquist M. and B. Segrestin (2008) "Developing innovative capabilities: lessons from an experimental process in the automotive industry using a design theory approach", EURAM, pp. 1-27.

Geels F.W. (2005) "Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective", *Technological Forecasting and Social Change*, vol. 72, n°6, pp. 681-696.

Geels F.W. and J. Schot (2007) "Typology of sociotechnical transition pathways", *Research policy*, vol. 36, pp. 399-417.

Geels F.W. (2004) "From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory", *Research policy*, vol. 33, n°6-7, pp. 897-920.

Hanna S. and M. Munasinghe (1995) *Property rights and the environment, social and ecological issues,* Beijer International Institute of Ecological Economics and The World Bank, Washington.

Hansen L.-B. (2000) "Consequences of selection for milk yield from a geneticist's viewpoint", *Journal of dairy science*, vol. 83, pp. 1145-1150.

Hatchuel A. (2002) "Towards design theory and expandable rationality: the unfinished program of Herbert Simon", *Journal of management and governance*, vol. 5, n°3-4,

Hatchuel A. and B. Weil (2008) "L'activité de conception : figures anciennes et défis contemporains" in *Les nouveaux régimes de la conception, Langages, théories, métiers* (Dir.Hatchuel et Weil), Editions Vuibert/Cerisy, Paris.

Jasanoff S. (2003) "Technologies of humility: citizens participation in governing science", *Minerva*, vol. 41, n°3, pp. 223-244.

Jeantet A. (1998) "Les objets intermédiaires dans la conception. Eléments pour une sociologie des processus de conception", *Sociologie du travail*, vol. 3, pp. 291-316.

Jeantet A., Tiger H., Vinck D. and S. Tichkiewitch (1996) "La coordination par les objets dans les équipes intégrées de conception de produit" in *Coopération et conception* (Dir.De Terssac G. et Friedberg), Octarès Editions, Toulouse.

Kemp R. (1994) "Technology and the transition to environmental sustainability : The problem of technological regime shifts", *Futures*, vol. 26, n°10, pp. 1023-1046.

Labatut J., Aggeri F. and N. Girard (2007) "Building dynamic capabilities by means of routine creation: the case of a technological breeding routine in sheep farming", Vienna, 10-7-2007 pp. 1-30.

Labatut J. (2009) Gérer des biens communs: Processus de conception et régimes de coopération dans la gestion des ressources génétiques animales, Doctorat de l'Ecole Nationale Superieure des Mines de Paris, spécialité "sciences de gestion" Mines Paris Tech, pp. 1-382.

Le Masson P. (2000) "La gestion des connaissances : au-delà des effets de modes, une notion essentielle pour comprendre et affronter les évolutions de l'entreprise", pp. 1-57.

Le Masson P., Weil B. and A. Hatchuel (2006) *Les processus d'innovation. Conception innovante et croissance des entreprises,* Lavoisier, Paris.

Le Masson P. and B. Weil (2008) "Conception, Recherche, Innovation : le raisonnement de conception, maillon essentiel de la relation recherche-innovation", Formation doctorat Science et Entreprise, 14-18 janvier 2008

Lengwiller M. (2008) "Participatory approaches in science and technology: historical origins and current practices in critical perspective", *Science Technology Human Values*, vol. 33, n°2, pp. 186-200.

Moisdon J.C. (1997), *Du mode d'existence des outils de gestion,* Seli Arslan, Paris.

Moisdon J.-C. (2005) "Comment apprend-on par les outils de gestion ? Retour sur une doctrine d'usage" in *Entre connaissance et organisation : l'activité collective* (Dir.Teulier R. et Lorino P.), La Découverte, Paris.

Nonaka I. (1991) "The knowledge-creating company", *Harvard Business Review*, vol. Septembre-novembre 1991, pp. 9-

Nowotny H., Scott P. and M. Gibbons (2001) *Re-thinking science. Knowledge and the public in an age of uncertainty,* SAGE Publications,

Pahl-Wostl C. (2005) "Actor-based analysis and modeling approaches", *The Integrated Assessment Journal*, vol. 5, n°1, pp. 97-118.

Pestre D. (2006) *Introduction aux Sciences Studies,* La Découverte, Paris.

Redmiles D. (2002) "Introduction to the special issue of CSCW on Activity Theory and the practice of design", *Computer-Supported Cooperative Work*, vol. 11, n°1-2, pp. 1-11.

Simon H.A. (1991) "Sciences des systèmes, sciences de l'artificiel", *Trad.Fr.J.L.Le Moigne, AFCET Systèmes*, pp. 223-

Simon H.A. (1995) "Problem forming, problem finding, and problem solving in design" in *Design and systems: General applications of methodology. Volume 3: Praxiology. The International Annual of Practical Phylosophy and Methodology* (Dir.Collen A. et Gasparski W.W.), Transaction Publishers, New Brunswick, NJ.

Star S.L. and J.R. Griesemer (1989) "Institutional ecology, "translations" and boundary objects: amateurs and professionals in Berkeley's Museum of vertebrate zoology, 1907-39", *Social Studies of Science*, vol. 19, pp. 387-420.

Theureau J. and G. Filippi (1994) "Cours d'action et conception d'un système d'aide à la coordination. Le cas de la régulation du trafic du RER", *Sociologie du travail*, vol. 4,

Vanloqueren G. and P. Baret (2009) "How agricultural research systems shape a technological regime that develop genetic engineering but locks out agroecological innovations", *Research policy*, vol. 38, pp. 971-983.

Vinck D., Blanco E., Bovy M., Laureillard P., Lavoisy O., Lécaille P., Mer S., Ravaille N. and Th. Reverdy (1999) *Ingénieurs au quotidien. Ethnographie de l'activité de conception et d'innovation,* PUG, Grenoble.

Vinck D. (2004) "Les objets intermédiaires dans les réseaux de coopération scientifique. Contribution à la prise en compte des objets dans les dynamiques sociales", *Revue Française de sociologie*, vol. XL-2, pp. 385-414.

Visser W. and P. Falzon (1992) "Catégorisation et types d'expertise. Une étude empirique dans le domaine de la conception industrielle", *Intellectica*, vol. 3, n°15, pp. 27-53.

Whitley E.A. (1999) "Understanding participation in entrepreneurial organisations: some hermeneutic readings", *Journal of Information Technology*, vol. 14, pp. 193-202.

Winston P.H. (1984) *Artificial Intelligence,* Addison Wesley Publishing Company, Cambridge.

Zacklad M. (2003) "Un cadre théorique pour guider la conception des collecticiels dans les situations de coopération structurellement ouvertes" in *Psychologie Sociale Appliquée; Economie, Médias et Nouvelles Technologies* (Dir.Bonardi C., Georget P., Roland-Levy C., et Roussiau N.), Coll Psycho, Paris.

Zouinar M. and P. Salembier (2000) "Modélisation du contexte partagé pour l'analyse et la conception des environnements de travail coopératif" in *Ingénierie des Connaissances. Evolutions récentes et nouveaux défis.* Eyrolles, Paris.