Learning Processes in Bounded Social Experiments: the Case of Mitka

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ABSTRACT

Bounded social experiments, BSEs (small-scale on the time and space dimensions), are a way to test the feasibility of radically more sustainable potential alternatives to current technologies and societal arrangements. BSE is successful if it meets one or more of the four criteria: (1) large scale diffusion combined with commercial and environmental success; (2) capturing interests of consumers, business, and institutions, and leading to new experiments; (3) branching out into new experiments or applications; (4) generating higher order learning within and outside its own boundaries. In this paper we analyze in depth the dynamics of two ongoing BSEs in mobility, in which the Design for Sustainability Group at TUDelft has been involved: Development and introduction of a new ‘bike-plus’ vehicle; Development of a mobility system on the Dutch island of Texel. The cases succeeded by criteria 3 and 4, but not 1 and 2. Key conclusions: (1) Three structural dilemmas occurring in bounded social experiments can be serious impediments to their success; (2) Repeated experimentation is unlikely to produce a blueprint for BSEs that succeed by criteria 1 and 2; (3) In order to occur, higher order learning requires the presence of facilitating factors, such as: Sense of urgency, failure or threat of failure; Diffusion of ideas among related BSEs; Deployment of structured visioning exercises, modeled on the authors’ SusHouse project. These facilitating factors should be strategically built into BSEs; (4) Universities and the government have roles in inducing diffusion of ideas and knowledge among BSEs.

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1. INTRODUCTION

The underlying premise of this paper is that bounded (small-scale) social experiments (Irwin et al, 1994, Verheul et al 1995, Hoogma et al., 2002) are a way to test the feasibility of radically more sustainable potential alternatives to current technologies and societal arrangements. Furthermore, we accept as a working hypothesis that at least some of the new technological and social arrangements that have proven effective on a small-scale experimental level can contribute to large scale societal changes, referred to as regime shifts or transitions (Kemp et al, 2001). The latter assumption is yet to be supported by data.
This paper has the following objectives:
• To consider the role of learning in enhancing, and assessing, success of social experiments;
• To examine how visioning can be used to enhance learning;
• To examine the role of horizontal diffusion of ideas from and into social experiments in assessing the experiment's success;
• To consider the ways in which the results of multiple social experiments can be utilized to generate new knowledge about transition management.

Our analysis confines itself to social experiments bounded in space and time, without immediately attempting to extrapolate the findings to large-scale societal shifts in technological regimes and systems. Thus we do imply that observations made on a small scale regarding the role of learning and visioning cannot be extrapolated directly to higher order regime shifts and transitions. First, we do not know whether or not, and by what mechanisms, outcomes of successful experiments – individual or in aggregate -- can diffuse into a larger scale adoption of new technologies and social arrangements (the mechanism suggested above is a hypothesis). Second, we do not believe that the forces acting in bounded experiments, including personalities of the key actors, the flexibility of shifting a project trajectory, the level of involvement of government, and the magnitude of business risks, are comparable between the two scales. Addressing these crucial questions would require a different research program from that on which this discussion relies.

The analysis draws on several sources: theoretical concepts of social and conceptual learning, primary analysis of two bounded social experiments in mobility which are currently under way at TU Delft Design for Sustainability Group (DfS), analysis of the experience with the *SusHouse* project, and limited secondary analysis of other social experiments.

2. RECENT EXPERIENCES WITH BSEs.

We define a bounded social experiment (BSE) as an effort to introduce a new technology or service on a scale bounded in space and time. The time dimension is around five years or less, and the space dimension is defined either geographically (a community) or by a number of users (small). A bounded social experiment is typically carried out by a fairly loose coalition of very diverse actors, including business, government, technical experts, educational and research institutions, NGOs and others. An experiment may or may not turn into a commercial success. Its purpose is to create a functioning, socially-embedded new configuration of technology or service, which would serve as a starting point for other processes: further innovation, market diffusion, or strategic public policies. An experiment can have five possible outcomes (these are adapted from, with considerable expansion, Hoogma et al 2002):

1. The results of the experiment are adopted on a larger scale and become a commercial as well as environmental success. They contribute, in measurable ways, to technological regime change;
2. The results are successful commercially but not environmentally. In a successful experiment the outcome is dependent on the actual behavior of adopters. Often one sees rebound effects or other mechanisms by which the original environmental aims have not been reached.
3. The results capture interests of consumers, businesses and societal institutions, and lead to investments and further experimentation;
4. The results do not diffuse into a larger scale but the experiment itself branches out into a new application or a new, related, experiment;
5. The experiment does not attract sufficient attention, or does not produce desired results, and is abandoned. The abandonment does not imply that all the investments are lost. Collateral gains may include network development, learning, reputation gains and others.

The last two outcomes are noteworthy because the judgment about a success or a failure of a specific experiment may depend on how these outcomes are interpreted.

Efforts have been made to evaluate experiments in transitions towards sustainability , and to draw lessons about factors that can facilitate their completion and subsequent diffusion. One cluster of such evaluations of experiments in transportation that have *not diffused* into a broader scale (outcome 1) comes from Weber (Weber et al., 1999) Tables 1 and 2 list the key lessons drawn from the evaluation of 16 BSEs in transportation, grouped (following the authors) into suggestions for designing BSEs (Table 1) and lessons drawn from the experiments (Table 2). The lessons listed in Table 2 are each derived from a different experiment.

Looking at Tables 1 and 2 we quickly see that, while useful, collectively these observations cover a very broad territory. No particular patterns emerge from the individual experiments with regard to how to set up an experiment with the largest chance on success (however measured). This is, in our view, not coincidental. We submit that further experimentation will only increase the list of lessons, *without clarifying it*. In fact, we suggest that no such unifying characteristics of failed (or successful) experiments exist. Each experiment is destined to fail or succeed for its own unique combination of reasons. This is because we are dealing with a problem set. As defined by Trist (Trist, 1983), a problem set consists of several interconnected issues -- each of which characterized by high uncertainly -- such that a response to one affects the other issues in the set. Therefore, causal relationships between the variables are difficult to establish.

Does that mean that nothing can be done to increase the probability of success of a bounded social experiment? This question is considered in the next section.

3. SUCCESS IN BSEs.

Based on the preceding discussion, we propose the following criteria for evaluating success in bounded social experiments:

1. The extent to which the results of an experiment, in the form of a new technology, product, or service, are adopted on a larger scale and become a commercial as well as environmental success.

2. The extent to which the results capture interest of consumers, businesses and societal institutions, and lead to investments and further experimentation
3. The extent to which the experiment itself branches out into a new application or a new, related, experiment;
4. The extent to which higher order learning occurs within the BSE-oriented coalition and beyond it.

Many experiments in transportation have failed by criteria 1 and 2. With regard to criterion 3, considerable research needs to be done to reveal the extent to which the new applications or experiments have taken place. Partly, the reason for the lack of knowledge about this outcome is that the diffusion and branching out is slow, and the causality postulated in this criterion is difficult to establish. How do we know that experiment has inspired other experiments? Another reason for not knowing about outcome 3 is that the design of a typical experiment does not provide for systematic monitoring of such horizontal diffusion of ideas.

We know even less about the learning taking place (criterion 4). And yet, learning among the coalition members and society at large may be among the most lasting successes of a bounded social experiment. We discuss that further on.

To reflect on the role of learning in BSE, let us consider the typical goings-on in the conduct of an experiment in scientific research, and to then translate those to the BSE case. Although the comparison with a scientific experiment is risky (because we analyze here a problem-set), something may still be learned from it. One of the key characteristics of a scientific experiment is its openness to unexpected developments. Surprising results are the key source of new ideas and hypotheses. The experimenter is prepared to continuously evaluate the new data *vis a vis* the initial plan or inquiry, and to plan the next steps of the inquiry accordingly. Translated to BSE, this means that throughout its duration the experimenter must be open to the idea of reassessing the problem definition driving the experiment, its objectives, approaches, and tools used in its execution.

The second characteristic of a scientific experiment is that it entails hypothesis testing. In translation to a social experiment, this means that BSE starts with a particular combination of problem definition and a perceived solution, but both are likely to be replaced in response to new evidence and new developments in the experiment's context. The third relevant characteristic is that new knowledge from other experiments in a related or sometimes unrelated scientific area often provides crucial insights into interpretation of data and the choice of direction of the scientific inquiry.

The above characteristics imply that societal actors who embark on an experiment in technological or system innovation need to retain a great deal of openness and flexibility in defining its objectives and expected outcomes and to be prepared to change them in mid-course. They also need to be outwardly oriented and intellectually entrepreneurial, as manifested by active scanning of related ongoing experiments, identifying new links between problems and solutions (especially problems for which their own experimental approach may be a good solution), and by identifying new potential partnerships.

Creating an atmosphere that is conducive to such openness and flexibility is a matter of appropriate design of an experiment. These features are especially important because BSEs are more messy and harder to analyze than controlled laboratory experiments in the conduct of science. This is for several reasons. First, BSE is not controlled, meaning that several variables change simultaneously. This makes for permanent uncertainty in evaluating data and deciding on strategies.

Second, BSE is designed and implemented by coalitions of societal actors, not by an individual experimenter. That means that agreements need to be negotiated around goals, objectives, strategies, tools, interpretation of data, and other key dimensions of an experiment. The third characteristic of BSE is that the coalitions of actors change over time. The significance of that characteristic is that any agreements among the participants need to be renegotiated over time. Fourth, BSE takes a very long time in comparison to most scientific experiments. This is particularly true for experiments in system innovation. This makes the uncertainty greater and planning more difficult. Fifth, success of BSE depends on variables difficult to control or change, such as markets, infrastructure, and others.

In short, champions of bounded social experiments in sustainability transitions must be flexible, adventurous, intellectually entrepreneurial, and have high tolerance for uncertainty. They also must have a high capacity for self-assessment, reflection, and change of objectives in response to new developments. Stated differently, they have to have a capacity for learning.

4. LEARNING IN BSE

We define learning in BSE as three interrelated cognitive shifts: (1) A shift in the framing of the problem and of the perceived solution (or a menu of solutions), (2) A shift in the principal approaches to solving the problem, and in the weighing of choices between desirable yet competing objectives; (3) A shift in the framing of the relationship to other participants in the experiment, including mutual convergence of goals and problem definitions.

These cognitive shifts can occur among the participants of the experiment as well as in the broader sphere. In fact, learning must occur outside the experimental boundaries in order to facilitate a horizontal diffusion of the ideas and experiences from an experiment into the society at large or to another experiment (criteria of BSE's success).

This definition emerges from two distinct areas of research: organizational learning; and policy-oriented learning. Both bodies of research make a distinction between lower-order and higher-order forms of learning (Argryis and Schon 1994; Senge 1990; Keohane and Nye 1989; Hall 1993; Sabatier 1999).The so-called 'technical', 'adaptive' or 'single-loop' learning consists of searching for new policy instruments in the context of fixed policy objectives (as applied to policy) or of fixing new problems within the same problem definition and procedures (as applied to organization). Examples of first order learning in the experiments involving introduction of electric vehicles include: improvements in technological design or better marketing and pricing to improve sales.

In contrast, the higher order 'conceptual' policy-oriented learning involves redefining policy goals and adjusting problem definition and strategies. In relation to organizations, the higher order 'generative' or 'double-loop' learning involves higher changes in the norms, values, goals and operating procedures that govern the decision-making process and actions of organizations. Drawing on recent review of the experiment with electric vehicles in La Rochelle, France, higher order learning occurred when users reconfigured their personal mobility patterns (Hoogma et al, 2002). Both organizational learning and policy-oriented learning fields assume that higher order learning is a gradual process occurring over time, and that it occurs through self-examination and reflection. Failure is often seen as the primary driver of learning in organizations (Lant and Mezias 1990, Argyris and Schon 1994; Bolman 1978; Sitkin 1995). Sitkin (1995) proposes that learning in organizations is best achieved through experimentation rather than an apparently safer route of risk avoidance, referring to such a cycle of experimentation-failure-learning-experimentation as ‘intelligent failures’. In this perspective, failure challenges the fundamental organizational assumptions, its core identity, and thus induces self-examination and conceptual change. Other researches (Cook and Yanow 1993) postulate that new information or new organizational strategies can also trigger learning, in the absence of overt failures, although the data in support of this thesis are rather limited.

The organizational learning framework is useful in two ways for thinking about learning in BSE: it makes a distinction between lower- and higher-order learning; it draws attention to reflection, self-evaluation and interactions among actors as the key paths for achieving higher order learning. Clearly, in this paper we *focus on higher order learning in BSEs*.

The main limitation of organizational learning framework for BSEs is that BSE-oriented coalitions lack some the key characteristics that play a role in organizational learning: shared culture, goals, norms, procedures and routines. In fact, sharing of values and norms is precisely what may be absent among the participants in BSE, who may be drawn from such diverse societal domains as: businesses (usually more than one and representing different sectors), governmental funding agencies, private lending institutions (e.g. banks), government ministries and other policy-making public bodies, local governments, research institutes, universities, consumer groups, civic organizations, non-governmental advocacy organizations, utility companies (for example, in the case of electric vehicles), railroads and other transportation companies, private/public cooperatives (for example, in the case of bicycle sharing schemes), and others.

The literature on policy-oriented learning addresses this latter limitation of the organizational learning theory by concerning itself with learning processes occurring within a *loose coalition* of often competing actors (government, industry, non-governmental organizations (NGOs), expert communities, and the media). Three useful lessons from that field of study are: higher order learning can indeed take place within such coalitions, despite the absence of the cohesion provided by organizational boundaries; perceived failure of existing policies and strategies is a common trigger of policy-oriented learning; policy-oriented learning occurs in response to new information, when it is facilitated by high media attention and public interest (Keohane and Nye 1989; Sabatier 1999; Lee 1993; van Eijndhoven 2001).

The main limitation of policy-oriented learning as a framework for considering learning in BSEs is that the drivers of individual actors are quite different in both cases. Policy-oriented learning concerns itself with collective acquisition of knowledge and experience by the actors in order to devise a strategy for addressing a specific and shared problem. A sense of urgency usually accompanies these efforts. In contrast, solving a shared problem is not the driver of many BSE-oriented coalitions. Rather, it is often a collection of individual interests built around the prospect of a new technology or social arrangements that attracts and keeps the members together. (Irwin et al, 1994. These interests may range from potential commercial success to gaining visibility, to improving corporate image and social legitimacy, to contributing to long term sustainability. The sense of urgency, if present, is unlikely to be experienced equally by all the participants, if at all.

In spite of their limitations for BSE, the two literatures -- on organizational learning and policy-oriented learning -- are consistent on an important count: that higher order learning is best achieved in the presence of *facilitating factors.* Failure, unanticipated problems, public and media pressures, and other adverse events or *threats* of such events, are effective facilitating factors.

5. VISIONING: EXPERIENCE FROM THE *SUSHOUSE* PROJECT

Since problems always occur in social experiments – and, the more complicated the experiments, the more complicated the problems – such experiments can be viewed as opportunities for learning. This is especially so in the presence of adverse outcomes or threats of such outcomes. However, whilst such tacit, on-the-job learning is both essential and inevitable, we submit that structured exercises, braided into the experiment at key points, are also likely to be effective in inducing learning, embedding it into the practice of the participants and offering some 'breathing spaces' for explicit identification and review of the options for further development. 'Visioning' is an example of structured exercises with which the authors are familiar through the *SusHouse* Project. The *SusHouse* Project - 'Strategies towards the *Sus*tainable *House*hold" - was undertaken from 1998-2000 and involved 5 European countries. Its aim was to develop and test a set of structured methods, broadly under the name of 'visioning' that would identify how the satisfaction of certain human 'needs' could be fulfilled in much more sustainable ways than at present (these needs were called 'household functions'). The researchers focused on *households* because it is in and from these basic social units of human living that social and individual human functions are fulfilled. The Project focused on three household functions: namely, Food (Shopping, Cooking and Eating); Shelter (Heating, Cooling, and Lighting the house) and Clothing and Clothing Care. (For a fuller description of the methods developed, see Vergragt, 2000; Green and Vergragt, 2002).

The methodology involved the construction of imaginative, 'micro-normative' scenarios ('visions' of how the household functions could be fulfilled in the year 2050) that suggested new ways of fulfilling various household functions in more sustainable ways. The scenarios are intended to generate a vision of sustainable household function fulfillment that differs radically from the present, breaching current trends. Such visions may open new ways of thinking, researching, designing and acting *in the present* (or, at least in the next few years). Sustainability would be achieved by radical combinations of both technological *and* social innovations (the importance of social innovations was especially stressed), leading to 'Factor improvements', it was hoped, of up to 20-fold.

The scenarios were subjected to a series of three 'reality checks': the first, an *environmental* assessment, evaluated what Factor improvement the scenario seemed to offer; the second, an *economic* assessment, identified what issues for changes in employment, competitiveness and industrial restructuring the scenarios implied; the third, a *consumer acceptance* analysis presented the scenarios to focus groups of consumers to identify possible barriers for consumer adoption of the technological and lifestyle innovations within the scenarios and, crucially, getting ideas for modifying them to increase their probability of adoption.

The researchers were keen to develop a method that would enable companies, governmental policy organizations and NGOs to carry out *their own* analyses of any household function whether large-scale (the whole system of Shopping, Cooking and Eating, for example) or small-scale (such as a focus on one particular type of food or on one region of a country). Such analyses would lead to the identification of possible product, system and social innovations that could offer business opportunities and policy initiatives *now* to start the transition to sustainable economies and societies.

To maximize the *action* aspect of visioning, one of the central features of the *SusHouse* methodology is the involvement of a wide range of 'stakeholders' in the generation of the scenarios, as well as in their assessment and the development of innovative and policy initiatives that the scenarios suggest. The stakeholders that took part were chosen to represent the full 'supply chain' of each household function; for example, in Shopping, Cooking and Eating this involved stakeholders from agriculture, food processing and retailing as well as food system and transport system experts and people from professional and consumer bodies (see Quist *et al.*, 2002 for details of stakeholder involvement). It also sought to include people who might be representative of *future* stakeholders (such as small firms, that might see opportunities for growth in markets for 'sustainable products/services' or young people, who might represent future, 'greener' consumers).

The *SusHouse* method thus favors a participative and interactive way of devising policy and identifying new innovations than is usually employed in more traditional policy-making that focuses on regulation rather than on innovative behavior by social and economic actors (Grin and van der Graaf, 1996). The methodology is also concerned to lead to *designs*, of products, systems of provision, social arrangements and cultural attitudes rather than just an orientation to policy. It assumes that visionary (some would say "crazy") ideas for future system re-design will trigger the imagination and enthusiasm of stakeholders; it uses creativity workshops and scenario development as central tools of the methodology

Whatever the practical outcomes, the *SusHouse* methodology can be see as a structured way to induce higher-order learning both in the concrete outcomes of new scenarios and new products, services and policies for Factor improvements in sustainability and in the kinds of *social* outcomes that are necessary to such radical innovation: the building and maintaining of new network coalitions. We see these visioning exercises as an avenue for introducing learning into the types of BSEs where threat of failure is not high, such as the Mitka case described below. The role of visioning (or lack of it) is highlighted in the two examples that we now turn to.

6. ONGOING EXPERIMENTS IN MOBILITY at TU Delft

The two case studies described in this section have been developed through joint efforts between the Design for Sustainability (DfS) Group at Technical University of Delft, TNO Industry (hereafter referred to as TNO), and several other actors. These and several other projects in product-service innovation have been carried out through a cooperative agreement between TU Delft and TNO under the umbrella of the so-called Kathalys Program (Brezet et al, 2001), with the funding from the Dutch ministries of environment and economic affairs. The case studies are in various stages of development, and their outcomes cannot be predicted at this time. This is both an advantage and a disadvantage. On the one hand, it is too early to assess the impact of either case. On the other hand, the *in situ* analysis allows us to consider the dynamics of interactions among the project participants, which is rarely possible in retrospective case analyses.

The analysis of the dynamics of each case is the basis for drawing inferences about the learning processes taking place, the factors facilitating the learning, and the role of learning in the trajectory and fate of the experiment.

6.1 CASE ONE. Bicycle-Plus: Mitka

Mitka (an acronym derived from 'mobility solution for individual transportation on short distances', in Dutch) is a roofed three wheel human-powered vehicle with an electric engine that can double its power. Its maximum speed is 30-40 km/hour, and it is able to tilt and steer automatically. Mitka has an innovative shape with a natural position of a driver's body (Fig. 1). It is intended as an alternative to a car for commuting on distances between 5 and 25 kilometers. Its environmental impact is estimated to be one-third of that of a car. Mitka will be ready for testing in the September 2002.

Mitka's story has its beginnings in 1996. In rendering this story we focus on the interaction among the participants (actors) and its impact on the development of the artefact within a social context.

6.1.1 Stage one: visioning and building a coalition.

The initial idea of Mitka was both a brainchild of a student's project (Easy Rider Project), and of several individuals who happened to talk to each other at various encounters between 1996 and 97. One of those was a TNO manager with a vision of a mobility system for commuting to work (5-25 kilometer distances) that would be radically different from the unsustainable dependence on car driving. His answer was a new type of a vehicle with a low environmental impact that would persuade daily commuters to leave their cars at home. Through discussions between the TNO manager, two managers of a bicycle company, and a manager of an engineering design firm for automotive company, the idea of a "bike-plus" vehicle was born. The concept soon found a positive response from academic quarters in the person of director of the Design for Sustainability (DfS) Program at TU Delft. During the preceding several years a number of TU Delft students worked on the transportation issues, focusing on environmental impacts of short term commuting by car, and designing various bicycle-related alternatives. The emerging partnership between DfS and TNO was formalized as the Kathalys Program, giving rise to numerous future projects.

At that initial stage, the key characteristics of the new vehicle were identified. While several creativity-visioning workshops were organized for that purpose, many of the ideas and much information emerged randomly, through existing networks and individual interests of the participants. Uncertainty, lack of knowledge, scattered information and no organizational strategy, created space for such behaviors. In this context of scattered information, a leading actor was able to mobilize other key actors, although the process took time before acquiring momentum. Intellectually-entrepreneurial groups, such as a research institute or a university, which are capable of collecting the necessary information and fleshing out ideas, was a good milieu for the emergence of a project champion.

Two sets of ideas drove this initial exploration. One was the *presumed* causes of the failures of previous efforts at creating bike-plus vehicles: the image conjuring disabled persons, conservatism of bicycle consumers who reject radical departures from the familiar bicycle form (i.e. horizontal position), and the lack of marketing. These ideas were not based on a systematic analysis but rather on the interpretation of individual and shared knowledge held by the actors. The second type of ideas had to do with the individual visions held by the team members. As a result, the emergent concept was that of a vehicle that would be faster than a normal bike (power assistance), flexible and reliable, attractive, resembling a bicycle (and definitely not an aid for a disabled person), safe and comfortable, and have low environmental impact, although few calculations were made at that time. A flexible modular system would be desirable, such as interchangeable modules for frame, steering mechanisms and brakes, which could be customized to individual preferences. It was also deemed essential to have a business partner, with capacity for development and marketing.

While the ideas for the features of the new vehicle were brewing, the TNO manager, whose enthusiasm, commitment and energy kept this initiative alive, pursued two essential objectives: funding for the project and links with viable business partners (all the business managers who were involved until then dropped out of the project due to the lack of interest by their respective firms). Both tasks suffered from the chicken-and-egg syndrome, meaning that in order to find good partners and/or funding one needs to show the presence of funding/partners, respectively. The way out of this dilemma would be to find a specific Mitka idea from the level of abstraction, where it resided at that time, into a very practical societal context. In short, the *solution was searching for a problem*.

It was therefore fortuitous when the environmental manager of Nike Europe became interested in the project. In addition to the recognizable “big name”, Nike offered a valuable opportunity to test the new vehicle among the employees at its European headquarters in Hilversum: the company was running out of car parking space, and welcomed alternative solutions to bringing more cars.

In short succession, Gazelle bicycle manufacturer joined as a designated product developer, drawn by the prospect of association with Nike, and funding was obtained from the Ecology, Economy and Technology Program of the Dutch Government. Notably, efforts to draw car manufacturers into the project failed.

The coalition that emerged from that stage consisted of the TNO manager, the environmental director of Nike Europe, DfS director at TU Delft, and Gazelle Managing Director. We list them as individuals, rather than as organizations to underscore the power of individual entrepreneurship that drove the project at this stage, and the dilemma faced by these individuals. Three of the four joining the TNO project champion in the newly created coalition largely followed their own individual interests and values rather than those of their respective organizations actors (Gazelle representative was the exception). This created a tension – a dilemma – for each, as summarized in Table 3. While they went far beyond the mainstream agendas of their home organizations, they were also sensitive to those.

Another dilemma, largely internalized by the project champion, was that of a tension between the need to create broad support and to the need to create a common vision among the actors. The participation of Nike and Gazelle were crucial to the survival and the success of the project. But that meant that facing up to some fundamental differences in problem definitions and expected solutions among the participants were set aside during that stage (only to emerge later). Table 4 summarizes the differences among the actors.

The TNO team leader was eager to develop a new concept applying the Ecodesign principle for a more sustainable vehicle. TNO is not a business organization; its goal is to develop technical concept designs and to get the rights to them, not to market them. The Nike Company was willing to participate because the sustainability issue was part of the mission statement, and the participation in the project was seen a beneficial to its public image. Additionally, the scarcity of parking spaces in the coming years gave an additional reason to become a client for the new concept. The enthusiastic manager approached volunteers, the employees, for market research but without having a strong commitment to the project, which was inconsistent with Nike's market niche. His expectation of the vehicle was that it should reflect the company image: fast, sporty and attractive.

Gazelle's decision to participate resulted from the possibility of working with Nike Company, and to gain publicity. However, in contrast to TNO's vision of developing and implementing a new concept in sustainable transportation, Gazelle sought through this project innovative ways to promote sales of "normal" bicycles. From a technical point of view, Gazelle was interested in adapting any innovative solutions that might emerge during the design of the new "bike-plus" concept for improving a bicycle construction.

The mission of the Design for Sustainability group at Delft University of Technology is to design, create and study opportunities for any sustainable concepts or systems. As a research and teaching group, DfS is looking for learning experiences to foster sustainable solutions in the society.

The tension between the individuals and their institutions affected the behaviors of the Nike and Gazelle representatives in a particular way: they avoided taking radical steps within their organizations, especially making major institutional commitments of resources. Nike risked relatively little by allowing its manager to participate in the project, while keeping the option of potentially large gains to the companies' images open, even if the project would fail. Gazelle, who at that stage viewed the project primarily as an opportunity to increase its visibility, also took few risks. Both partners could therefore afford the wait-and-see attitude that would characterize the project for some time to come. Other coalition members carried only somewhat higher risks -- reputation and future funding opportunities – but they, too, were not taking financial risks for their organizations.

These attitudes were not a major impediment to progress of the project as long as the government funding continued. But it had other consequences for the project: no self-correcting mechanisms were put in place at that early stage for robust separation of viable from less viable design ideas, and for the reality checks of the emerging artefact *vis a vis* the societal context in which it would have to function. In short, low individual actor's risks (individuals and their organizations) meant greater project risks shared by all. One of the manifestations of this configuration was the absence of a business plan.

6.1.2 Stage two: From vision to design concept

Early in 2000, after more than three years of incubation, the vision of a flexible modular bike-plus vehicle emerged, along with a coalition of actors poised to develop it and pilot in a specific 'real-life' context. As stated earlier, the design of Mitka, like other bounded social experiments, is a problem set. A problem set consists of several interconnected issues -- each of which characterized by high uncertainly -- such that a response to one affects the other issues in the set. In the Mitka case, the types of issues contributing to the complexity included: the technical design of the artefact itself, the consumer behavior, the infrastructure, and any concurrent developments in the transportation arena.

The nature of the coalition that was established to address this problem set has some of the characteristics of what is referred in the literature as a network. A network is generally viewed as a third form of co-operative social arrangement (beyond market and organization),which forms in order to reach certain goals unattainable by individual members (Fadeeva. 2002) or to reduce uncertainty. Individual entities join a network when the potential profit of cooperation exceeds individual strategies to maximize benefit (Kuppers G., 1999). The reduction of uncertainty results from the emergence of rules in a network. These rules integrate individual interests and competencies, and form a social system with a given boundary beyond the "rationality" of negotiations and contracts. A sense of urgency (to reduce the uncertainty and risks, to undo a gridlock in the pursuit of individual interests, to protect individual investments) is a powerful agent of cohesion within a network.

The Mitka coalition, comprising a wide range of interests and perspectives held together by a specific shared goal -- development of the commercially successful "bike-plus" vehicle for a particular use – has some characteristics of a so-defined network. On the other hand, the sense of urgency that arises from taking large financial or reputational risks is not experienced by the actors. As shown in Table 4, none of the key actors has taken large financial risks, if any, and the reputational and prestige risks taken by some of the actors are not large in this one of many BSEs in which the TNO, DfS and the Government subsidies participate through the Kathalys Program. Without a sense of urgency, the shared goal and uncertainty are weak drivers. The main driver here is the *set of different opportunities*.

Viewed in that light, the subsequent developments in the Mitka story, and the omissions made in that process, are not surprising.

In March 2000, Nike conducted an internet-based exercise among its employees in Hilversum, in which they were asked to 'build' on a computer screen, out of individual components, a vehicle that would meet the general set of specifications earlier defined by the Mitka coalition as well as their own preferences as the future users of Mitka. One of the central findings from this exercise was the users' preference for a two-wheeled vehicle over a three-wheeled version. Nevertheless, the coalition chose (in May 2000) a three-wheeled Mitka, the choice that would have great downstream consequences in terms of infrastructure, user acceptance, and others. Notably, the Gazelle representative was the leading champion of three wheels, *in contradiction* to the company's preference for a vehicle that would closely resemble a bicycle, its core business. Should Gazelle, in the future, contemplate making major financial investments in Mitka, the three-wheeled vehicle would raise questions within the company.

This behavior by the Gazelle manager was a clear illustration of a high-risk behavior with regard to the project, in a situation of low-risk behavior by the actors in the coalition. In the absence of a business plan, there were few incentives for the other actors to question the wisdom of this choice or to push for considering alternative designs. Two factors explain the choice of two-front-one-back-wheel: the coalition members found its sleek innovative appearance very appealing; there was *no opposition* to it, despite the considerable engineering challenges it presented, and despite the mixed reactions from users. Furthermore, the imperative of maintaining a unified coalition in the face of low commitment by the key parties produced a counterincentive for revisiting the initial vision for the project, including the considerations of infrastructure and ease of use, or for confronting each other's interests and expectations. Thus the project entered the development phase with many open questions.

6.1.3 Stage three: From design choice to a working model.

For the next two years, with the continuation of the government subsidies, efforts were directed in three directions: (1) soliciting users' feedback; (2) generating publicity; (3) refining the design of Mitka and solving the engineering and construction problems. This stage was dominated by interests and inclinations of the project champion TNO. Any problems arising from a possible mismatch between the vehicle's design and either the users' response to it, or the infrastructure, were dealt with strictly by consecutive changes in the technical design, without revisiting either the design choices or the mobility concept the Mitka represented. The focus on the technical fixes in the construction of the artifact was also consistent with the organizational affiliation of the project champion: TNO's mission is to provide technical assistance to client companies engaged in technological innovations.

Here, the story of Mitka takes a new turn. Sometime in 2000, the DfS director became aware of another case of transportation problems and searches for solutions. On the Island of Texel the tension between the desire to promote tourism while holding back the number of cars on the island reached a crescendo. An idea emerged that Mitka might be part of the solution to the Texel's problem. This was an opening to the second case study described below.

By early 2002, Mitka has evolved into a working vehicle, ready for testing with Nike employees in September 2002. As the project approaches the pilot stage, several unresolved issues loom large. The most acute of those are summarized in Table 5. The table shows that many of the unresolved issues are related to the three-wheel design, the radically different sleek appearance, and the practicalities of a daily life with Mitka. Notably, there were numerous opportunities during the preceding two years to foresee these problem areas. As summarized in Table 6, Nike's studies of consumers' views identified many of the current obstacles.

For a project of this magnitude and duration to arrive at a pilot stage without having addressed the rather predictable obstacles listed in Tables 5 and 6 illustrates the consequences of the two dilemmas of the actors. It was difficult to break up the pattern of risk-averse behaviors and low commitments. It also illustrates another dilemma, this time related to the process: selective focus versus comprehensiveness. In a complex problem such as this, the scope of the analysis and the number of variables can easily overload the analytical capability and the resources of the team, leading to paralysis and abandonment of the project. It is therefore useful to focus selectively on some of the issues – in this case the technical design – and let others "wait". The particular concentrated focus of the project reflected that mission and competencies of the project leader TNO: addressing technical problems in the process of technological innovation by TNO's client companies. The risk of doing so is, however, that the weight of the unresolved issues may threaten the viability of the project.

Meanwhile, the publicity-generating activities for the Mitka project included photo opportunities with the crown princely couple sitting in the Mitka. The high publicity raised the stakes for all the participants. While the financial risks continued to be low for all the actors, the heightened public expectations increased the reputational and prestige risks for all the participants. The commercial failure of the project, should it occur, would now carry a price. Partly in response to this development, the coalition brought in a new actor, a consulting firm whose assignment was to commercialize the new vehicle.

This was a turning point in the project. After a long period of low risk-taking and keeping the social context of secondary to the engineering and product design, the new actor introduced a sense of urgency into the coalition. By reopening the questions of consumer needs, marketing, and business opportunities, the new business partner brought a new reality into the project. The results have been surprising. For a start, the rapidly approaching pilot stage has raised the Mitka project to a higher level of corporate attention. General Manager of Nike Europe as well as General Manager of Gazelle became personally involved in the project. One of the consequences of raising stakes is that these two key actors are confronting the incongruency of their individual visions of Mitka, which was never resolved: radically new concept versus bicycle-look-alike.

Second, new actors became interested in the project: Brabant Development Corporation and a major Dutch insurance company. The company is currently in the process of expanding its core business to providing employers with complete mobility programs for their employees. It became interested in including Mitka in its range of transportation alternatives. The Brabant project is interesting. This semi-private development agency for the Brabant Region in Holland has been pushing hard during the past several years towards innovation in transportation services. Through its VLITS Program (VLITS stands for Innovative Light Individual Transport System, in Dutch). Brabant plans to build a 13-km demonstration route between Eindhoven and Helmond. The route is intended to become testing grounds for innovative ideas in transportation, including fast no-stopping bicycle lanes and other innovative vehicles. Centering on users' needs and on infrastructure, the VLITS Program aims at becoming a magnet for vehicle-oriented initiatives, such as Mitka. Already, another university has approached Brabant about testing an innovative vehicle concept on the planned route.

One of the consequences of the emergence of the new actors is that the coalition has jointly revisited the initial vision of the mobility problem which Mitka was intended to solve. In a significant turnaround in problem definition, Mitka is now viewed as one element in a "mobility solutions" package. Mitka has been redefined. Rather than being a solution to the Nike' parking problem, or to the bigger problem of unsustainable dependence on cars, Mitka is now a place holder, a space, a generic element among many in designing new approaches to transportation.

6.1.4 Analysis

This is where the project stands right now. It is impossible to tell whether or not Mitka will succeed commercially, or diffuse to a larger scale, or lead to a next generation of a bike-plus vehicle (criteria 1 and 2 for assessing success of bounded social experiments). On the other hand, it appears that Mitka has considerably advanced another experiment in mobility on Texel Island, as described in Case two below (criterion 3 of success).

In order to consider the fourth criterion of success – learning – we examine this case from two perspectives: (1) how conducive the process was for learning; (2) what, if any, higher learning occurred, and by whom. A process is conducive for learning when its participants behave in a manner required of a well-conducted social experiment, as discussed earlier in this paper: they are open to surprises, are tolerant of uncertainty, absorb and utilize new data, are intellectually entrepreneurial, and reflect on the problem definition, potential solutions, and each other's roles in this project. The presence of higher order learning among coalition members manifests itself by one or more of the following processes: shifts in the framing of the problem and of the perceived solution, shifts in the principal approaches to solving the problem, shifts in the framing of the relationship to other participants in the experiment, including mutual convergence of goals and problem definitions.

Stage one, lasting more than three years, was by definition a learning experience during which a broad vision of a societal problem in mobility was tackled by consecutive generations of students and faculty at TU Delft, and by the TNO and business managers, and turned into a more concrete vision of a bike-plus vehicle. The actors tolerated a high level of uncertainty, showed intellectual entrepreneurship, and openness to new ideas and new data. Reflection, self-assessment and consideration of each other's roles appear to have been part of that stage. On the other hand, the coalition did not clarify each other's visions, and did not attempt to create a shared vision. The problem definition, and the proposed solution, articulated by the project leader was not reassessed against the accumulated experience from previous social experiments in mobility, both domestically and abroad. Partly, the dilemmas of actors – individual entrepreneurs vs. their organizations, and the imperative of broad support vs. congruency of goals – contributed to these omissions. Partly, this was due to the mindsets of the project champions and other coalition members.

In stage two, the coalition failed to meet the standards of a well-conducted experiment on several counts. It narrowed down their design options rather rapidly, while disregarding the evidence on users' preferences. It chose a single design option, thus limiting the flexibility in responding to future surprises in technical design and in social embededness of the new artefact. While the design ideas converged, the individual problem definitions held by the coalition members did not. Reflection, self-assessment, critical evaluation of goals and objectives, and of problem definition, played a minor role in the coalition's decisions at that point. What learning took place in that stage was primarily of lower order.

In the first part of stage three the coalition continued the stage-two behavior. It demonstrated neither openness to new ideas nor a capacity to absorb surprises or to reappraise the project's trajectory. There is no evidence that reflection, self-assessment, or re-consideration of problem definition played significant roles at that stage, as demonstrated by the strictly technical-fix-type approach to any new problems with Mitka. Technical was the dominant mode of learning at this stage within the coalition. This was, in part, a continuation of the behaviors from the preceding stages, and in the absence of external stimuli that would shake up the coalition (such as major failure or societal pressure). But it is also the case in which the dilemma of the process – selective focus vs. comprehensiveness of analysis – played a role. In addition, the creative process of Mitka development was a prisoner of the technology and product orientation of the project leader (TNO). Absent strong commitment of all actors, the project champion disproportionately influenced the project with the cognitive bias rooted in his institutional affiliation: solving technological problems.

On the other hand, it was a that stage that the Mitka experiment branched out into a new context, in Texel, largely owing to the outwardly-directed intellectual entrepreneurship of one of the members of the coalition. Furthermore, during the second part of stage three , higher order learning took place among the members of the expanded alliance. Regardless of whether or not we shall see Mitkas on bicycle routes of Holland, the executives of Nike, Gazelle, the insurance company, Brabant, TNO, FreeWheel Engineering and Van der Veer Designers have entered the social discourse about sustainable mobility, mobility services, and product-service combination. They have, some for the first time, considered the possibility of having their respective companies invest in mobility solutions far removed from the core businesses of their respective companies. Each has seen their individual problem redefined, and each has considered its role in relation to the other actors in the coalition.

In summary, the Mitka coalition missed opportunities for higher order learning at several key junctures in the project. The absence of the threat of failure -- which could have arisen either from the actors' greater investment in the project and risk taking, or from the urgency of the problem itself – is at it roots. The question arises whether 'formal' visioning exercises could have played a more central role in inducing learning in this project. Formal business analysis might point to the absence of a 'business plan' (at the beginning of Stage two) as a major failing. But this absence is a symptom rather than a cause of the protracted trajectory of Mitka's development in Stages two and three. 'Visioning' , in the form we have discussed within the *SusHouse* Project, is not focused on product design *per se* or on the financial calculations that inevitably must frame any project. Rather, in workshops of stakeholders - including representatives of actual future stakeholders (even through proxies) - it is focused on exploring a range of possible 'scenarios' and building coalitions of stakeholders in support of any project design ideas that emerge from analysis of these scenarios.

We believe that visioning could have provided for more higher order learning during the second and third stages of this experiment. Regular visioning exercises, in the form of workshops involving both the proclaimed stakeholders (that is, those already included as the project's partners) and others representing stakeholders that might not have yet declared their support for the project might have introduced more flexibility in considering a wider range of options for both the design of the Mitka artefact itself as well as the supporting infrastructures. It is crucial to the successful launch of any radical innovation to explore the barriers to and supports for (in terms of social actors) that innovation. Stakeholder-oriented workshops and subsequent economic and consumer assessment exercises (of the kind developed in the *SusHouse* Project) exercises might have helped the Mitka team to learn something about those barriers and supports.

6.2 CASE TWO: Mobility solutions at the island of Texel.

Texel is a 9 by 30 km Dutch Island of the coast of North Holland, reachable by a ferry from Den Helder. Its permanent population of 14,000 swells in the summer to approximately 60,000. Tourists come to Texel for its unspoiled nature, bicycling, beaches, and the cultural ambiance of the six quaint villages. The original population of the island is a close-knit community with their own culture and traditions and their own dialect. They accept tourists because tourism is the mainstay of Texel's economy, and cycle renting is an important part of it (there are twenty bicycle renting companies).

By the end of 1990s the use of cars on Texel created a dilemma for future economic growth. The ferry could not accommodate the demand for the growing car transport (90% of vacationers bring cars to the island), and the parking space at food markets and other businesses was becoming scarce. Although both could have been expanded, the local government and businesses were keenly aware that such expansion would, in the long run, undermine the main attraction of the island as a tourist center: its unspoiled natural environment and unhurried lifestyle. Something needed to be done.

6.2.1. Stage one: Problem definition.

In the late 1990s, leading citizens of the island, including the manager of the ferryboat, the bicycle rental companies, the taxi company, and others established Environmental Texel Foundation (ETF). ETF's mission was to promote economic growth of Texel through tourism while protecting its main cultural and environmental assets. The issue of cars figured prominently on the ETS's agenda. During the next two years ETF and the local government debated the island's development plan. The Mayor advanced the idea of free public transportation but vigorous resistance (led by taxi and bicycle companies) lead to his resignation in 1999. One positive outcome of the increasingly heated debate was that the bicycle rental companies, until now fierce competitors, organized themselves into a single umbrella organization.

Despite the polarization, by 2000 the key actors shared a common problem definition, namely that future increase in tourism would have to go hand in hand with a diminishing use of the car per visitor. There was also a broad agreement that any solution would have to protect the short-term economic interests of the existing businesses.

6.2.2. Stage two: Search for solutions through radical visions.

The director of the DfS program at TU Delft, who has a summerhouse on Texel, had been following the debate over the island's development plan for a while, and established a dialogue with the Environmental Texel Foundation about developing an integrated mobility plan. Sometime in 2000, ETF and DfS director jointly presented an initial plan to all the other actors. The plan included introducing Mitka to the island as well as other elements of a chain mobility system using high tech communication technologies. It received uniformly positive reaction. Thus encouraged, the DfS director invited a group of TU Delft students to further investigate the mobility solutions on the island, which was part of the regular teaching activities. The TU Delft group brought with them a considerable experience in mobility solutions, including the techniques of future visioning and scenario building. After interviewing the key stakeholders on the island and mapping their individual interests, students came up with a vision of the future transportation system

At the core of that vision was a chain-mobility system consisting of Mitka (and its analogues), taxis, bicycles and a redesigned environmentally friendly ferryboat with capability for accommodating new transportation modalities such as Mitka. In the Delft vision, stationary orientation stations would be distributed throughout the island, which would allow the visitors and locals to instantly identify the best modes of transportation from that point, and to summon them in an efficient and convenient manner. Every vehicle in the chain-mobility system would be equipped with a computer. Utilization of the state-of-the-art communication and information technologies (ICT), including global positioning system (GPS) formed the backbone of this plan.

Environmental Texel Foundation, whose several members were energized by Delft radical future vision, organized several seminars for its membership as well as the local government to discuss it. The efforts received considerable publicity and legitimacy when the Minister of Transportation attended one of the seminars. On this round, however, the response was generally skeptical. One of the problems with the process was that the techniques of future visioning and backcasting were not well enough understood by the participants. Future visioning and backcasting are intended to describe *possible* future situations, and should serve as sources of inspiration for developing specific short- and long-term plans.

But in Texel, the enthusiasm for the vision shared by several of its protagonists, clouded that purpose. The majority of the seminars' participants interpreted the *vision to be the plan* of action. Viewed as such, the vision had major shortcomings. Its radicality threatened the economic interests of the key actors who envisioned being asked to make substantial investments into hardware and software, without any evidence of consumers' interests in the proposed chain mobility system. Also, its broad brushstrokes did not account for various practical barriers, such as the ban of electric vehicles from many bicycle routes on the island and other infrustructural issues connected with Mitka, as described in Case one.

The vision presented by the TU Delft group, although rejected by the key actors, was in fact significant in advancing the planning process. First, its radicality disturbed the *status quo* and thus mobilized the key parties to become active participants. This development was aided by the fact that the previously fragmented bicycle lobby was now represented by a unified organization. Second, by identifying the solutions that they did not want, the key actors were discovering the ideas they could accept or directly support. Third, their mental range of options for Texel's mobility widened through exposure to the radical student ideas, even if the latter's were found unacceptable. They were therefore receptive to the proposal from the DfS director to hire an independent party to write a business plan acceptable to all parties. His own vision was that of a new company, which would implement the emergent mobility plan.

6.2.3 Stage three: emergence of incremental solution.

An independent consultant was hired with financial support of the local municipality, the province of North Holland, and the Ministry of Transportation. His task was to write a business plan, which would be endorsed by all stakeholders on the island. The consultant's approach was not to start from the future vision, but rather from the existing ideas offered by the Texel's key individual economic and civic interests. During the first round of interviews he inventoried all the ideas and grievances and formulated an initial plan, which was refined through another round of interviews. The final business plan is under consideration at the time of this writing.

The underlying premise of the plan is to enhance and to build on the activity that is central to the enjoyment of the island by the tourists: bicycling. It is based on three elements: innovation, service, and information. The innovation part consists of cycling on solar power with new types of 'power assisted' bi- and tricycles, starting with the introduction of the Mitka. The service part is to provide for the take-back bicycle retrieval from any point on the island to its origins. The information element consists of installation of fixed and mobile ICT stations for Texel to inform tourists about their location and the possibilities for transportation, food services and other available amenities.

Each actor, including the Delft group, can recognize some of their own ideas in the plan. At the same time, the radical elements of the Delft visions – promoting Mitka, installing ICT technologies on all vehicles, employing the GPS system – occupy a distant second stage, although are notably not precluded by the plan. Moreover, the idea of a new business has been replaced with a proposal for a foundation, Texel Own Mobility Organization, TEMO in Dutch (which alliterates with TESO, Texel Own Shipping Organization). Rather than threatening existing business, as the proposed new business would, TEMO would gain their support by offering assistance to the local business in the field of marketing, fundraising (subsidies and sponsoring), sourcing (lease contracts for innovative bikes), etcetera, and offering the possibility to participate and influence the present and future decisions about the island. TEMO will act as an umbrella organization with a board of directors and with public-private financing. Future private and public initiatives in mobility and other dimensions of Texel's development will be accommodated and nurtured under the TEMO's umbrella.

The stated mission of TEMO is interesting, for it reflects both its underlying premise and the recent compromises. It states that "…growing tourism on Texel will be supported by the reduction of car use", and that TEMO's goal is to "to encourage people to leave the cars at their island residences and to increase bicycle ridership instead". The earlier mission formulation, that "Texel can only grow in tourism if people leave their cars at hotel or home", which focused on a car as the negative force which needs to be tamed, and which was more reflective of the initial problem definition by the islanders, has been rejected in during the second round of recent interviews by the consultant. Part of the toning down of the language about cars reflects the influence of the ferryboat company, which is pursuing a plan for a new vessel with greater capacity for cars.

6.2.4. Analysis

This case is different from the Mitka case on several fundamental counts: First, this was a problem looking for a solution, and the sense of urgency was present. Second, the key actors were available from the outset, thus eliminating the need for a project champion to attract participants in order to get the project off the ground (there was no such a prominent player in this story). Third, all but one (TU Delft) key actors had serious financial stakes in the project (in fact, the financial stakes were at the roots of the overall initiative); Fourth, the key actors shared a common problem definition: how to stop the growing car congestion on the island in a way which does not effect the local economy in any negative way (e.g. preventing unbalances in the local economy).

Collectively, these circumstances produced different tensions from those in Case one. Since both the interests and the financial risks of individual participants were synonymous with those of their respective organizations, the first dilemma of actors – individual versus his/her organization -- was not at issue. They did not need to change their respective roles. The DfS director who, as in Case one, was departing from the primary activities of his university -- teaching and research -- was an exception, but his risk was reputation and future opportunities, not livelihood.

Similarly, the second dilemma of the actors -- gaining broad support and commitment versus pursuing a congruent clear vision - was not a prominent factor in this case. The relatively low systemic tensions in Case two made the coalition much more stable than in Case one. Everybody was deeply invested in finding a way to grow economically through tourism without undercutting the capital of this growth: the unspoiled natural environment, unhurried lifestyle and access to the charm and cultural heritage of the old villages of Texel. This created an atmosphere in which differences in opinions could be openly voiced and worked through. But there were other consequences: the parties acted in risk adverse manner with regard to both their own interests (as in Case one) and with regard to the project (in contrast to Case one). These attitudes were not receptive to radical solutions.

The third dilemma identified in Case one – comprehensiveness of analysis versus singularity of focus – also never became a significant element in the debate. This is because the details of the business plan were hammered out in the context of incremental approach with a relatively small number of variables to consider for the analysis. Building the future step by step, creates the opportunity of 'learning by doing' and adapting to changing consumer requirements on the road towards sustainability. Consequently, entrepreneurs who have to put their money in business solutions are not blurred by comprehensive, unfocussed discussions. Should the radical vision of the TU Delft have been adopted by the coalition, this dilemma would have become prominent.

This case illustrates how an intellectual entrepreneurship of an individual can induce a horizontal diffusion of elements of one bounded social experiment to another, where they in turn can have major impacts on the trajectory and outcome. In this case the import of the Mitka idea brought about by outsiders facilitated the emergence of a radical, highly technological vision of mobility on Texel. While Mitka's future is highly uncertain, on or off Texel, these efforts created a conceptual space for a bike-plus vehicle on the island, which appears to be embraced by the conservative forces within the island's society. The adoption of the cellular phone services as well as the proposed network of solar powered recharging stations throughout the island manifest this. Clearly, the mental space for electrically powered bike-plus vehicles and other innovations in mobility has been created. The key players have also accepted other elements of the rejected radical Delft vision.

This brings up the key issue of higher order learning in this bounded social experiment. One area where it took place was problem redefinition. The Texel story started when some leading institutions on the island defined 'car transportation to be the major threat to the future development of Texel,' and structured the search for solutions around the ways of keeping the car from the island, or at least from its roads. It was a negative approach to both problem definition and possible solutions, and was inward looking.

By the end of the process, the problem identification became positive and outward looking. It is defined as 'insufficient infrastructure and marketing for maximizing the island's principal asset: bicycling as one of the key forms of recreation and relaxation on the island.' Stated that way, the problem facilitated the emergence of a wide range of incremental solutions in the present, and created an opportunity for future experimentation, all intended to make biking more enjoyable and easier. The major compromise in the form dropping the plan to restrict the number of cars entering the island does not detract from these accomplishments.

Another manifestation of the presence of higher order learning is that the key actors are more positively predisposed to collaborative mode of problem solving than two years ago. They are also more open to radical ideas in transportation, such as Mitka and its analogs, that may emerge from outside of their bounded island society. On the other hand, the collective learning curve on Texel is timid. The institutional actors, and the majority of individual actors, have not changed their roles or reconsidered their missions and interests.

As stated before, the current plan has elements recognizable by all participants, including radical Delft ideas. In particular, the employment of ICT and photovoltaic technologies is a major shift in the mental range of approaches ever contemplated by the traditional Texel society. Without compromising their cherished lifestyles, and without exposing the key businesses to high financial risks, the plan opens the doors for future experiments in mobility other than bicycles through the introduction of photovoltaic and other infrastructural elements. In the future, Texel can become testing grounds for innovative ideas in alternative mobility that will be implemented at a rate that is comfortable for, and through TEMO controllable by, its stakeholders. The businesses on the island have learned that business opportunities may emerge from such future experiment.

Visioning exercises were instrumental for arriving at this point. The initial vision presented by the Delft group at local seminars, although initially rejected, nonetheless left an indelible mark on the future process and its participants. It mobilized participation and creative process, gave a direction and a focal point to the debate, enlarged the range of possibilities, and ultimately contributed to both the problem redefinition and the solutions. It is possible that the visioning might have been more effective if the communication about its objectives and techniques were clear from the outset to the audiences. This hypothesis awaits testing in other similar experiments.

7. CONCLUSIONS

Our detailed analysis of the dynamic processes occurring in two bounded social experiments in mobility shows the mechanisms by which diffusion of ideas from one BSE to another might occur. In this instance, intellectual entrepreneurship, one of the elements of a well designed social experiment, drove the diffusion. A group of university students and professors introduced technology-based mobility ideas, including Mitka, into a narrowly conceived debate over the future economic development of an island community. The consequence of this transplantation was that a rather unremarkable local problem-solving turned into a bounded social experiment in mobility, and its most probable trajectory significantly changed in the process. The first social experiment was thus a success by criterion 3 of BSE success, regardless of the ultimate fate of Mitka.

The two case studies highlight the structural dilemmas occurring in bounded social experiments. The dilemmas are particularly pronounced in those BSEs that are driven by an attempt to introduce new technology in order to solve a larger societal problem. This is because activist visionaries frequently initiate such technological experiments, and they must build heterogeneous coalitions of actors in order to gain momentum and to identify promising commercial niches (hence, solutions looking for a problem). Incongruent visions and interests, low commitments and risk-taking by key actors, and complex sets of variables to consider, are likely to emerge in such experiments. These are not easy to resolve or to confront. In contrast, in BSEs where an existing local problem is collectively recognized (problem looking for a solution), and where an innovative technology is one of several approaches to solving the problem, the three dilemmas are less pronounced.

Given the dilemmas and the behavior they engender among the actors, it is not surprising that much discussion takes place at this time among the leading proponents of each experiment regarding their conducts and accomplishments. There are many “what if” and “we should have/shouldn’t have” conversations. The fact is that we have no way of telling whether Mitka would become a greater commercial and environmental success, or Texel a more radical pioneer in sustainable mobility, if an opportunity presented itself to rewind the tape and start the experiments again, this time avoiding the “mistakes” we recognize in retrospect. Quite possibly not. In that sense, the two experiments join the existing list of other experiments in mobility that (1) made no measurable major impact on the prevalent technology or system, (2) gave rise to many “lessons learned”, (3) did not provide a blueprint for making an experiment a commercial and environmental success.

Arguably the most enduring of these lessons is in what the experiments reveal about higher order learning and the conditions under which it occurs. First, the two cases show that while higher order learning can occur in BSEs – for example, incremental problem redefinition or enlargement of the range of solutions perceived by the actors and the coalition -- it requires co-presence of particular facilitating factors. A *sense of urgency* is the most effective facilitating factor, in the form of risk taking, financial stakes, reputations, or mounting of the problem in need of a solution. The magnitude of the sense of urgency is likely to fluctuate in the course of an experiments, as shown in our Case one. These findings are consistent with the literature on policy-oriented and organizational learning, which see failure or threat of failure as drivers of higher order learning.

Second, the cases suggest that deployment of structured visioning exercises can be important strategic tools for enhancing higher order learning. This way of enhancing learning is especially relevant for those BSEs which have a low sense of urgency, and which are particularly vulnerable to having one actor dominate the project in a way that recreates their own institutional biases.

The third observation from the case analyses is that a diffusion of ideas among related bounded social experiments (for example, in the transportation area) may be a key agent for inducing learning. Intellectually entrepreneurial societal agents, such as universities, may play an important role in this process.

Which brings us to another observation about bounded social experiments: their isolation. A striking lesson from the multitude of BSEs in mobility is their relative isolation from one another. Arguably, the next great challenge in designing bounded social experiments is to find ways to link them. A role for government in facilitating this phenomenon is apparent.

Finally, the data presented in this paper provide support for our earlier proposition that diffusion of ideas from one BSE to another, and the occurrence of higher order learning, are legitimate criteria for judging success of BSEs. In fact we suggest that the conditions for enhancing these processes should be strategically built into the design of bounded social experiments.

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Figure 1, The Mitka-vehicle (May 2001)

<u>Table 1. Suggestions for designing bounded social experiments in mobility</u> (from Weber, 1999)

·	Choose technology or concept that is as close as possible to the existing regime, but which allows to induce more radical changes later on
·	Seek to keep open a variety of technological options; therefore phase your experiments and organize them in modules in order to avoid becoming too complex
·	Keep the experiment sufficiently broad in terms of partners (users, suppliers, government, operators) and have committed partners in the team
·	A successful experiment needs not be conducive to niche formation, and vice versa
·	Explore which types of market pressures could be operational in the experiment
·	Create opportunities for the active involvement of pioneer users in the early phase of an experiment, and of mass users in the later phase
·	Create opportunities for discussing results of the experiment with groups that are not actively involved in the experiment but are affected by it
·	Monitor the tacit and vague expectations and visions of participants and articulate them specifically
·	Seek broad coverage of opportunities for learning about new implications of a technology
·	Reflect upon existing mobility patterns and changes which the new technology may bring about in relation to the mobility objectives pursued
·	Be aware of changing requirements in terms of network structure in the course of the progress and scale-up of the experiment
·	Consider which kinds of complementary policies could be conducive, needed or detrimental to the experiment
·	Look for opportunities to replicate an experiment and try to keep experiences stored in a network
·	The technology or concept needs to be customized with the pioneer market turns into a mass market
·	Seek to establish productive and smart ways of protecting an experiment
·	When phasing out a niche development process, try to enroll the established network into the development of other options for addressing similar problems

Table 2. Lessons from bounded experiments in mobility that have not diffused beyond the experimental boundaries (From Weber, 1999)

· Well chosen small innovations can lead to unexpected opportunities which can have major impacts upon existing transport regimes.
· Modular projects allow for changes to be made in light of the experience gained.
· Committed partners increase the changes of project success.
· Balance the drive for high-risk reward project innovation with a low-risk, more conservative incremental strategy.
· Governmental financial support of experiments may sometimes have ambiguous effects.
· Incorporate high profile users within the experimental partner network.
· Prepare strategies to deal with possible opposition to the project before they occur.
· The expectations of all parties need to be continuously articulated to ensure co-ordination of partner activities.
· When designing a new experiment, seek out and utilize previous relevant experience.
· Experiments should be used to question underlying assumptions at all levels; these include technology options, technology diffusion strategies and effects upon patterns of mobility.
· At all stages within a project, chose a management style which maximizes operational effectiveness.
· Complementary measures, external to the experiment, might be required to achieve project goals.
· Seek out independent observers to assess the extent of the project's success.
· Overprotection of a technology can unrealistically raise expectations of its potential and draw attention away from a poorly devised experiment.
· Monitor carefully potential barriers to co-operate between partners in an experiment, especially if they have competing stakes and are prone to free-riding.

Table 3. First actors' dilemma in Stage One: individual versus the organization

Mission of entrepreneurial individual	***Organizational mission***
Nike manager: Interested in environmental initiatives	Manufacturer of youthful, innovative, sleek, 'winning' athletic products Sustainability a strategic asset for corporate image. Corporate environmental strategy does not include solving transportation problems.
TNO manager: Committed to idea of innovating in product-service for sustainability	Advises industrial clients on product development in technological innovation. Sustainability not on the agenda
Gazelle director: Interested in business opportunity	Seeks to increase bicycle sales through innovative changes.
DfS Director: Committed to idea of innovating in product-service for sustainability. Interested in teaching through empirical problem solving. Interested in attracting funds to support research	Design for sustainability not a mainstream activity of the university. Social experimentation not in the engineering tradition.

Table 4. Actors' second dilemma in Stage One: broad support versus congruency of goals

Roles of Actors	Problem definition	Solution to problem	Risk taken	Attitude
TNO Project leader	· People drive cars for short distances because bicycles are slow, too much effort, and weather-dependent · People reject bike-pluses because of image, poor marketing, conservatism	· New vehicle that is faster, power assisted, weather protective · New vehicle: sleek, bicycle-look-alike. Partner: high marketing potential	Reputation, prestige	Active in finding financial support, Assembling project team, visioning, design, networking and publicity
Nike Company Client	· Insufficient environmental image · Insufficient parking for employees · Maintain company image	· Participate in the project while using Nike logo on new vehicle · Offer new vehicle to employees · New vehicle: fast, attractive, innovative, sleek	Low financial	Contributed by soliciting input from users. 'Wait-and-see'
Gazelle Company Business developer	· Bicycle market saturated. Need for innovation	· New vehicle: conservative, bicycle-like. Avoid radical changes	None	'Wait-and-see.' Passive participant. Brought product designer (Van der Veer Designers) and engineering designer (FreeWheel) into the coalition
DfS Knowledge keeper. Strong project supporter	· Current trends in car use for home-work commuting not sustainable. Alternative product-service needed in mobility	· New product service system combination for sustainability transition	Reputation, prestige	Involved in all stages. Students involved. Networking and publicity seeking
Governmental Program Financial support	· Niches needed for development of radical ideas in sustainability	· Promoting experiments in development and testing of new product-service	Financial (diffused), reputation, prestige	Long-term support without interference

Table 5. Some unresolved barriers to adoption of Mitka

Technical design	Several unresolved issues remain
Infrastructure	The front-two-wheel-back-one-wheeldesign imposes 90 cm width on vehicle that exceeds permitted 75 cm. Two Mitkas cannot pass on bicycle path. In “walking” cities (i.e. Amsterdam) Mitka can be perceived too wide for the small roads. Residential storage difficult. An obstacle to widespread adoption. Facilities for battery recharging and technical assistance for maintenance and repairs problematic.
Regulations	A paradox: attainable speed above 25 km/h requires use of helmets but human powered vehicles do not require helmets
User acceptance	Sleek form attractive to some potential users, but liability to others, for whom Mitka departs radically from their accepted meanings and routines of daily life.
Market factors	Price a deterrent to individual users, although alternatives to private ownership exist. Nike likes sleek and innovative design, including three wheels, while Gazelle seeks to avoid radical departure from a bicycle.

Table 6. Solicitations of users' input in the Mitka development

TIME	EVENT	RESULT
March 2000	Nike employees were asked, via internet, to "design" a vehicle from individual parts	· Majority preferred 2-wheeled version over a 3-wheeled · 15-kilometer distance was the maximum; more luggage storage space was preferred
Key decision: May 2000	Choice of three wheels, two in front	
September 2000	Coalition members and Nike employees evaluated a 1/3 scale model of Mitka	The response was positive
February 2001	Visioning exercise with 9 Nike employees focused on "imagining" life with Mitka	· Potential users have difficulty envisioning the daily life with the new artefact · The three-wheel vehicle seen as a problem of maneuvering · Mixed reaction to the radically in design · Strong preference for leasing over ownership
March 2001	Interviews with bicyclists at a bicycle fair, where a prototype of Mitka was displayed	· Mixed reactions towards Mitka · Concerns about the infrastructure –technical service and parking · Not appropriate for transporting children · Strong preference for non-ownership
April and May 2001	In-depth interviews with 12 Nike employees, who were presented with the prototype	· Hesitance about the radicality of the design · Seen as a substitution for the second family car · Strong preference for non-ownership · Mixed reactions to rain protection · Preference for two-wheel version · Potential users have difficulty envisioning the daily life with Mitka