The sustainable fibres of generative expectation management: The “building with hemp” case study.

Marc Barbier, Pauline Caron, Pascal Le Masson, Franck Aggeri

Chapter 12. The sustainable fibres of generative expectation management: The "building with hemp" case study

Pascal Le Masson [1]

Pauline Caron [2]

Marc Barbier [2]

Franck Aggeri [1]

Abstract

This chapter accounts for an emerging logic underpinning the governance of innovation at the level of socio-technological regimes facing expectations and promises for emerging industries. Beyond the scientific literature on management of R&D resources, IP rights and core competences, we question the governance of innovation when it consists in managing the dual expansion of expectations (value landscape, creation of new visions and new interests, etc.) and the realisation of those expectations in organisational arrangements at the niche level. This chapter shows that generative expectation management is clearly based on innovative design activities, i.e. on the capacity to create and refine many possible futures within research processes and socio-technical arrangements. It suggests that efficient generative expectation management would benefit from tools and processes able to support innovative design processes.

[1] MINES-PARISTECH CGS, Center for Management Science, 60 Bvd Saint Michel, 75 272 Paris Cedex 06, France, Corresponding author Email: lemasson@ensmp.fr

[2] INRA, UR SenS, Université Paris-Est, Bois de l'Etang, 5 Bd Descartes, Champs sur Marne, F-77454 Marne-la-Vallée, France

1. INTRODUCTION

In cases of systems innovation and radical change in emerging industries, the innovation process seems doomed to experience costly cycles of hype and subsequent disappointments. Expectations are a vital element as they encourage different actors to commit to the process; but the initial promises are often not realised due to the numerous unknown quantities and stakeholders that come into play. This leads to disappointments, to costly cycles and slow convergence towards solutions and sometimes to the end of collaborations. Can these cycles be avoided? Is it possible to manage expectations in cases of systems innovation? To address this issue, we made a detailed study of the emergence of a new industry, which shows unusual features of expectation management: hemp-based construction.

Over the last two decades, a whole industry has emerged around the use of a natural fibre, like hemp, straws, flax, as a "new" construction material. The growth of this new industry has proved to be a long, unpredictable journey based on a number of experiments. What was initially no more that an emerging network of actors gradually became an industry, which tends now to be a robust business with a host of coordinated actors: biomass producers and transformers, lime producers, architects, entrepreneurs, masons, prescribers, state agencies, insurance companies, research labs, etc. The industry is now based on new products, services, competencies and publicly recognised R&D programmes. The process has been a clear success in systems innovation: with neither large financial resources nor the intervention of a prominent, powerful actor, it has been more the result of a *collective process* based on the active cooperation of heterogeneous actors (with different backgrounds, expertise and goals) with a range of scattered, different competencies who succeeded in turning a small, somewhat unlikely project into a successful collective enterprise. In this process, expectations were raised to create the 'bundle' of actors and to support their action. Later, these actors also created expectations to attract the interest of large companies (material and construction firms) and public agencies interested by the promise of sustainable construction using natural fibres.

In the case of hemp-based construction, it is important to stress that the success was anything but predictable. The actors had limited resources; industrial hemp was a marginal crop grown in small areas of land, with small R&D investments and a public image associated with the use of illicit substances, even though industrial hemp is different from the varieties cultivated for such purposes. These were clear obstacles. Expectations helped to overcome them, but strangely enough they did not create the usual pathologies identified in the literature of innovation studies. In this kind of situation, we could have expected to find cycles of expectations, hype and disappointment, and finally one winning paradigm (or a collective failure). Our empirical investigation was carried out under a question that became a constructive enigma: how did this cooperation between a small

network of actors become a large-scale design process, which is now recognised as an industry and a legitimate research and innovation field? Of course, the answer could simply be that it was a fortunate realisation of the initial promise. However, when we analysed the matters of facts to be discovered in this case study, we found that there was more to it than a single expectation in the usual phenomenology. In hemp building, we discovered a new way to deal with expectations, which we labelled "generative expectation management", addressing an ongoing thread of scientific discussion in the growing literature about expectation and innovation through a case study.

A recent body of literature underlined a fascinating phenomenology of expectations, showing striking features in cases of systems innovation. Such situations tend to create hype and disappointments that can be linked to technology-driven speculative bubbles; these bubbles repeat over time in cycles of expectations, which can sometimes slowly converge towards economic growth. The phenomenology also identifies two types of expectations: rational expectations, with a clear promise of profitable investment, and "second-order" expectations (Borup et al., 2009), i.e. expectations that enable first-order ones. It is these second-order expectations that occur in cases of systems innovation. We propose that second-order expectations be called "generative expectations" as they are a condition of rational expectations. Whereas quite a lot is known about the management of rational expectations (clear promise, attracting funders, basing funding on the value of the realised promise), the same cannot be said for generative expectations. Moreover, it appears that when generative expectations are managed as if they were rational ones this leads precisely to the pathologies described above, i.e. fragile collaboration with non-relevant stakeholders, resulting in repeated, costly cycles of hype and disappointment. Managing generative expectations is hence an open research question.

The hemp case is an exemplary case of generative expectation management, which did not lead to the classical "pathologies". Through an in-depth case study, using the most recent analytical frameworks available to study proposals on partially unknown objects (C-K design theory), this chapter describes a new model of generative expectation management. We show that generative expectation management is based on the dual, simultaneous and complementary realisation of promises and the renewal of promises; that it is aimed at committing designers (instead of funders); and that it is based on the creation of a common space for collective, innovative design, managed as a common good.

2. ANALYTICAL PERSPECTIVE AND RESEARCH QUESTIONS: GENERATIVE VS. RATIONAL EXPECTATION MANAGEMENT

2.1. A phenomenology raising critical issues for the management of expectations

The literature has helped uncover a phenomenology of expectations, which is particularly visible in Van Lente's cases (Van Lente, 1993; Van Lente and Rip, 1998), in Geels and Raven's Biogas case (Geels and Raven, 2006) and in Robinson and Propp's study of lab-on-a-chip technology (Robinson and Propp, 2008b). Expectations have been described as a "natural" phenomenon associated with radical systems innovation (Smith, Voss and Grin, 2010). As underlined by Borup et al. (2006: 2329), expectations can guide activities, provide structure and legitimacy, attract interest and foster investment. They give definition to roles, clarify duties, offer a common perception of what to expect and how to prepare for opportunities and risks. They help to mobilise resources at all levels and to build bridges across boundaries and between communities or groups, or between different levels or scales and different times. However, these phenomena are not necessarily positive and also raise critical issues.

First, with respect to the effects of expectations: they are supposed to create hype – and hence involvement, engagement, investment, etc. - but, as several authors (Borup et al. 2006, Callon, 1993: 2489, Nowotny, 1997: 2490) have pointed out, they may also generate disappointment by creating lasting damage to the credibility of industry, professional groups and investment markets: "Expectations are accompanied by serious costs in terms of reputations, misallocated resources and investment" (Borup et al. 2006). Geels and Raven have also shown that they are *highly sensitive to external factors* (influence of oil price on biogas investments for instance) (Geels and Raven 2006); and van Merkerk and Robinson have focused on the creation of 'irreversibilities' (van Merkerk and Robinson 2006). Some authors have shown that expectations follow cycles linking them to requirements, and that these cycles can converge (requirements are met) or diverge (when requirements are unmet, i.e. expectations are not fulfilled, new promises have to be created) (Van Lente, 1998: 2337; Van Lente, 1993: 2487; Geels, 2006: 2330).

Second, with respect to the people involved: expectations support alignment towards a single shared vision, but this alignment can prevent exploration and divergence (Van Lente 1998). Expectations are supposed to involve actors, but cognitive models of expectations and uncertainty (Sung and Hopkins 2006) have underlined that some expectations tend to involve non-experts, who are less sensitive to uncertainties, contrary to experts who are more knowledgeable about uncertainties and therefore believe less in the expectations, with the effect of downsizing alignments.

This phenomenology therefore calls for a system of management capable of taming the negative effects whilst keeping the positive ones. Following the

programme traced by Borup et al. (2006), we propose to investigate how to avoid exaggerated expectations or hype, without throwing the baby out with the bathwater. What can be done to prevent disappointment from undermining the things that hype is supposed to achieve, such as attracting interest and investment? Expectation management consists in finding a balance between two traps: the first risk is that *expectations are too low to provoke commitments*; the second is that *expectations are too high and hence too sensitive to disappointments.* More generally, we must not only analyse the phenomenology of expectations, but also address the question of how they are managed, i.e. the way in which they can be collectively produced, built up, shared and used as a basis for collective work.

2.2 Contrasting two models of expectations management: anticipative expectations management vs generative expectations management.

The issues raised by the phenomenology of expectations might be due to the fact that there are two very different types of expectations management, associated with two different types of expectations, which are clearly distinguished in the literature.

Expectations as rationale anticipations

The first model is very well described in Propp and Moors' synthesis (Propp and Moors 2009). The authors give the following definition: "*An expectation is an anticipation of the kind of future that may be 'on its way' from within the present. Anytime we speak of a 'trend towards (x, y, z)', we actually extrapolate current events into the unknown ahead; experience may tell us in some instances which outcome is likely, but the results have not occurred yet and are uncertain*." Expectations can be managed so that they follow that pattern: "*Actors simultaneously talk up the deterministic momentum of current developments and suppress uncertainty and alternative futures, hoping for alignment of other actors - and the resources they have or can distribute - around these expectations*" (Propp and Moors 2009).

We find several examples of these kinds of expectations in the literature. For instance, Geels and Raven 2006 showed that in the 1970s biogas development was based on the expectation of "cheap alternative energy generation" based on existing knowledge on digestion and, later, on the promising outcomes of a pilot plant in 1979. In van Merkerk & Robinson(van Merkerk and Robinson 2006) the authors studied a "micro-total analysis system", giving the following example: "*In 1993, Harrison and Manz revealed a large breakthrough in the journal Science with a successful miniaturization of the analytical technique of capillary electrophoresis*". They articulated their expectations as follows (p. 897): "*The application of micromachining techniques to the miniaturization of chemical analysis is very promising and should lead to the development of analytical laboratories on a chip.' Typical advantages of chip-based analysis systems are*

speed, less sample needed and possibly portable." In both cases it is expected that there is a high probability that a new piece of knowledge As (in the example above, micromachining techniques applied to chemical analysis) will give a future F (in the example above, "analytical laboratories on a chip") that meets performance criteria (or more general speaking sources of users value, called S) (speed, portability, small sample,…). The anticipative expectation is the probability to realize F given the assets As P(F/As) to get the value of F given the sources of value Ss, V(F/Ss).

We can underline that these anticipative expectations are constructive in the sense of Borup et al.: there is not necessarily a "real" future F, this F can be imagined and figured out by people at a certain moment of the innovation process. We call them "anticipative" because people need to figure out what the future result will be and decide to "take" this future F or not (anticipate, according to the Latin root *ante-cipare*, means to take in advance).

How is this type of expectation managed? The "expectation raiser" has to design the good sentence "A,S → F with a high value V(F/S) and high probability of success P(F/A)". An anticipative expectation is well-formed when it meets certain criteria: the value of the future state V(F/S) has to be desirable and clear; the probability of reaching F also has to be high and warranted by the initial asset (A). In negative terms, this implies that F should not be emerging, partly unknown or partly undefined. The design effort linking A and S to F has to be minimized. One does not expect changes in As and Ss that would change P(F/A) and V(F/S).

These expectations address a clear, mobilizing (already known, self-evident) value, which is not supposed to change during the realization of F. The expectation raiser tries to prove that the relationship between A, S and F is almost certain (almost deterministic). It is expected that the asset A and the sources of value S will enable the realization of F and its associated value. *Ideally, anticipative expectations are design-free.* Anticipative expectations provoke an alignment of the actors towards F, based on A and S. Alignment means three simultaneous effects regarding collective innovation:

- it leads to identify a network of partners
- it supports their coordination (division of labour) to realize F
- it supports their cohesion (common interest) , based on sharing the value of the future F

As underlined by Sung et al., in this type of expectations, experts and designers aware of the uncertainty, risks and design efforts expect less (Sung and Hopkins 2006). Anticipative expectations mobilize funders ready to pay for A in the hope of F. There is a clear asymmetry between the expectation raisers - who establish the relationship between A, S and F- and the people carrying the expectations.

Anticipation as second-order expectation

Borup et al. suggested that there is another model of expectations, which they called "second-order expectations". In some cases, there is neither a clear asset A, nor clear sources of value S, nor a clear predictable future F. Nonetheless, there is a particular innovation field in which some actors propose to work with others with a view to making some assets (As), some sources of value (Ss) and some valuable future (Fs) emerge. In that sense, this proposal is a "second-order expectation": it is the promise, or the expectation, of *creating* first-order expectations (i.e. anticipative, asset-based expectations). What is expected is the creation of the unexpected, or the 'unexpectable', at a certain moment when well-formed "first-order" expectations cannot be formulated yet. Strictly speaking, rather than generating a single stabilized deterministic link between assets As, sources of value Ss and one valuable future F, expectations tend to support the *emergence* of new assets (As), new sources of value (Ss) and new futures, Fs. Hence, such expectations should help design many possible futures! This is why we call our model a model of ***generative expectations management***. This means that in case of generative expectations an expectation F based on As and Ss will be so unknown that it is impossible to define P(F/A) and V(F/S). Generative expectations are asset-free and design-intensive, whereas anticipative expectations are asset-intensive and design-free.

When this kind of situation is managed in the same way as anticipative expectations, this tends to create hype and a technological speculative bubble. Initially, the expectation raiser might identify a credible A, credible source of value S, and a credible F, with an apparently high probability of reaching F on the basis of A to get high value on the basis of S (anticipative, first-order expectation). In this case, the logic of anticipative expectation does not lead to the exploration of a variety of As, Ss and Fs, but will tend to *reduce* explorations around A, S and F. In anticipative expectations, the link from assets (A) and sources of value (S) to expected future (F) is ideally deterministic, design-free.

Hence, when second-order expectations are managed in the same way as first order expectations, they are formulated to attract investors and tend to be "low-hanging fruits" for non-designers who will ask for simple "first-order" expectations, reinforcing the drift. Moreover, since second-order expectations are related to radical situations of systems innovation with high levels of uncertainty and unknownness, disappointment is very likely to follow on from the hype surrounding "A, S→F". This explains why, in cases of higher uncertainties, this kind of expectation provokes cycles of promises and requirements, as explained in Geels and Raven (2006), Van Lente (1993) and Van Lente and Rip (1998)) and leads to emerging irreversibilities, as explained in Robinson and Propp (2008b).

One can note that the bubble is not caused by a distance between belief and reality (as is the case for classical financial bubbles) but by a distance between the belief and the outcomes of the design process. This is not even an overestimation of the design process (we thought we could get F but finally we can't) but a misunderstanding (or an underestimation) of its real generative

potential (the design process is non linear, expanding, and it generates future that couldn't be anticipated at the beginning – ie that could not be "taken in advance").

To conclude, when second-order (generative) expectations are managed as anticipative ones, they tend to create fragile collaborations, with non-relevant stakeholders, or even non-designers, resulting in cycles with slow or even no convergence.

2.3. Research questions

We can now clarify our research questions relating to the management of generative expectations, in contrast to the management of these expectations in a "rational expectation mode". Is there another model? What features might it have? What are the relevant questions to address?

- Q1: The process of generative expectations management. What are initial generative expectations and how do they evolve over time? In particular we wonder how expectation managers avoid hype and disappointment and long, repeated and poorly convergent cycles.
- Q2: The partners. Who are the relevant partners in cases of generative expectations? What do they expect from the "promise" resulting from their collaboration? In second-order expectations, the notion of "realisation" has no clear meaning since, strictly speaking, there is no clear capacity to realise. Hence, who are the "relevant" partners becomes: what are their interests and how can they be involved in the process?
- Q3: Principles of cohesion. What are the principles of cohesion in cases of generative expectation management? In the absence of a clear valuable future that would echoed a clear robust set of initial assets, the cohesion cannot be based on a sharing of the value of the future, which is uncertain, nor on the costs of it, which is already distributed in property assets, On what can it then be based?

By answering these questions, we expect to clarify some aspects of generative expectations management.

3. RESEARCH METHODOLOGY AND EMPIRICAL DOMAIN

3.1. Case study methodology

Given the limited theory and the goal of exploring organisational phenomena in a new context, we adopted an exploratory approach based on grounded theory-building (Glaser and Strauss 1967; Eisenhardt 1989; David and Hatchuel 2007) and a practice based approach of transformations in agriculture and agricultural R&D (Barbier and Lemery, 2000; Barbier, Cerf and Barrier 2005).

The research method was an inductive, in-depth case study of hemp production and the quest to increase the commercial value of natural fibres. Around 50 interviews were held and analysed with Computer Assisted Qualitative Data Analysis Software and Network Analysis Software (Caron and Barbier, 2009). Two longitudinal case studies were also carried out. Comprehensive meetings were organised with the actors during the research process to improve the robustness of our grounded hypothesis and to discuss their specific stakes.

The empirical study shed light on a revealing case of collaborative design in an emerging industry on the subject of "building with hemp" in France, in the context of the growing interest and value given to sustainable development (Garnier et al. 2007). Despite the fact that single case study methods make general empirical validation impossible, they can nonetheless reveal interesting phenomena, provide opportunities for learning (Siggelkow 2007) and help to propose new models of collective action (David and Hatchuel 2007).

3.2. Empirical domain

This case study is interesting since it does not follow the usual patterns of the dynamics of emerging industries. Even though the core design "team" was composed of small actors, they were able to organise an industry architecture with the majors of the cement and concrete industry (contrary to the classical model in which the incumbent leads the industry architecture or the situation of new entrants as lone entrepreneurs (Ferraro and Gurses 2009)). Even though many hemp producers, material providers, architects and masons were not convinced by the new architecture and could have opposed the new rules, they all participated or at least "went with the flow" without blocking it, as they would have done with a traditional standards committee (Morris and Ferguson 1993). Even though some companies possessed critical assets in the projected industry architecture, they did not freeze the process in a single direction and kept up the broader collaboration (Teece 1986; Jacobides, Knudsen and Augier 2006). This is largely explained by the fact that they all shared expectations for the future of hemp building and that these expectations went beyond their direct (positive or negative) interests.

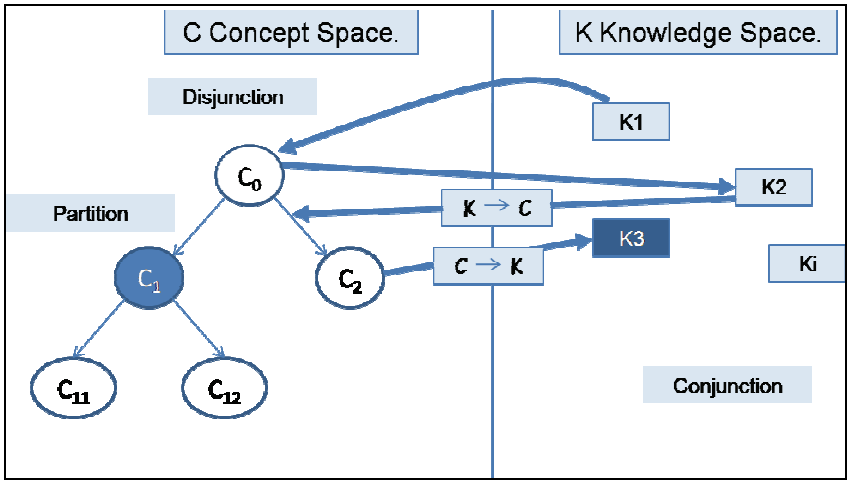
3.3. Interpretative analysis of data

K.M. Eisenhart, with many other authors of organisation studies, suggested that a set of different methods has to be used to "triangulate" results; in this study, discussion seminars and documentary analysis were used as a complement to the interviews. Using the reference framework proposed by (Geels and Raven 2006) we rigorously followed the evolutions of expectations, learning and networks over time. Building on the works on multi-path mapping (Robinson and Propp 2008b), we analysed the *various* expectations of the actors over time through the detailed study of settings, significant events or pathways, and narratives as

proposed by innovation studies (Callon and Law, 1992; Deuten and Rip, 2000) and their application to sustainable innovation in agriculture (Barbier 2008). This retrospective account was organised in what can be called a map of the "value landscape" (Thomke, Von Hippel and Franke 1998; Levinthal and Warglien 1999; Baldwin and Clark 2000). It consisted in *mapping all the identified potential futures* envisaged by the main actors with their related value proposal.

One critical issue in our work was the ability to follow the design of new visions and promises. For these purposes, we used the most recent models of design reasoning (C-K theory) (Hatchuel and Weil 2003), which generalise classic engineering design models (Pahl and Beitz 2006) and search models (Simon 1969; Hatchuel 2002). *C-K theory* describes design reasoning as the interaction between two spaces, the concept space (called C) and the knowledge space (called K). Design begins with an initial concept, a proposition that is neither true nor false, i.e. that is undecidable in terms of evidence-based knowledge: we call this separation, a disjunction). In design briefs of this sort, it is impossible to say whether or not the concept is feasible, marketable, and scientifically grounded. For instance, "building with hemp" was already a concept in the 1990s. The design process consists in refining and expanding the concept by adding attributes from the knowledge space (hemp raised issues on water absorption for instance). The process can also lead to the production of new knowledge to be used in the design process (e.g. new criteria and new test bench for hemp concrete, hence mobilising evidences from scientific and technological experiments). The initial concept set is partitioned step by step into several, more refined, subsets. The process unfolds until one refined concept is sufficiently specified to be considered as true by the designer, at which stage the concept becomes a piece of knowledge: we call this coupling, a conjunction). This often means that the concept becomes a manufacturable, marketable product when the conjunction corresponds to commercial products. The generic structure of this design reasoning is presented in Figure 1 below taken from Hatchuel and Weil (2009).

Figure 1. The generic pattern of design reasoning in C-K design theory



The C-K framework helped to encode the set of stylised facts derived from interviews and to enable a complete picture that accounts for the collective and cognitive processes that shape expectation management. We tracked the expansion of the knowledge space and that of the conceptual brief into several varied alternatives. When data was missing or links between C and K were unclear, we went back to our data and if needed to the actors in order to obtain more information (to complete with new data, to confirm shortcuts in collective reasoning, etc.). In this sense, this very general, abstract framework helped to control the consistency of our analysis. The detailed picture of the process under study helped to identify the pieces of knowledge used in the organisation to incrementally develop new products (including strategy, organisations and mental models). These were the design rules, i.e. the routines of action used for incremental innovation. We were able to identify three important types of behaviours: (1) whether designers in radical innovation situations make use of existing design rules (Baldwin and Clark 2000; Baldwin and Clark 2006) or create new ones, (2) how designers are able to define missing knowledge characteristics (from C to new K) and (3) how it results in the production of new knowledge (from K to new K). This method helped us to rigorously identify the competencies used and created throughout the process, and the various paths followed for the different industry architecture alternatives that emerged during the process.

In parallel to, and based on this cognitive perspective, we also analysed relational phenomena by identifying the relevant actors, the types of relations between them, and the structures and activities of organisations. In particular, we followed the type of actions and decisions they faced at critical moments in the history of "building with hemp". Such analytical framework can be found in different works initially promoted by Science and Technology Studies (Latour, 1987; Callon, 1991; Callon et al., 1992; Law and Callon, 1992) or Longitudinal analysis of case studies in Organisation theory (Van de Ven and Poole, 1990; Pettigrew, 1990). We followed the same perspective with one specific improvement: we paid a great attention to the logical status of the propositons held by the actors. As justified above, the study of expectations requires to clarifying whether the proposition relates to the "known" (the proposition is considered as either true or flase) or to the "unknown" (the proposition has still no logixal status).

This distinction is particularly critical in the study of expectations:

for any given proposition on the expected future F, when this proposition is considered as knowledge (in K space in C-K theory) then it tends to raise anticipative expectations, people pay attention to the consequences of the proposition and wonder whether they have an interest in these consequences;

conversely if a proposition on the future F is considered as a concept (in C space), then it calls for knowledge and further concept expansions to explore beyond the concept. People pay attention to the expansions that could be stimulated (suggested) by the concept.

Recnet studies related to issues in creativity in Management Sciences have led to use such a method, where one pays attention to the patterns and momentum of

critical pathways in creative organisations based on the C or K status of the propositions (Ben Mahmoud-Jouini, Charue-Duboc and Fourcade 2006; Elmquist and Le Masson 2009; Gillier et al. 2010; Hatchuel et al., 2006; Hatchuel et al. 2010). Our methodological device tries to articulate these two phylums of thought, particularily requested to address sustainable transition issues that convoke inter-organisational dynamics (Barbier, 1998; Aggeri, 1999).

4. CASE STUDY ANALYSIS: SMART EXPECTATION MANAGEMENT IN "BUILDING WITH HEMP"

The cooperative "La Chanvrière de l'Aube" (hereafter called LCDA) transforms raw hemp into by-products (fibre, hemp chaff, fruit, oil, etc.) with commercial value. Historically, only the hemp fibre, which was sold to cigarette paper manufacturers, was really profitable. However, this business decreased steadily from the beginning of the 1980s and LCDA tried to find new value for hemp products by exploring new uses. We studied the history of one of these explorations – building with hemp – from its beginning in 1986 until 2008, focusing on how LCDA employees were able to manage expectations and finally create a new industry.

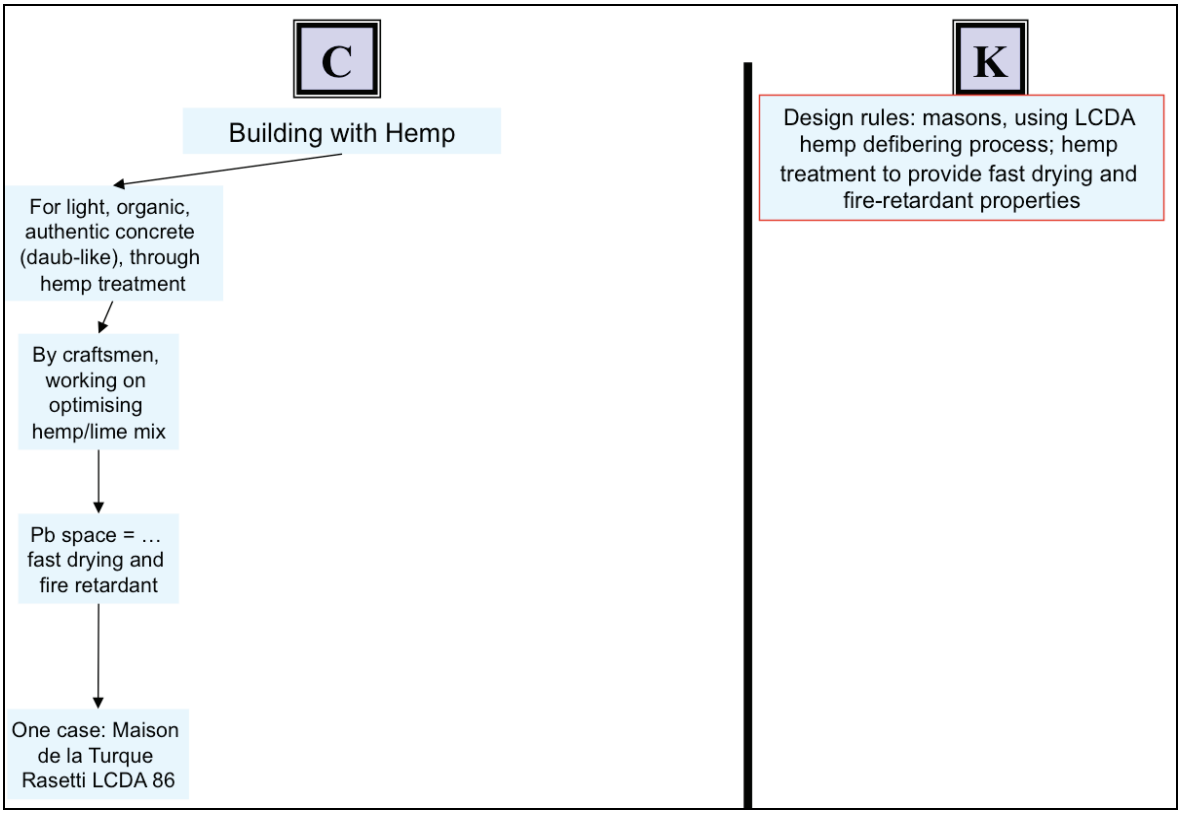
From the collected data, we can clearly distinguish three milestones in the history of the exploration, each of which is structured around a meeting of the stakeholders in "building with hemp". Phase 0: the reference situation, without "expectation management" (1986-1993); Phase 1: raising expectations by designing (and expanding) the innovation field (1993-1998), the first meeting taking place in 1997; Phase 2: developing the first templates of an industry architecture by broadening the innovation field (1998-2005), the second meeting taking place in 2001; and Phase 3: business growth by maintaining the exploration effort (2005-…) with the third meeting taking place in 2006.

4.1. Phase 0: innovation by means of local experiments (1986-1993)

In 1986, Mr. Rasetti, a mason, asked LCDA to supply him with some hemp chaff for building purposes. With Mr. Rasetti, LCDA developed an aggregate of hemp chaff for light cement, Canobiote ®. Competitive products were also launched (Isochanvre®, Canosmose ®). In the following years, LCDA provided several masons with hemp chaff, which they used in cement. The cooperative realised that these entrepreneurs were carrying out technical trials to combine lime with the hemp in order to obtain a daub-like concrete. However, the trials were relatively unsuccessful as there was little market growth and no reliable solutions were found to use hemp in construction. Nonetheless, several applications had been identified by the masons (light concrete, substitution, historical restorations, etc.). One example at that time was the restoration of the *Maison de la Turque* in Nogent sur Seine. As its properties are close to those of daub, the

historians and architects involved in the project considered that hemp cement was an appropriate material for the restoration.

Figure 2: Design reasoning on hemp building (1986-1993)



In this initial phase, from 1986 to 1993, the hemp transformer and all the masons followed one main design rule: *the integration of hemp into cement will be obtained through a treatment of the hemp fibres*. The knowledge regarding cement, construction and lime was limited, as confirmed by the actors at the time. The use of this design rule was determined by LCDA's strategy, whereby construction was merely an opportunity to sell the products derived from an investment in a new defibring process. LCDA also wanted to be independent from cement makers and to avoid any impact on the recent investment in a hemp defibring process. It expected a technical solution to be provided by the customers (i.e. the masons). This was coherent with their organisation, as LCDA's limited resources were devoted to meeting the demands made by the customers of the new defibring process (and not to developing a new hemp-based solution). As a consequence, LCDA kept constant contact with a network of masons who needed hemp by-products for their concrete. It was aware of all the experiments on cement-with-hemp and made marginal adjustments to its defibring process, based on the knowledge acquired from the masons.

Hence, expectations were limited and "building with hemp" was associated with one narrow concept, i.e. hemp for renovation, for light organic, daub-like concrete, for masons, etc. (see Figure 2). Secondly, expectations were not managed at a collective level. Cooperation was limited to an emerging network,

based on informal, reciprocal recommendations between a group of masons and LCDA. Knowledge production was restricted to experiments on fibre treatments. As a result, actors in the field were confronted with decisions such as whether or not to "buy hemp aggregate" or "fund this hemp aggregate company".

4.2. Phase 1: Raising expectations by expanding the innovation field (1993-1998)

In 1993, LCDA decided to invest more heavily in the creation of new applications for hemp, in particular in construction, "*because of several years of very low growth*" (to quote BB, head of new applications for hemp in building at LCDA):

"[W]e had the intuition that the initial path was too narrow and that we should find new alternatives, not necessarily based on hemp treatments for special masonry."

Previous experiments had mainly resulted in unsuccessful trials and difficulties in addressing problems such as the choice of the binder, the type of cementing process, etc. LCDA decided to embark on a rule-breaking phase based on more ambitious objectives. In this perspective, BB started to contact lime producers and managed to launch a development programme with one of them, on a new tack coat. It was officially launched in 1997 and a trademark, "tradical 70" ®, was registered. He also got in touch with new actors – architects, materials scientists – to convince them to work on hemp. For instance, a public research programme was launched jointly by LCDA and ENTPE (an engineering school specialised in construction techniques) on hemp cement characterisation (thermal, acoustic and mechanical properties). From then on, network building continued, but in a different direction.

At the end of 1997, LCDA organised a workshop with a wide attendance base (all the hemp builders at the time), to clarify the potential of "building with hemp". Several experts made presentations on previously unknown aspects of building with hemp, revealing the limits of past experiments. The meeting was an interesting way of providing new knowledge to change mental models and imagine potential collective strategies.

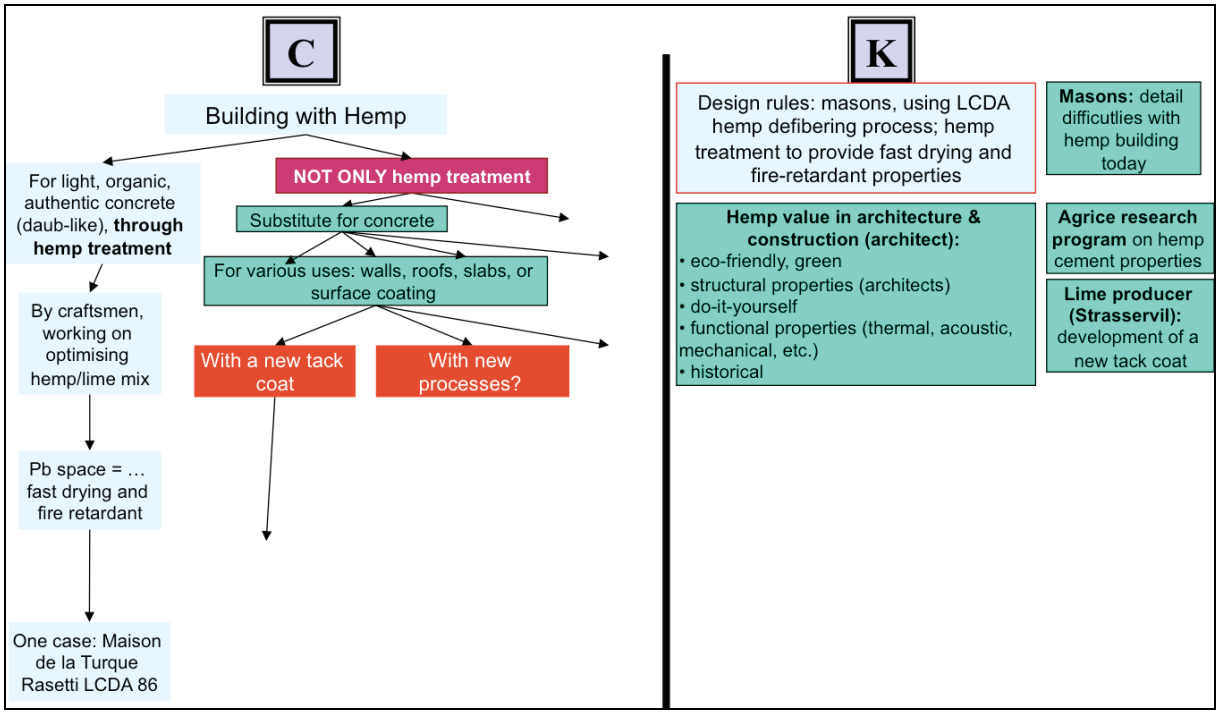
We must underline the very specific knowledge and understanding produced at this meeting. The C-K diagram below (Figure 3) represents a simplified version of the cognitive dimensions of the innovation field that participants discovered during the meeting. To raise expectations, LCDA did not provide one specific promise but set the provisional frontiers of an expanded innovation field, opening new paths with several pending questions. New pieces of emerging knowledge were also assembled by means of the presentations made by researchers, architects, masons, etc. These preliminary results opened more questions than they provided answers. As LG, a mason-entrepreneur explained:

> *"We had a roundtable discussion where everybody explained how they had experimented with hemp building and that there were no problems. When it*

came to my turn, I said: 'I don't understand, you all build with hemp but nobody has mentioned the problems. I have problems, for example that the mortar doesn't dry, I don't know how to mix it, I don't know how to fix it on the wall, the setting is uncertain, etc.' Then we went round the table again and it became clear that we all had the same problems."

Hence, the meeting helped to *raise and share new expectations* and made people aware of the *absence of any reliable techniques*. It could be said that LCDA raised expectations at this meeting, not by validating the technique but by expanding the innovation field to new alternatives. It reinforced the logic of generative expectations.

Figure 3: Raising expectations by structuring the innovation field (1993-1998)



During this meeting, LCDA confronted the participants with a simple decision: whether or not it was worthwhile for them to take part in the "hemp building movement". Rather than having to decide to "buy" or "fund" a business, they had to decide whether or not to commit to an open design process. The decision tree was based on the innovation field described above; it did not show particularly good "first-order" expectations. The emerging industry might show high or low (or even negative) profits in the future, and the meeting had clarified that: 1) there were different alternatives for the future and that 2) none of these alternatives had high or clearly identified probabilities, and all of them were at least partially unknown (and some were almost completely unknown).

This is therefore a case of smart expectation management based on:

- Increased expectations concerning the innovation field, illustrated by the creation of many valuable, high-level alternatives. By correctly managing the

options, LCDA and its partners increased the variety of alternatives, not the means of their success.

- No explicit solution. However counterintuitive this may seem, contrary to classical business plans and fundraising processes, neither credible technical solutions nor clear project management solutions were presented. On the contrary, the meeting underlined the participants' ignorance! However, it helped to identify "shared uncertainties" (Aggeri, 1999) as well as the potential contributions that each participant could provide to the others. This process of identifying shared uncertainties was important as it helped to avoid building up too much hype. It also enabled the commitment of designers and not only funders.

- The action consisted in deciding to "design" or "not to design" with LCDA and its partners, and not to "fund" or "not fund". This decision-making situation led to the selection of *design contributors* as stakeholders (see appendix for more details on the structure of the set of decisions that LCDA was able to design to "select" design contributors)

As a consequence, this first phase ended in 1998 with the creation of a new collective actor, in the form of an association for building with hemp, designed to act as a research and innovation platform for all the participants. The association was created with a stable legal status and an initial mandate from the participants. A governance structure was defined with a *core team of founding members* (hemp transformers, lime producers, material researchers, architects, entrepreneurs, masons), all of whom had relationships with LCDA.

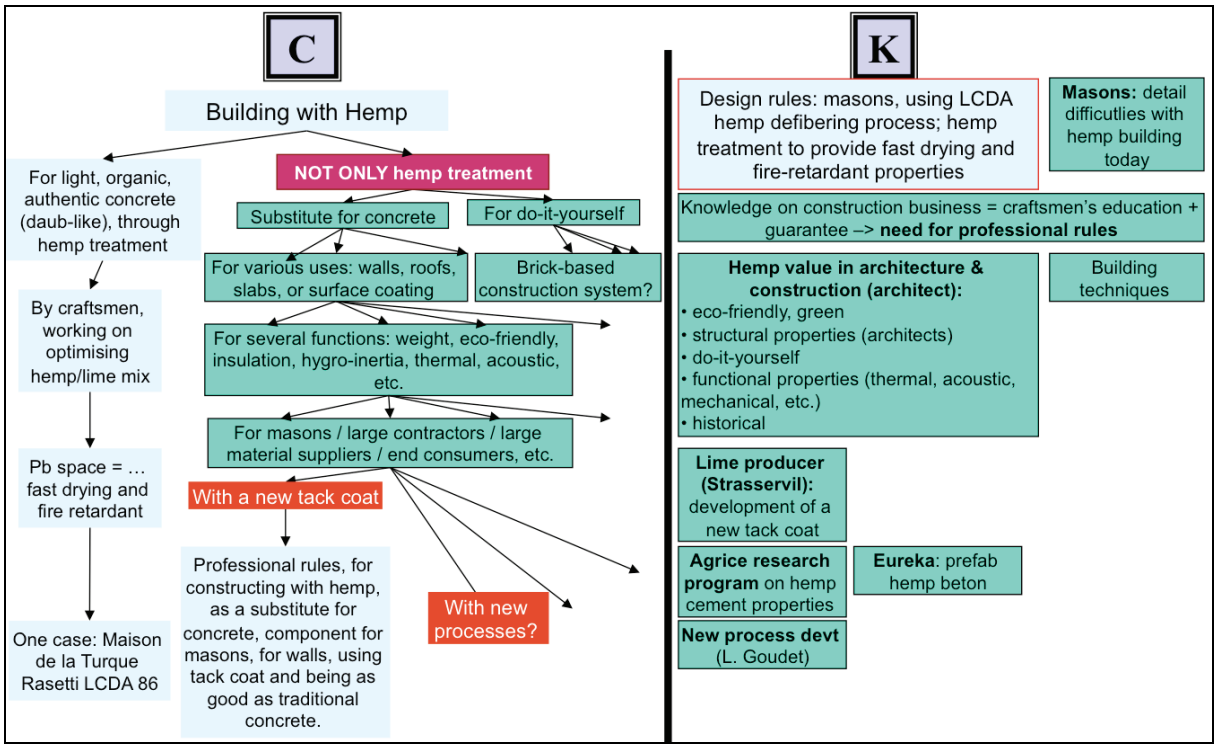
4.3. Phase 2: Developing the first templates of an industry architecture by broadening the innovation field (1997-2005)

After the creation of the "building with hemp" association, the participants started to explore new paths and design complementary experiments. LCDA and Strasservil developed their new tack coat. Research labs started to work on hemp cement properties. Entrepreneurs developed and experimented on their own different processes. Masons worked on how to use hemp concrete in several geographical locations and for various different uses. The core team met every two months between 1998 and 2000 to set in place the association's status, organisation, projects and strategy. In parallel, new members joined the association, in particular the institute in charge of controlling hemp production (FNPC/CCPSC)[4]. During this period, promises began to be converted into products, services and quality criteria. The process of path creation was nevertheless maintained and several processes were explored for building with hemp. New forms of business were discussed, such as selling hemp concrete

[4] The strains of cannabis approved for industrial hemp production produce only minute amounts of psycho-active drug (Δ9-tetrahydrocannabinol (THC)) and certainly not enough for any physical or psychological effects. However, trade in hemp grain and hemp production are severely controlled. Very few countries currently authorise hemp production (France, China, Canada).

building blocks with a complete construction "system". New properties for hemp concrete were also investigated, demonstrating that hemp concrete was not only a "sustainable product, as good as traditional concrete" but that it also had breakthrough properties. As a porous system, hemp concrete enables new types of air circulation in buildings; as a water-absorbing product, it can help regulate humidity; and it can also offer new forms of acoustic comfort.

Figure 4: Developing the first templates of industry architecture by broadening the innovation field (1997-2005)



It became increasingly clear that it was indispensable to organise the industry because robust construction businesses must obtain decennial liability coverage from insurance companies and this requires stable, standardised, validated materials (hemp, lime, aggregates, etc.) as well as routinised practices, implemented by masons qualified to use hemp. The rule-making process consisted in drafting a set of "professional rules". The building profession validated these rules as the "good practices" to be followed to obtain decennial liability insurance. To write these rules, the actors had to select (and validate) some types of products (and hence exclude others) and select (and validate) some practices (and exclude others) to finally stabilise a division of labour (between hemp producers, hemp transformers, lime producers, aggregate producers, masons, architects, etc.) and, unavoidably, the division of value. Professional rules emerged as one way to support business development in building with hemp, but their design automatically meant that potential "winners" and "losers" were identified. This happened at a critical moment when a stable industry architecture was required (i.e. with templates for the division of

labour and value) (Jacobides, Knudsen and Augier 2006) but introduced the risk of conflicts of interests.

The second major meeting on "building with hemp" took place in this context in 2001. 250 people took part, far more than at the first one. In particular, new construction firms and institutions attended the conference (craftsmen, the French Federation of Building (FFB), CSTB (Scientific and Technical Centre for Building), ADEME (French Environment and Energy Management Agency). The participants were informed of the progress made since the last meeting and gradually became familiar with the innovation field as a whole. They also became aware of future issues regarding the professional rules: how could they be developed and taught? What could be done to spread their use?

Interestingly, the focus of the conference was *not* on the professional rules. Participants were simply asked whether or not they would go on building with hemp. As a consequence, the expectations encompassed the whole innovation field, beyond the professional rules. This framework had interesting effects on the stakeholders' commitment. Let us analyse three critical cases:

Potential free riders: one risk in stabilising industry architecture is the emergence of so-called "complementary assets" (Teece 1986; Jacobides, Knudsen and Augier 2006). Owners of complementary assets avoid paying the cost of innovation development although they know they are certain to benefit from it. If a complementary asset owner has to choose whether or not to commit to the development of professional rules, the expectation of utility is greater for the negative response since the revenues and probabilities are the same whatever the choice, but the costs are lower in the case of refusal. In the case of building with hemp, when owners of complementary assets for professional rules had to choose between "go" or "no go" (in committing to the broad "building with hemp" innovation field), they were likely to choose to participate since:

- the innovation field made it clear that there were still many different types of professional rules, so that the complementary asset was not certain;
- the innovation field also made it clear that the professional rules were not the only path and that other paths remained open. For instance, some of the actors interviewed were concerned by the fact that the adoption of professional rules should not be the only option and that other trajectories such as building blocks for the "do-it-yourself" market would still be possible.

Stakeholders hostile to professional rules: another risk in stabilising industry architecture is the emergence of conflicts of interests. As long as the details of the promise remain unknown, the economic consequences and conflicts of interests are unclear. With stabilised industry architecture, the benefits and losses are more easily evaluated. If a potential loser had to choose whether or not to commit to developing professional rules, he would refuse and might even fight the project. However, with the choice of taking part in building with hemp, he was likely to go ahead since:

- the professional rules were still unknown, potentially leaving some degree of freedom for obtaining value from one of their future versions;
- he may have been in a stronger position for the design of other businesses in the "building with hemp" innovation field.

The members interested in the professional rules followed their logic of action and went on developing knowledge to meet the rules' requirements. They were in a favourable position for developing such rules, since their experience in the context of "building with hemp" encouraged them to share knowledge and identify missing knowledge to meet the requirements. The association attracted competent, relevant members, who provided knowledge on the process of creating new professional rules. Moreover, some members of the association took part in the process of validating the professional rules. For instance, the French Building Federation distributed the first versions of the professional rules to its members for criticism and comments.

Hence, the potential contradictions were moderated by an interesting rule according to which members of associations may or may not participate in the professional rule-making process. Those interested in the standardisation of processes opted to work on professional rules; the opponents refused to become involved but still remained members of the association. We must underline that this means that the association had configured two *separate types of decisions*: the stakeholders had to decide to be members of the association; on the other hand, some members had to decide whether to take part in the "professional rule" project. This flexibility and openness encouraged participation in the "building with hemp" association, which continued to expand after 2001. It also produced a paradoxical result: the association launched the professional rule project even though opponents of the project were members of the association. Initially organised as an informal initiative, encouraging results convinced partners in the professional rule group to turn this into a formal project in 2004. The first draft rules were established in early 2007. New research projects were also launched during that period, in particular one launched in 2004 to study prefabricated hemp concrete building blocks with associated systems design principles.

4.4. Phase 3: Business growth by maintaining the exploration effort (2005- 2009)

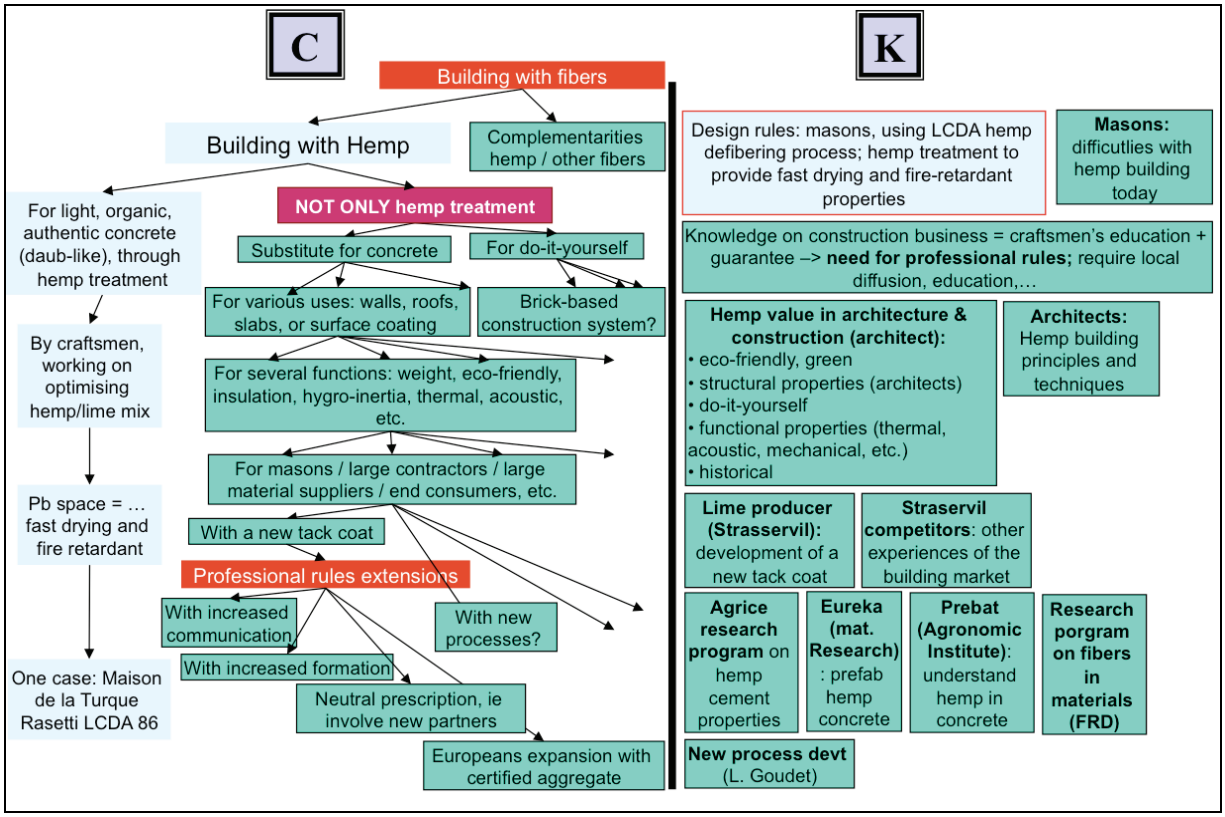
In 2005, the professional rule-making process had reached convergence and templates were about to be set. At the same time, expectations were rising and with them, greater risks of disappointment. In the context of the French presidential election campaign (2006-2007), the left-wing candidate promoted hemp as a sustainable development material for eco-building, which also raised stakeholders' expectations.

During this period, LCDA and its partners followed two main paths in terms of the design process. On the one hand, following on from the professional rules project, they began to design related services, e.g. information on the professional rules;

education and training for masons, based on the rules; generalisation of the rules in the European Union; increased standardisation, etc. One striking action consisted in involving new partners from the construction materials business. The "building with hemp" association contacted the competitors at Strasservil (at the time called Lhoist-BCB) and global firms such as Lafarge, Calcia and other concrete, lime and cement producers. These new partners provided their experience of the construction market and gave increased legitimacy to the association, which could no longer be viewed as an agent for one particular lime producer. In research, the new national Prebat research programme (on energy efficient construction) allowed agronomic researchers to gain a better understanding of hemp in concrete.

On the other hand, new exploratory initiatives were prolonged or launched: a European Eureka programme continued to study construction principles and building blocks for hemp concrete; at the same time, alternative properties were explored for building with hemp (acoustics, hygrometric comfort, etc.); and connections with other fibres were put on the research agenda, for instance by studying complementarities in hemp, straw and wood.

Figure 5: Business growth by maintaining the exploration effort (2005-2010)



In this context, a special effort was made to structure the set of potential decisions. The third meeting on "building with hemp" took place in 2006. This time, it was a major event and hemp was clearly recognised as a matter of national interest. Instead of taking place at LCDA's premises in Bar-sur-Aube, near Troyes (Champagne region), it was held at the Ministry for the Environment

in Paris under the patronage of national representatives. This decision demonstrated the state's support for the association and also meant that several other public administrations and agencies could take part, as representatives from the Ministry of Infrastructure and the Ministry of Agriculture, standardisation agencies and social housing agencies also attended. Why did hemp attract political interest at that time? The major reason was that building with hemp had been recognised as a potential path for addressing issues of sustainability in the construction sector. Over the years, this issue had gradually emerged and had, by this stage, become a major driving force for the development of the nascent industry. These stakeholders were not only a powerful reference for the association, offering valuable support for the public recognition of the professional rules, but also potential partners and funders for new explorations.

From the point of view of LCDA and its partners, the "expectation managers", this event was a great opportunity. Yet, they were concerned about the risk of it creating bubbles of hype and expectations that the actors would not be able to meet. The sustainable development "fashion" might fade, and/or the expectations surrounding the professional rules might be disappointed for large-scale construction. It should be said that hemp was only grown on a total surface area of 10,000 hectares in France, mostly located, like LCDA, in the Champagne region. Confronted with the growing fad for building with hemp, the head of LCDA, Benoit Savourat, tamed expectations in an interview in the newspaper *Ouest-France* in July 2009, by stressing that there were still many uncertainties in the business and many unknown factors to be dealt with. He underlined the fact that large-scale industrial and commercial applications were still far off and that more R&D would be required before a reliable industry architecture could be achieved. LCDA and its partners were nevertheless still interested in expectations design but they hoped that expectations would attract relevant stakeholders, i.e. potential partners to reinforce the network rather than create disturbance. In this perspective, new stakeholders were approached to launch a collaborative research programme on fibres – rather than hemp alone – with applications for building, and on other composite materials.

5. MAIN RESULTS AND IMPLICATIONS FOR INNOVATION GOVERNANCE: EXPECTATION MANAGEMENT AND THE LOGIC OF THE COMMONS

The story is still in the making. Rising expectations are moving in tandem with continuous growth. More farmers have started to cultivate hemp and large investments have been made to develop industrial hemp processes. How far can this innovation lead? To what extent can building with hemp emerge as a credible competitor to concrete, wood or other natural fibre systems (such as straw balls) for sustainable construction? This is still an open question. An interesting evolution is that building with hemp has recently become an international issue with achievements and extensions of the industry's network in the UK, Germany

and the US, where certain states have decided to legalise the cultivation of industrial hemp again on the grounds of sustainability.

Based on this empirical study, we can now return to our research questions to formulate research proposals relating to generative expectation management and then to propose a new model of expectation management.

- R1: promises and realisations co-evolve over time.

Contrary to the usual representations of first-order expectations and business development, instead of the creation of an initial promise *followed* by the realisation of this promise, we see a constant renewal and expansion of promises all along a series of developments. Generative expectations constantly create first-order expectations that are fulfilled on a regular basis of short-term incomes management. There is not just one "expansion" for one business project, but a dual expansion, one for business development(s) and one for a common technological imaginary muddled through time! This dual expansion is managed as a mutual feedback process in which new visions support realisations and vice-versa..

- R2: design commitment: expectation managers design to encourage the commitment of stakeholders who are designers and who expect to obtain better design resources from the collaboration.

Contrary to classical approaches to business development, expectation managers do not look for new business funding; they try to encourage commitment to design. They constantly encourage stakeholders who participate in the design process. One consequence is that, formally speaking, expectation management consists in avoiding the need for stakeholders to make decisions, in the strict sense of decision making under uncertainty, i.e. when the decision does not influence the future "states of nature". Expectation managers tend to favour situations where the stakeholders are precisely those who are able to design, i.e. to create new states of nature!

- R3: the cohesion model can be analysed as the management of a new common good (Ostrom 1990), a common space for generative action.

The cohesion model of expectation management is not based on a pre-existing value to be shared between partners following a common logic of payback maximisation. Cohesion is based on the value of a shared "space" for generative action. The collaboration consists in developing shared value that increases the action capacity of each partner. This space follows a logic of "common good" management in the sense developed by Ostrom (Ostrom 1990). It is neither a private space (a private company competing against the others in an innovation field) nor a public space (a publicly supported innovation field) but a commonly owned one (several stakeholders in an innovation field collaborating to make it grow). Expectation managers are internal regulators of expectations: they keep up a constant momentum, "raising" and "decreasing" expectations to counteract the "hype cycle".

6. CONCLUSION

We have contrasted two models of expectation management: rational expectation management versus generative expectation management. Rational expectation management is well-known. In cases of radical systems innovation, the literature has shown that expectations are necessary but that they are of a different nature, characterised as second-order or, as we propose, generative, i.e. that there is the expectation of creating a first-order, classical expectation. The literature has also underlined that using rational expectation management in cases of second-order expectations leads to fragile collaboration and repeated, slow and poorly convergent cycles of hype and disappointment. Based on the in-depth case study of building with hemp, we revealed a model for managing second-order expectations. This model is characterised by three features:

- The management aims to meet first-order expectations but it also constantly aims to create new first-order expectations and to renew and expand second-order expectations. This is not a process of transforming a promise into a reality, but one of dual (and complementary) expansions of promises and realisations.
- Instead of aiming to convince funders, generative expectation management aims to commit designers. It does so by designing new expansion areas for potential stakeholders.
- The cohesion is not based on an ex ante profit-sharing process relating to a valuable future, but on the management of a common space for generative action. The management of this common space consists in protecting it from external risks and in maintaining collective actions.

This research highlights a new logic for the governance of innovation at the level of innovation fields for emerging industries: *there may be a place, or even a need, for a new actor to manage the dynamics*. Beyond the management of R&D resources, IP rights and competences (which can be done by traditional firms, R&D labs, public regulators and socio professional groups), the role of this new actor in the governance of innovation consists in *managing the dual expansion of the second-order expectations (value landscape, the creation of new visions and new interests, etc.) and the realisation of first-order expectations (i.e. the realisation of visions for some interests).* This new actor could be a private company (see Intel and platform leaders and all the cases studied by Gawer (Jacobides, Knudsen and Augier 2006; Gawer and Henderson 2007; Gawer and Cusumano 2008)); it could be a group of private companies (see our case study; plus innovative design consortia such as the International Roadmap for Semiconductors, ITRS - (Walsh 2004; Cogez, Le Masson and Weil 2010)); or this role could be played by public bodies such as the French clusters. This paves the way to further work on the activities and roles of this collective actor and the different organisational forms it could take in innovation fields.

This research also underlines the fact that generative expectation management is clearly based on innovative design activities, i.e. the capacity to create and refine

many possible futures. It suggests that efficient generative expectation management would benefit from tools and processes able to support innovative design processes, as shown by the pioneering work of Bram and Bos (Grin 2005; Bos and Grin 2008).

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