Managing breakthrough innovations: the SOCROBUST methodology

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Breakthrough innovations are again high on the agenda of management research. Because of the uncertainties faced, they require specific management approaches, both at firm and at project level. The SOCROBUST methodology addresses the latter aspect. Two central results of the sociology of innovation have been mobilised. The most critical one lies in the inversion of scenario making, focusing not on external scenarios but on the project s own endogeneous scenarios, in order to unfold the de-scription of the future world inscribed in the project. The second critical element lies in the implications of the notion of breakthrough innovation. As demonstrated again by the sociology of technics, to break from present market structures, requires a collective agreement. This supposes debates and fora where agreement takes place. Success in fostering agreement is then measured by the robustness of the alignment of arguments and actors arrived at, which makes it difficult to go against the grain, as in the famous example proposed by Rip on tobacco and health. Together these features underpin a methodology based on (i) unfolding the future world of the project and, by comparison with present states of affairs, identifying and characterising strategic or key changes required, and (ii) via a focused external search/watch, assessing the societal robustness of key changes along the three possible breakthrough dimensions identified in the literature: technological, infrastructural (especially the legal, administrative and regulatory environment) and in user-producer relationships. This helps in further characterising the project and the firm s capacity for shaping the market. One test case is used to illustrate it.

1. Introduction

Most innovation projects developed by firms are based on extensions of existing capabilities / competences. However, firms sooner or later reach the point of diminishing returns in their incremental improvement programs (so that) radical, non-linear innovation is the only way to escape the ruthless hyper-competition that has been hammering down margins, industry after industry (Hamel, 2000). Said otherwise and a few years earlier (Tushman and Anderson, 1986), technological change is a bit-by-bit process until it is punctuated by a major advance so significant that no increase in scale, efficiency or design can make other technologies competitive with the new technology . There is thus a need for new lines of businesses, new for both the firm and the marketplace (Colarelli O Connor, 1998), new because (1) they typically present a different package of performance attributes (at the outset not valued by existing customers) and (2) (their) performance improves at such rapid rate that the new technology can later invade those established markets (Bower and Christensen, 1995).

How can these different kinds of innovation be managed? One very clear answer comes from Bower and Christensen (1995) who conclude that, once a firm has coined the strategic significance of a disruptive technology and located its initial market, it should establish an independent organization and keep it separate from present mainstream activities. Abernathy and Clark (1985) suggested another path in their famous article concluding: While a firm may have a dominant orientation, it is likely that the firm will face the task of managing different kinds of innovation at the same time . Tushman and Reilly, a decade later (1996) insisted on the need for ambidextruous organisations able to manage evolutionary and revolutionary change while Colarelli O Connor (1998) considered that sound management practices for the development of incremental improvements may well be detrimental to the development of discontinuous, breakthrough innovation .

Work done recently on how established firms succeed in making radical breakthroughs can be grouped under three headings: the competences needed by individuals, the capabilities firms must enhance through developing appropriate organisational settings, and the project management and monitoring environment. One interpretation of this is that the managers of radical projects require rather specific capacities and capabilities. Chen and Van de Ven (1996) speak of a charismatic leader with enough imagination to create a new vision which narrows attention and rallies unity out of diversity . Tushman and Reilly (1996) speak of ambidextruous managers characterised by relatively long tenure and the will to be constantly striving to renew themselves . Collarelli 0 Connor and Rice (2001) add to these points that the individuals they label as opportunity recognizers must have boundary spanning capabilities . A second interpretation — often complementary to the first one — highlights the organisational features that help in fostering the management of breakthrough innovations. Most recommendations made in this second stream remain rather general with the exception of Collarelli O Connor and Rice (2001) who propose the creation of radical innovation hubs as supporting units.

However we consider it difficult to develop organisational recommendations without considering the very specific dimensions entailed by breakthrough innovations and their implications both on project management and on the environment in which projects are monitored or evaluated. We locate our own elaboration in this third stream following work done by Noori and colleagues on an umbrella methodology (1999) and by Cooper on a strategic marketing planning approach for radically new products (2000). Both Cooper and Noori share the idea that what is required is not a one-off action, but a management framework which provides a place to start, a direction for improvement and a way to update continually a dynamic planning document (Cooper, 2000). Through very different channels, both works highlight three core principles: (i) Scenarios have to be made about the future world in order that uncertainties can be identified. (ii) By taking into account the present situation and the firm s competitive advantages, it is possible to identify steps which can be taken in order to clarify these uncertainties, (iii) The approach must provide for periodic repetition because the development path is generally discontinuous and because additional moments of opportunity recognition are therefore required.

The presentation focuses on the first two aspects which directly address project management. Furthermore, following Chen and Van de ven (1996), we shall focus on the problematic part of the innovation journey they call the exploration phase. We shall mobilize four main results of the sociology of innovation (point 3) to propose an alternative model of characterisation and assessment of the societal robustness of radical innovation projects. The results also explain why societal robustness was selected as a relevant vocabulary rather than embeddedness or more market related terminologies such as those related to risk management. The SOCROBUST[1] methodology is a 4 step process which will be presented globally first and in its different steps through one case study (point 4). This however requires us to render explicit the criteria for success that underpin our approach. Before doing so, we consider some of the characteristics and limitations of conventional and current methods for managing and monitoring breakthrough innovations. Finally, we discuss how this model can be used to successfully guide suppliers and customers through technology partnerships. In the course of time, the development of the technological linkage and the mutual resource-based dependence changes the context of the partnership, and adaptations to the strategic supplier integration may be necessary.

2- Current methods for managing breakthrough innovations — and their limitations

The works done on breakthrough innovations all insist upon the need for a specific positioning of the project within the firm which facilitates its dynamic

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[1] We reserve the term SOCROBUST to describe the process and method we have developed, using it as a trademark .

monitoring. However the solutions put forward remain very traditional. Cooper (2000) locates such processes within the organised marketing function which he describes as one that regulates the flow of resources (in both directions) across the organizational boundary , that is in a functional position within or along the project. Other authors recognize the need for specific organisational arrangements. However their answer remains the classic one of relying upon (mostly external) experts: the team of experts is essential to the success of the approach says Noori who has developed designs for the management of such groups (Noori, 1995). Collarelli O Connor and Rice (2001) suggest that each radical innovation project should be attached to a project oversight board staffed with company members who can make the long-term commitment needed by such innovation and by appropriate company outsiders (to foster commitment by alliance partners and avoid bureaucratic routines). In our view, such solutions have three limitations.

(i) The first limitation lies in the fact that neither decision makers within the firm nor project managers are entrusted with, or believed to have the necessary competences. However, if we follow Abernathy and the need for firms to simultaneously manage incremental and radical innovation projects, such projects have to be included in the processes used to determine the allocation of investment money, on top of whatever other advisory committee might be established. They need to enter into a competitive process, the objective of which is to determine whether or not projects should be allocated the funds and means asked for. Duret, Latour et al. (2000) propose the establishment of an second track of investment funding, specifically designed for breakthrough innovation projects. In addition, theysuggest that a specific evaluation procedure, called PROTEE, replaces that normally used for allocating resources.

(ii) The second limitation is that conventional management solutions do not offer any guidance on how to examine and interrogate project development: instead, the right answer simply depends upon gathering together the right bunch of experts. If we accept the idea of a dedicated method for evaluating investment in breakthrough projects, , the issue is then one of equipping the evaluator so that he/she can make informed and well founded decisions about which projects to proceed with and in what direction. The process of equipping the evaluator is of procedural and not substantial meaning in the sense that, as when calculations such as ROI are used, the evaluator is not required to know about the specificities of the project. However the tools required differ from the traditional armoury of instruments used for calculation and monitoring. In

this case, the evaluation process does not end with the production of figures describing costs, future sales, profits ... and estimated returns from the final output of the investment (which are then regularly updated). Rather, it concludes with a description of the project and the risks taken. The evaluation exercise is, in other words, part of the process of developing the vision of the future market, identifying the uncertainties faced, selecting issues in urgent need of clarification and defining the next round of actions through which to further explore and clarify the possibilities. This second track differs from normal procedures on four counts: (i) due to the limitations engendered by uncertainties faced, calculability (and its numerous sophisticated methods) is replaced by descriptibility (of the risks taken); (ii) it is not only a method for determining the allocation of resources: it also helps to specify the next steps to be taken and the direction to be followed; (iii) it does not commit the parties involved until the end of the entire process (modulo periodic control), but only until the end of the next step (at which point a new evaluation will determine the next course of action), and (iv) success is not measured against market returns but against the capacity to return to the normal firm investment track (meaning that uncertainties have been solved, thus that project selection can leave the shores of costly descriptibility and return to routine investment calculations and practices).

(iii) The third limitation of traditional expert committee approaches is that they are costly, and thus de facto tend to be focused on the development phase (when there is a good chance that the project will exist), and not the exploration one (where elements of what could form a project are still being explored). However, the prospect of following a second evaluation track also depends upon providing the evaluator with relevant tools with which to monitor the exploration phase. How can the evaluator be sure that critical issues linked to the identification and characterization of uncertainties have been addressed, and that he/she is faced with a relevant description of the project on which he/she can make or propose decisions about its future? In one word how can he/she ensure the relevant descriptibility of proposed breakthrough innovations?

To some extent, his/her knowledge is based upon his/her own previous experience (as project manager and as project evaluator). The issue is however to avoid a situation in which the evaluator wants to impose his/her views derived from previous experience or to put it crudely to simply apply the recipes, may they be from his/her own experience or from so called best practice. When dealing with breakthrough innovations, one lesson not to forget is that best practices are unlikely to apply since the well defined situations and stabilised settings which such

strategies propose are themselves being questioned. Latour suggests equipping evaluators with a specific questioning frame on the one hand, and a guide for assessment, on the other (see Protee experimental manual, Bijker et al., 1999). Though it is not the purpose of this presentation to elaborate further on this, it is important to mention since it is in the context of these ideas that the SOCROBUST methodology emerged.SOCROBUST was thus created as a project with the ambition to develop a methodology which makes it possible to **describe** the risks taken and to follow the **exploration** made. Box 1 presents the dynamics of this two and a half year project (1999-2001) supported by the EU TSER programme and developed in a consortium of 7 teams from 6 countries. The central assumption and starting point of the project was that important developments within the sociology of science, technics and innovation over the past 20 years have generated a repertoire of concepts, frames and even tools that could serve the purpose of filling this recognised gap in management methods.

Box 1: SOCROBUST as a project

Given the many methods of research evaluation and technology assessment that have been developed during the last 20 years, the project was initially thought of as a feasibility study, the central task of which was to determine the existing tools to use, when, and how to tailor and integrate them to fit the problem in hand. An initial literature review revealed an overwhelming number of potentially relevant concepts but at the same time showed that relatively few were either derived from empirical studies (observed reality) or had been tested (meaning translated one way or another and implemented in reality). The project thus entered into an unanticipated form of exploration which led to two important simplifications.
(i) We selected only concepts that had already been used in practice (at least for the analysis of past cases). This selection was tried out and further hardened through an extensive thought experiment based upon one in-depth case study on the development and deployment of large scale wind mills. There were, however, a number of aspects not covered by existing tools (especially relating to the assessment per se) and in dealing with these we constructed a handful of new techniques (at present still at the state of laboratory pilots).
(ii) We organised our main trial as a form of consultancy interaction between the SOCROBUST team and project managers responsible for five on-going cases. The projects selected correspond to EU supported projects in three areas: new energy sources, telematics application in health and telematics for public administrations. The selection was arrived at through discussion with EC programme managers (selecting within their portfolio of projects those they consider to be of the breakthrough variety). 8

projects were identified and gave rise to initial contacts. Because of funding and time constraints, only 5 were fully developed. We had two objectives in mind. One was to test the technical feasibility of the proposed scheme — would it be possible to product an assessment report along the lines we had envisaged? The second was to test the strategic capability of the method: would the SOCROBUST assessment report provide the project manager with a relevant description of his/her project? Did the process and the robustness assessment generate new insights for the project manager? Did it change his/her way of thinking about the next steps to take?
The testing process went as follows: for each project a consulting team of two persons was formed. This team was responsible for getting hold of existing literature on the project and for undertaking two interviews designed to sketch out the innovation journey and to unfold critical aspects of the project (future world, present TEN), always remaining within the logic of the project manager. The consulting team was also in charge of making the external check (a web search conducted with the assistance of a specialist team), and of drafting the assessment report. In order to monitor difficulties encountered along the way, for example, in explaining the approach and working with it, and in order to learn from the process of interaction, the two interviews were followed by an observer. A third meeting was held between the project manager and another member of the SOCROBUST team after the assessment report had been completed and sent out. The purpose of this final meeting was to consider the relevance of the method and the process. In practice, most also turned into strategy making discussions involving consideration of the results of the consultation and their meaning for the future course of the project.

3- The SOCROBUST method: main principles

Chen and Van de Ven (1996) consider that the critical issue in innovation journeys lies in the initial phases and the management of the period of ambiguity, that is the period when traditional mechanisms of accumulation do not apply[2]. They suggest that

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[2] Following March (1991) on organisational exploration and exploitation, they propose an expanded definition of learning: The definition of learning presumes that learners have some a priori knowledge about (1) alternative courses of action that can be taken, (2) outcome preferences or goals that are desired, and (3) the institutional rules, resources, and setting in which the task is undertaken. An expanded definition of learning examines not only how action-outcome relationships develop, but also how prerequisite knowledge on alternative actions, outcomes and contexts emerges.

exploration is at the heart of the initial phases of breakthrough projects. The PROTEE case studies demonstrated that the result of this exploration is to learn whether or not there is a possible project and if so, which one it might be. It is only then that the narrowing process proposed by Chen and Van de Ven, usually involving sequences of trial and error, can take place and only then that the traditional management tools apply (not forgetting lessons embedded in the chain-linked model and the notions of lead-users and co-conception or co-design). This line of reasoning led us to focus on means of tracking and monitoring the positive development of breakthrough innovation projects during their exploration phase. In addressing this question we extracted four complementary resources from the sociology of innovation.

(i) Rather than anticipating external events, as proposed in scenario making, the central anticipatory task, for SOCROBUST, is that of rendering visible the **script** of the future world already embedded in the positioning of the project, and already implied in choices made by the project management (Akrich 1992, De Laat, 1996).

(ii) The process of project development is no longer explained in terms of a sequence of states (e.g. concept, pilot, prototype, industrial development) which projects are expected to go through (however many times and in whatever order) but, rather, in terms of the **trail of trials** to which projects subject themselves in the course of progressively testing the relevance of hypothesised configurations of human and non human actors (this is what organizational colleagues refer to as the action-outcome relationship) (Latour, 1987, 2000). Put briefly, what Chen and Van de Ven term prerequisite knowledge is the outcome of what the sociology of innovation labels a trail of trials the role of which is to discover whether actors (human and non human) can be enrolled and how they can be articulated together.

(iii) The question of how one might know that actors are enrolled and that uncertainties are indeed clarified becomes a central issue. There are two aspects to this. The first aspect has to do with following the **techno-economic network** that supports the project (Callon, 1992, Callon et al., 1992, Laredo and Mustar, 1996). The key move here is to equate the state of a project to the network that supports it. Having taken this step it is possible to progressively map the results and consequences of each exploration by recording and characterizing the consequent transformation of the network.

(iv) The second aspect of monitoring enrolment lies in what the sociology of science calls the **robustness** of propositions (Rip, 1986, Callon and Rip, 1992). Propositions can be said to be robust when the assumptions on which they depend are no longer challenged. To grasp the extent of robustness — that is to determine the range of situations across which assumptions are no longer challenged — it is important to characterize the **fora** or arenas in which they have been debated, accepted, and come to be taken for granted (naturalised following Latour). The centrality of this process is such for breakthrough innovations that we have derived from it the acronym of the method: SOCROBUST stands for the societal robustness of breakthrough innovations.

These lessons have helped establish the four main elements of the SOCROBUST methodology which seeks to (i) unfold and render visible the future world inscribed in the project, (ii) identify the key changes required (by comparing the future world with the present project network), (iii) assess the robustness of assumptions made about the key changes, and especially identify competing views of the world or of ways to address these key changes, and (iv) identify/evaluate the project s current margins for manoeuvre.

4- The SOCROBUST process

The basics of SOCROBUST can be explained relatively simply. It is a four-step process backed by the use of 10 tools. The 10 tools each contain some kind of image or visualisation like a map, a table or a graph. These are deployed in a pre-determined order in which the result of one tool are taken up by the next. The sequence corresponds to the principles mentioned above, and the tools together help build the four main steps of the protocol: description, key changes, assessment, capacity for action (see tables and pictures at the end). The following paragraphs provide a brief outline of the process and of each tool. We take the example of the Eurovet project, one of the case studies which helped in developing the method, as an illustration.

Step 1 - Description

At any moment in time, a project manager is in a position to provide a narrative account of his/her project. This enables him/her to trace both the past trajectory of the project (with its turning points or critical moments where branching occurred) and to consider its future path, the next step being quite precisely specified, later ones being more tentative,

assuming all goes as hoped/expected (sometimes the project manager may envisage several possible futures, any and all of which would constitute success). Two tools support this preliminary effort: the **project narrative (tool 1)** and the **critical moments table (tool 2)**.

The starting point (tool 1) is to write a convincing 2 page presentation of the project for a non specialist audience[3]. Here is the case of Eurovet', an EU financed project designed to produce a standardised system for recording and registering animals and their movements in Europe. The context of the project, which dates back to the end of the 1980s with first experimentations in accession countries started in 2001, is linked to BSE and the issue of European animal tracking. Animal tracking is seen as a support for food safety, and it concerns both the circulation of animals within countries (an attribute of nation states) and cross-border movements. The latter highlighted the need for a comprehensive system of data exchange between countries.

As shown in picture 1, Eurovet' managers offered a linear narrative of their project's development, highlighting events that took place and that led, step by step, to the present. It required further discussion to identify turning points, that is points where one route is taken, leaving aside other possible paths. We know from the innovation literature how crucial these branching moments can be, and often at a very early stage in the process (cf. Cowan, 1990, about nuclear power reactors or David 1985 on the economics of QWERTY). The objective of the critical moments table (picture 2) is to characterise each of these branching moments. It helps the project managers to be sensitive to the paths not taken and to monitor irreversibilities created along the way[4]. Remaining flexible does not help in fostering a narrowing process towards exploitation. It is thus not an issue of avoiding irreversibilities but of being explicit about why such choices are or have been made, to be able to monitor their consequences and to adapt actions in order to foster the chances that such irreversibilities turn positive.

Step 2 — Unfolding the project to identify strategic changes

What scenarios of the future world are inscribed in the project as it stands today? And how different are they from today's world? A key feature of the SOCROBUST methodology is to depart from external scenario making (as is typical of the methods we have reviewed) and to focus on the endogeneous scenarios that are inscribed in the project. We propose, following the sociology of technics a project description, delineating the script of the future world embedded in the project assumptions, some of which are explicit but, as shown by our cases, most of which remain implicit. In developing the method we felt it was important to start from safe ground, that is from where the project stands now.

The project present techno-economic network

In unfolding the project, we start by reviewing the present project network, using a simplified TEN approach for this purpose. We have selected the STUR network based on four poles —science, technology, user and regulation — which has been extensively used by public agencies such as ADEME in France and can thus be considered operational. This exercise results in a map showing which actors are involved, where they are positioned, how they relate to each other and which intermediaries bind them together. This map provides a first **visualisation of the present network (tool 3)** and the raw material for a first **table of critical actors (tool 4)**. This first mapping helps in questioning the richness and heterogeneity of the network and the nature and durability of the actors involvement. It also reveals the existence of other actors located at the different poles and pursuing similar goals (either as competitors with similar interests in market shaping; or representing anti-programmes proposing different avenues and approaches to market shaping). In addition, it helps identify blanks or poles so weakly or so generically developed that no spokes persons of interest for the project can be identified.

For Eurovet', drawing such a map[5] (picture 3) helped in identifying actors directly involved in the

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project. It showed that, besides the prometor of the project, the agricultural software company, the other partners were mainly instrumental, and that the dynamics of the project relied heavily on other actors, not directly involved. Three points were worth mentioning at the time of the assessment.

(i) EU regulation had a dominant influence and a central issue was to translate regulatory contexts into specific data standards.

(ii) This linked both to software methods (and the ways they structure standards) and to different technical options, as proposed by existing (partial) technical systems (such as Animo in picture 3). Data standards featured naturally on the map. While there has been extensive debate about the notion of non human actors , the fact that technical devices are active in shaping the project s trajectory was in this case taken for granted.

(iii) Potential users were identified but not involved. What is important here lies less in this very classical situation where user needs are assumed , that is generated by the developers self knowledge, than in the absence of links per se. Describing links helps in generating knowledge about actors interest and involvement in the project.

Such is the role of the critical actors table. There has been numerous works on the development of collaborative research and on partnerships. Faced with actual collaborative projects, we were once more surprised by the limited knowledge about partners on two aspects: their connection to the project (why are they involved — what is the role of the project in their strategy — how important is the project for them, how far do they share the project s objectives, what is their specific input, how unique it is, how easily can they be replaced, etc.) and their assessment of the representativity of those involved (as mentioned by one project manager, you never face company X, but team Y or Mr Z, what sociologists call spokes persons). Picture 4 illustrates one of the experiments made in the project to characterize actors involvement.

The project s future world
Having unfolded the present situation, it is easier for the project manager to project him/herself in the future, using the same network visualisation and the same mapping method. This allows him/her to describe the composition of **the future network (tool 5),** that is the future network as it would be, should the project have succeeded. This future oriented exercise helps to identify new critical actors who should be enrolled and aligned, and it provides a point of reference for further discussion about relevant spokes persons to involve and/or relevant actions to undertake in order to better identify competing views and approaches (in which these actors are often already involved).

Picture 5 highlights a radical transformation. In the future state of affairs, Eurovet' is divided into a set of standards and a service. Relationships are reversed: country states are now on a similar footing to the EC on the regulation side, while the service is provided to real user communities. New local IT providers are introduced to provide the actual service in each country and link with local stakeholders (farmers, vets, land owners, regional authorities). The role of the agricultural software company is to serve the standard (maintenance, development) and to mediate the nature of the service provided through local IT providers. The future network tool helps in better positioning the agricultural software company promoting Eurovet' in this future market, in identifying the drivers of added value and benefits, and in specifying the implications this has for the way the firm is organised.

However, the future network does not translate all of the characteristics of the future market. For Courtney et al. (1997), company intervention in situations of uncertainty should be aimed at shaping the market: the shaper s role is to provide a vision of an industry structure and standards that will coordinate the strategies of other players and drive the market toward a more stable and favorable outcome . We progressively felt it necessary to complement the company centred view of the description of the future network by a broader view of the market at large. We thus developed a preliminary approach to the future working world (tool 6) in order to better assess the extent of necessary or assumed changes.

In the experiment made, we suggested project managers follow three main directions. The first is classical but nevertheless difficult, re-assessing their views of users needs, preferences and their related competences. As Noori et al. recall, consumers are generally not aware of the needs revolutionary products will meet . Furthermore, substantial customer learning is often a prerequisite for use .

Noori at al. also recall that, most of the time, the success of breakthrough products/services depends upon the existence of an enabling infrastructure (e.g. the existence of regulations that permit and/or encourage the use of the product and the development of social values consistent with market acceptance). The second direction is to consider changes in the market infrastructure (be that the physical infrastructure, or the intangible one of norms, standards, rules, codes of conduct).

The third was to enrich the description of markets by replacing the classical dual relationship between producer and user, by a triangular relationship including the role of prescribers. We all know the role of advertising and of large distributors (such as Metro or Carrefour) in the shaping of demands. Similarly shaping the conditions under which consumers access

their products is a central feature of the success of Benetton, Zara or H&M. In this case (see picture 6), it helped identify Vets and meat retailers (such as TESCO where adoption of Eurovet' might help guarantee the health of the animals whose meat they sell) as potential critical prescribers beyond nation states.

Characterising key changes

It is now possible to compare the present state of the network and the hoped-for future working world. This in turn makes it possible to identify the key changes that will have to take place before this future working world exists. Picture 7 abstracts the 5 key changes identified for Eurovet'.

Identification is however not enough. Key changes have to be characterised more precisely, for example through specifying new practices that will have to become taken for granted and present practices that will have to be discarded (with implications for actors likely to represent a source of opposition /compromise). It will also be necessary to specify actors outside the project who share similar visions and (if any) to look for, and to detail fora in which such changes are already discussed. Key changes have also to be considered in terms of how they might be addressed: can they be addressed within the present network (what is at stake is then convergence within an existing network), or is there a need to enrol new actors, that is for extending the boundaries of the present network? And what are the project manager s views of these options: can the project be pro-active, that is can it actively enrol adequate spokes persons and thus shape the issue (or at least participate in its shaping)? Or is it only in a position to monitor / watch developments made elsewhere, and outside the borders of the project network? In which case, the challenge is to remain flexible and adaptable and to have early warning especially of negative shaping. The key changes so characterised are encapsulated in the **key changes table (tool 7)**. Picture 8 details one such key change for Eurovet', that is moving from a doing-all company to alliances with local IT providers and its implications on the company s activities.

Specification of these changes helps in articulating the project s core assumptions, the robustness of which is critical for its future development. The careful detailing of key changes is thus a precondition for embarking on an assessment of the project s societal robustness.

Step 3 — Societal robustness assessment

Once key changes have been identified and characterised, the methodology then opens up to take account of the wider world in which the project is located. It does so not in general terms but with reference to a central question: what can be said about the probability the key changes (specified above) will come about? It is not a general check (for example, on the implications of mad cow disease) but a check which focuses on issues which have been quite precisely identified through the analysis of key changes (what animal tracking systems exist which incorporate health issues? what governments have passed relevant legislation? which countries have tracking systems already in place? are there other actors, either at regional, sectoral or functional levels, also interested in animal tracking?). The objective is to know, for each key change, what can be found through a search for other actors having the same approach, for actors proposing other strategies and for studies, debates, and positions taken about the transformations (that is new market infrastructures) required, and hence about the direction to take. While we have labelled this phase an **external check (tool 8)**, we only focus on the critical assumptions made by the project.

In checking these assumptions, the method makes the following supposition: any antiprogramme that has taken shape, any competitor that follows similar goals, any organised group that positions itself with respect to one of the key changes (and uncertainties) will by now be visible on the worldwide web. The external check is thus focused on internet searching. Devoting even limited resources to such searches (on average between 3 and 5 person days) and using only standard search tools and procedures were however sufficient, in the 5 case studies made, to bring to the fore an extensive body of material much of which helped to reshape the project manager s approach to, and view of, the key changes required. In the Eurovet' case, for instance, the external check showed the existence of other approaches to animal health tracking than those based only on national regulatory issues.

By assessing the grounding of the project s key assumptions, the external check helps in constructing the central tool of the assessment, which we have labelled the **project positioning table (tool 9)**. Up to this stage, all elements mobilised in the SOCROBUST method have been developed and used before (even if in other contexts and even if not labelled as such). We are now entering the part of the process for which we found no relevant approach, even though the concepts involved are quite well established. The positioning table sums up where the project stands. It shows whether (or not) there are other approaches to handling the necessary key changes; it shows how the project stands with respect to these alternatives; and, as well as identifying potential allies and opponents, it shows the extent to which they have expressed their views and/or organised themselves. This provides an overall assessment of the project positioning vis vis the

related key changes. The table shows how the project is positioned with respect to key changes relating to the main dimensions identified in the above developments:

- changes in the technological landscape. For breakthrough innovations these are often associated with new paradigms or new dominant designs, in other words, with the development of new shared knowledge about what the technology can do and how to do it. Picture 9 shows that data management in Eurovet, conceived in the mid-1990s, is centralised while the new communication technologies enable other more decentralised approaches to data management. IT companies with a greater hold on the agricultural domain may well impose their de facto standard to Eurovet.

- Changes in the legal, administrative and regulatory environment. This includes the above-mentioned issues about norms and standards, but also ethical issues, issues about the environment, and about quality and consumer safety. We were struck, in quite a number of the case studies, by the importance given to the effective structuring of markets by public intervention such as pricing issues for wind energy or priority setting in health which in turn had important economic effects on the potential unfolding of projects studied. For Eurovet, the analysis had clear consequences: it was unlikely that an EU harmonised system would be adopted, subsidiarity will keep existing national systems in place, thus the main opportunity lay with aspiring EU members who would be required to adopt such a system but who do not as yet have one.

- Changes in user-producer relationships. This includes all above-mentioned aspects of customer preferences, and new knowledge which customers will require to value the qualities of the new products proposed and to be in a position to use them. It also deals with other potential users of the tracking system. The external check highlighted a phenomenon just mentioned but not yet considered by the project manager, that is the role of actors in the food supply chain other than national authorities, with two possible implications: that Eurovet focuses on a niche market, and that IT companies involved in other markets produce administrative data as a by-product, endangering the future of Eurovet as a single purpose tracking system.

This analysis of the Eurovet positioning table shows that key changes do not involve a radical break from the existing situation on all dimensions, most often only one, and in some cases in none since the necessity of such change is already shared by all relevant stakeholders. The table shows here the situation of a project that is very near its first real size experimentation. Taking the projects on the use of micro CHP for domestic energy or the development of a portal fostering organ transplantation, two other case studies conducted, would have highlighted a very different profile where the service providers required hardly exist and where house safety regulation has never been addressed, or where controversies still exist about what techniques should be retained for recipient-donor matching.

Step 4 - Lines of actions

The final step of the methodology tries to assess the project s margins for manˇuvre: what is the project s capacity for action with respect to the key changes identified and to the positioning to be done? The likelihood that a key change will come about as expected relates to the nature and scope of collective agreement. As demonstrated by Rip (1986), this depends upon the existence of a space for debate, a forum, where the required reshaping is discussed. The actors that make up the forum (thus its hybridity and representativeness), the arguments exchanged, the solutions sketched and the actions / directions defined, are all ingredients of the potential robustness of the outcome arrived at. A further element concerns the centrality of the project within the forum, that is its capacity to enlist key actors in the forum, to ensure that the project s position is not marginalised and that its goals are internalised by relevant groups in the forum. This is arrived at by mobilizing the results of the external check regarding the robustness of the constructions made or envisaged. These two features — to build and influence debate —are represented in the **capacity for action table** (tool 10 and picture 10). The capacity for action table summarises the project manager s ability to act as a market shaper . It helps addressing issues about where, when, with whom, about what and how to act next.

Some examples taken from different case studies will illustrate these different dimensions. Where first, or which forum to join or help create. In the project on the use of micro-CHP, it appeared that a relevant forum already existed but was defined only on US terms (i.e. 7 KW and above) while the project focused on 1 to 3 KW fuel cells. Project actors decided to organise specific sessions at the annual world CHP symposium.

When? During most of the 1990s large windmill producers were very active in EU projects promoting standardisation and cost analysis until the new EU directive on wind energy (1998) re-shaped the rules. Since then, they have stepped back, focusing upon industrial competition and national adaptations of the EU directive.

With whom? Car technology provides a typical example with the CO regulation at the beginning of the 1980s. One car manufacturer had demonstrated the possibility of respecting the rules without catalytic exhaust pipes while not wanting to share the

corresponding patents with other manufactuers. It is no wonder that the latter joined in pushing towards a regulation specifying the use of catalytic exhaust pipes. (this is not a very convincing example)

About what? Eurovet' is a good example: is the issue one of developing national data management systems, in which case there is only a niche market amongst countries aspiring to join the EU. Or is it an issue of constructing a harmonised and systematic method ofdata collection, with all that implies for developing Eurovet' as a possible standard focusing on interfacing and upgrading data about animal movements through the supply chain?

How to act, or what can the company do to promote its position and views in the forum? In the case of the transplantation portal, it was beyond the actors possibility to intervene in the controversy about receiver-donor matching, but it was possible for them to act on another debated ground: convince international associations of clinicians about the relevance and performance of establishing a portal. The project thus entered into a nation-wide demonstration on a specific organ, in one state where the existing regulation was favourable to such an experiment.

This latter case is typical in that it shows the multiplicity of debates in which numerous breakthrough innovations feature. It also underlines another issue faced in some of the case studies: the hierarchisation of issues to address, and of tests / trials to undertake. Finally it shows that acting upon the societal robustness of a potential breakthrough innovation requires not one but multiple actions. Typically, recommendations made about next steps mixed direct actions with passive or active watch. The action vocabulary is classical: to build, test, demonstrate etc. Yet recommendations may include precautionary measures especially regarding features which remain beyond the scope of direct influence. In these cases, the watching might remain traditional, that is passive. But it might also be much more pro-active, for example, monitoring specific developments (including participation in existing fora to make sure that events flow in the preferred direction), reflecting upon routes not taken (and the potential weaknesses that may result from others having selected these routes) or specifying alternative definitions of the project (depending on its flexibility), organising internal debate about the positioning of the project (in one case, this highlighted what might be gained by incremental adjustments in the project).

5 - Conclusion

Breakthrough innovations are again high on the agenda of management research. Because of the uncertainties faced, they require specific management approaches, both at firm and at project level. The SOCROBUST methodology addresses the latter aspect and is focused on market shaping or, to follow the results of sociologists of science and technics, on the societal robustness of want-to-be breakthrough innovations.

To address the critical part of such projects, at their exploration stage, two central results of the sociology of innovation have been mobilised. Probably the most critical one lies in ourinversion of scenario making, focusing not on external scenarios but on the project s own endogeneous scenarios. The first task is thus to unfold the de-scription of the future world inscribed in the project. The second critical element lies in the implications of the notion of breakthrough or, to follow Abernathy, of architectural innovation. As demonstrated again by the sociology of technics, to break from present market structures, requires a collective agreement. This supposes debates and fora where agreement takes place. Success in fostering agreement is then measured by the robustness of the alignment of arguments and actors arrived at, which makes it difficult to go against the grain, as in the famous example proposed by Rip on tobacco and health. Together these features underpin a methodology based on (i) unfolding the future world of the project and, by comparison with present states of affairs, identifying and characterising strategic or key changes required, and (ii) via a focused external search/watch, assessing the societal robustness of key changes along the three possible breakthrough dimensions identified in the literature: technological, infrastructural (especially the legal, administrative and regulatory environment) and in user-producer relationships. This helps in further characterising the project and the firm s capacity for shaping the market.

The methodology presented has been tested on actual on-going projects which have shown its relevance, and which have helped to consolidate the method as a whole. When discussed with project managers, four main aspects have beenhighlighted: it is interdisciplinary (mixing technology, marketing, consumer science), it internalises societal robustness within the project rather than externalising future problems as barriers or non-technical obstacles, it offers the potential for both periodic use (after each project step) and for project monitoring along the lines proposed by the Protee framework. It remains however a demonstration and further steps are being considered to address two main limitations identified. The process so far depends on tacit knowledge about innovation processes (which entails a consultancy style operation while we aim at self-operation by project managers). It also does not yet draw upon or relate to a taxonomy of trials (while, in all evaluation sessions with project managers, it proved important to locate and recognise certain types of achievements, to

identify typical situations likely to be encountered during the course of a project learning curve and to give examples which, on the basis of past experience, contain clues as to the chances of successful embedding, if not success per se).

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