



Energy research Centre of the Netherlands

Manual on the Socrobust tool and recent experiences with using Socrobust

Deliverable 1

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**Create
Acceptance**



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Abstract

This first task entailed familiarising the consortium with the original Socrobust tool. The project Socrobust incorporated twenty years of Science and Technology Studies literature into a reflexive method for anticipating future stakeholders reactions to innovation by making explicit the innovator’s assumptions build into the design of an innovation. The method needed to be flexible to adapt to a variety of situation and be useful for managers. A standard (consultancy) process was developed, composed by a tool-kit and a protocol for interaction with managers. The Socrobust tool consists of four steps with each different tools.

The original Socrobust is a method of assessment based on one stakeholder in the relevant position of managing an innovation project. It was aimed at reflection and learning and less aimed at action and implementation. The WP1 report is an introduction to the original Socrobust toolkit and a critical review of its suitability to measure, promote and support social acceptance of innovative RES and RUE technologies. In general it can be stated that the existing steps and most of the instruments of the original Socrobust toolkit can be maintained, but that additions and small alterations need to be made if the tool is to function as a tool that assists multiple relevant stakeholders simultaneously instead of only the direct developers or innovators. In addition, the Socrobust instruments need additions and alterations to function as a toolkit that can measure societal robustness and create a platform to involve relevant stakeholders in the process of developing a socially robust product. The above briefly discussed results and recommendations are the starting point for the consortium’s efforts in WP3, where Socrobust will be developed into a new toolkit and methodology for Create Acceptance.

Cultural Influences on Renewable Energy Acceptance and Tools for the development of communication strategies to promote ACCEPTANCE among key actor groups

Project co-funded by the European Commission within the Sixth Framework Programme
(2002- 2006)

Partners of Create Acceptance



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Executive summary D1

Manual on Socrobust and recent experiences with using the Socrobust tool

Introducing the project Create Acceptance

This summary provides results of research that has been conducted as part of the EU-funded project Create Acceptance. Create Acceptance is supported by the European Commission under its Sixth Framework Programme (Project no. 518351). This report describes the results of the activities carried out for the first work package 'WP1', which was coordinated by CNR/CERIS-Italy. The objective of WP1 was to explore the potential of an already existing methodology developed in the project Socrobust, supported by the European Commission under its Fifth Framework Programme. Create Acceptance is coordinated by ECN (the Netherlands), and involves research institutes in Italy (CNR/CERIS), Finland (NCRC), Spain (EcoInstitut), Germany (OEKO), United Kingdom (SURF), France (IAE), Iceland (INE), Hungary (MAKK) and Poland (IEO). More details about the Create Acceptance project can be found at <http://www.createacceptance.net>

Often, successful adoption and diffusion of innovations is assumed to be merely an issue of securing the techno-economic dimension. In practice, many technological projects such as wind turbines or biomass plants are facing severe resistance from various stakeholders. Aligning the views of these stakeholders and finding an agreed common view on the innovation lies at the heart of good management practices for successful technology development. Successfully diffusing innovations relies on creating the societal acceptance of the technology.

The project Create Acceptance contributes to facilitating the implementation of new and emerging sustainable energy technologies by assessing optimal conditions for the implementation of these new technologies in terms of socio-economic aspects, consumer preferences and citizen needs. The objectives of this project are to increase the competitiveness RES (Renewable Energy Sources) and RUE (Rational Use of Energy) technologies by developing a tool that can measure, promote and improve social acceptance of these technologies.

Introduction of Work Package 1

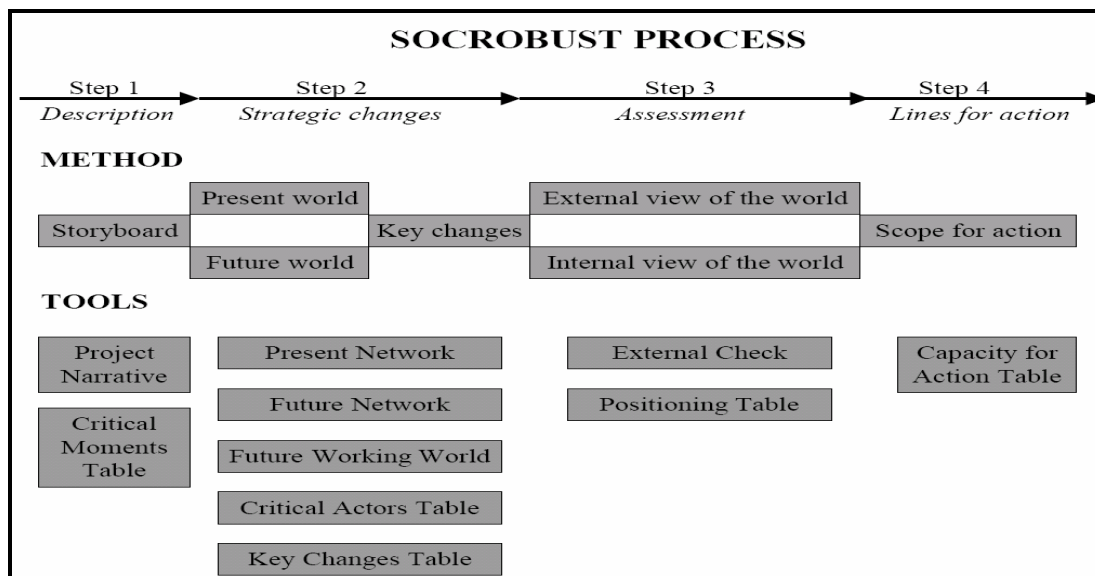
The first Work Package (WP1) assessed the already developed Socrobust tool platform for its suitability to measure, promote and improve social acceptance of innovations in general by mapping its potential to contribute to societal embedding of RES and RUE technologies and by means of identification of its limitations to assess the social acceptance of RES and RUE.

WP1 was divided into two tasks. The first task was to familiarise the consortium with the original Socrobust tool, and familiarise the consortium with experiences ECN built up while using the tool. Output of this task are a manual on the original tool, including a theoretical section to position the methodology amongst other approaches and a report on ECN experiences. The second task aimed to take the Socrobust tool as a starting point, critically review it for its use, and selectively choose which aspects need further research and implementation. A special focus was put on integrating mechanisms that influence public perception and acceptance such as trust, knowledge, capacity and capability. On the basis of the research conclusions were drawn on how to further modify the Socrobust tool. Output of this second task is a report consisting of an overview of gaps in the Socrobust tool with respect to mechanisms underlying social acceptance and a proposal on how to integrate this missing information in the existing Socrobust tool platform in WP3.

In the next sections the results of the first task of WP1 and recommendations following this task, are discussed in more detail.

Results Task 1.1 Getting familiar with Socrobust

This first task entailed familiarising the consortium with the original Socrobust tool. The project Socrobust incorporated twenty years of Science and Technology Studies literature into a reflexive method for anticipating future stakeholders reactions to innovation by making explicit the innovator's assumptions build into the design of an innovation. The method needed to be flexible to adapt to a variety of situation and be useful for managers. A standard (consultancy) process was developed, composed by a tool-kit and a protocol for interaction with managers. The Socrobust tool consists of four steps with each different tools (see overview in figure below).



In the first step the innovation journey of the project under investigation is described via a story, the *Narrative* and by means of a *Critical Moments table*, which comprises the key moments that modified the path of the project.

In the second step the context of the project is described. The present network of the project is made visible in an extended *Techno Economic Network (TEN) map* and the relevant stakeholders are further characterised in the *Key Actors table*. The *Future Working World* is a description of the future network, based on the TEN map. Since many projects can still envisage different developments in the future, it is possible to envisage more than one future world. After comparing the present TEN and the TEN inscribed in the future, a *Key Changes Table* is composed to understand in what direction the project is going. Finally the *Boundary Map* identifies three types of actors and circumstances which help to define what the project manager has realised, what he/she should have to do and what is difficult to reach.

The third step assesses the societal robustness of the project (the level to which the projects future networks actually fit with trends and expectations of external stakeholders and developments) by means of an *External Check* based on desk and internet research. Secondly a *Positioning Table* is composed in which the key changes of the ideal project world (future network) are re-examined in relation to a wider context.

The fourth step concerns the consultant activity of identifying space for action (Action Table) and drawing the Recommendations Box. The action plans (Action Table and Recommendation Box) do not comprise well defined plans of actions for implementing critical situations, but contains more general definitions of action.

ECN applied Socrobust to innovations developed by several of its units. These experiences were used in the second task of WP1 to determine Socrobust's usability for the purpose of Create Acceptance: developing a multi-stakeholder methodology.

Recommendations Task 1.1

Overall recommendation is that the original tool is very useful as a starting point to develop a tool that can measure, promote and improve social acceptance of innovative RES and RUE technologies. The original developers of Socrobust already recommend the following improvements to the original Socrobust methodology after the first line of testing the methodology:

1. With respect to all steps the developers recommend to attempt to make the instruments generic and not case specific.
2. All steps should be made less time consuming.
3. The key actor table should be made more descriptive, also focusing on reasons for (lack of) alignment between stakeholders, and identifying all stakeholder attitudes, the factors influencing these attitudes, and identifying the factors necessary to change the attitudes.
4. The power relations between actors should be analysed.
5. The fourth step should be developed into a more action oriented instrument. Not only the type of action should be identified, but it should also be identified how to undertake these actions. The possibilities for explicit mediation processes (through skill formation, communication, collaboration, an intermediary organization role) or competitive dis-alignment should be analysed.
6. The action table should also discriminate between stakeholders: which actor should undertake what action, and what can be the role of the innovator in steering or motivating these actions.

After a second line of testing the Socrobust methodology by ECN, the following adaptations to the original Socrobust methodology were recommended:

1. Involve multiple key stakeholders instead of the single key stakeholder the original tool takes into account, and have all these stakeholders draw a present and a future TEN network.
2. Both innovator and stakeholders could be asked to also draw intermediate TENs which describe the paths towards each of the desired future worlds. An analysis of the interrelatedness, competition and cooperation between these intermediate paths can help to find out the more robust alternatives.
3. Broaden the present en future network by working with seven dimensions instead of the four poles of producers, consumers, science and regulation. Use the following dimensions: law and regulation; social; cultural; economic/market; institutional; infrastructural; technological.
4. Broaden the methodology of the external check such that it not only uses a literature and internet check, but also assesses the 'shades of robustness' of the project by comparing its present network and future network with those 'desired' by the key stakeholders.
5. Make the action table more explicit with timing, priorities and level of actions for different actors at macro, meso and micro level.

Conclusions

The original Socrobust is a method of assessment based on one stakeholder in the relevant position of managing an innovation project. It was aimed at reflection and learning and less aimed at action and implementation. The WP1 report is an introduction to the original Socrobust toolkit and a critical review of its suitability to measure, promote and support social acceptance of innovative RES and RUE technologies. In general it can be stated that the existing steps and most of the instruments of the original Socrobust toolkit can be maintained, but that additions and small alterations need to be made if the tool is to function as a tool that assists multiple relevant stakeholders simultaneously instead of only the direct developers or innovators. In addition, the Socrobust instruments need additions and alterations to function as a toolkit that can measure societal robustness and create a platform to involve relevant stakeholders in the process of developing a socially robust product. The above briefly discussed results and recommendations

are the starting point for the consortium's efforts in WP3, where Socrobust will be developed into a new toolkit and methodology for Create Acceptance.

Deliverable 1.

Manual on Socrobust and recent experiences with using the Socrobust tool

1. Introduction

Technology developers and policy makers often assume that having secured the techno-economic dimension of innovations is enough to ensure its successful adoption and diffusion. In practice, many technological projects such as wind turbines and biomass plants are facing severe resistance from various stakeholders including actors that are not direct users or consumers of the technology (Wynne, 1989; Wolsink, 2000).

This phenomenon, classically labelled as resistance to technology (Bauer, 1995) has been thoroughly analysed by scholars from Science and Technology Studies (STS). Resistance has been shown to be associated with the societal transformation/impact, often associated with the diffusion of the technology in societies (Beck, 1992; Akrich, 1993). As many different actors usually are concerned with the social changes induced by technology development, conflicts may arise about the path to follow and the potential consequences and uncertainty involved (Wynne, 2001). Good management practices for successful technology development thus imply the management and co-development or co-shaping of both the new technology and the society it needs to be implemented in. Success relies on alignment of the views of different stakeholders, and it depends on finding an agreed common definition of what the innovation should look like, do, perform, cost etcetera (Akrich et al, 2002; Bijker et al, 1992). In other words, societal acceptance of the new technology is to be created simultaneously with the creation of the technology itself.

In the practice of technological project management questions often are as simple as - Who are the stakeholders? What do they want? What kind of changes in society are they ready to accept? These questions however are not easy to address and answer. This is further complicated by the fact that most questions need to be anticipated, answered in a prospective way, before the technology is actually diffused and stable. Existing knowledge and tools are rather inadequate and require further development. The STS literature for instance is to a large extent retrospective and still needs to be transposed into action oriented and prospective perspectives and methodologies. For example, it is not enough to be in a position to properly explain in retrospective why the European public massively rejected GMO's after its 1996 launch. If the aim is to develop a tool that can monitor, promote and even improve societal acceptance of an innovation, one needs to be in a position to predict the rejection before it even happens. Would focus groups or other participatory methods have been able to prevent or alter the course of these events? Did a company like Monsanto use some of these methods to create acceptance?

The main objective of the current project, Create acceptance, is to develop a method, a set of tools that allow for better management of the societal dimension of technological projects. To approach this question, we start by analysing and getting familiar with the major results of a prior methodology-development project called Socrobust. Socrobust paved the way for the development of a method to address the societal acceptance of projects (Laredo, 2002; Jolivet, 2003). Starting from the observation that many technological projects fail due to inappropriate consideration to the social and diffusion side of innovations, Socrobust focused on trying to help project managers anticipate future reactions to their products or services of consumer and society at large. 20 years of STS literature was incorporated into an exploratory method for anticipating these reactions to innovations of future stakeholders. The Socrobust method was first

tested in eight European small business innovation projects in areas such as micro-chip and telemedicine. After conclusion of this first Socrobust project, one of the developers of the methodology, the Energy research Centre of the Netherlands continued to test, evaluate and refine the methodology during a second series of application on Combined Heat and Power (CHP), Energy Management Systems (EMS), Photovoltaic Thermal systems (PVT) and fuel cells. Although the general orientation of Socrobust method was confirmed, a number of lines of improvements were identified in the process, and tools were adapted for better efficiency.

This report describes the efforts of the first Work Package (WP1) of the Create Acceptance project. WP1 assessed the already developed Socrobust tool platform for its suitability to measure, promote and improve social acceptance of innovations in general by mapping its potential to contribute to societal embedding of Renewable Energy Systems (RES) and Rational Use of Energy (RUE) technologies and by means of identification of its limitations to assess the social acceptance of RES and RUE.

WP1 was divided into two tasks. The first task was to familiarise the consortium with the original Socrobust tool, and familiarise the consortium with experiences ECN built up while using the tool. Output of this task are a manual on the original tool, including a theoretical section to position the methodology amongst other approaches and a report on ECN experiences. The second task aimed to take the Socrobust tool as a starting point, critically review it for its use, and selectively choose which aspects need further research and implementation. A special focus was put on integrating mechanisms that influence public perception and acceptance such as trust, knowledge, capacity and capability, knowledge on the influence of regional energy footprints on social acceptance of RES and RUE and knowledge on the origin of difference in risk perception between different social groups. On the basis of the research conclusions were drawn on how to further modify the Socrobust tool. Output of this second task is a report consisting of an overview of gaps in the Socrobust tool with respect to mechanisms underlying social acceptance and a proposal on how to integrate this missing information in the existing Socrobust tool platform in WP3.

In the next sections the results of two tasks WP1 and recommendations following these tasks, are discussed in more detail in a 'bridging' report which tackles the question how to translate the original Socrobust tool into a multi-stakeholder tool to assess and promote social acceptance of RES and RUE innovations.

The report consists of three parts:

- 1 In Deliverable 1, Part I of this report, the original Socrobust toolkit and protocol are presented, the ECN experiences with Socrobust tool and the suggested adaptations.
- 2 In Deliverable 2, Part II of this report, we present the decisions made on the new tool and the partners' contribution on how to fill the gaps between the original Socrobust methodology and the to-be-developed multi-stakeholder tool.
- 3 In the Annex some theoretical background of the Socrobust methodology is given.

2. The Socrobust toolkit and protocol

Socrobust is a method developed in 2002 by STS researchers as a support tool for technology developers and project managers dealing with breakthrough innovations - i.e. innovations that potentially raise problems of acceptance as they change existing practices in society (Laredo et al, 2002). These STS researchers had observed that many technological projects fail due to lacking consideration of the diffusion and societal embedding of innovations. Socrobust was composed as a tool-kit and a protocol for interaction with project managers to help these managers anticipate future consumers and societal reactions to the innovation. Twenty years of STS literature was incorporated into an exploratory method for anticipating future stakeholders reactions to innovation. It was then first tested in eight European small business innovation projects in areas such as micro-CHP and telemedicine. Socrobust is a tool that is developed with a *single* stakeholder perspective: the perspective from the innovator that aims to allow for a better management of the societal dimension of technological projects.

The Socrobust method had to meet two targets: being flexible to adapt to a variety of situation and being useful for managers. A standard process around the same set of tools was developed. The process was composed by a tool-kit and a protocol for interaction with managers, as a consultancy model. The consultancy-based protocol was conceived for the project managers. Since for business people time is precious, the aim was to get the maximum output with the minimum time investment: only a limited number of interactions with only one person (the project manager) before delivering a report. The instrument consists of four steps and several instruments that will be discussed briefly below.

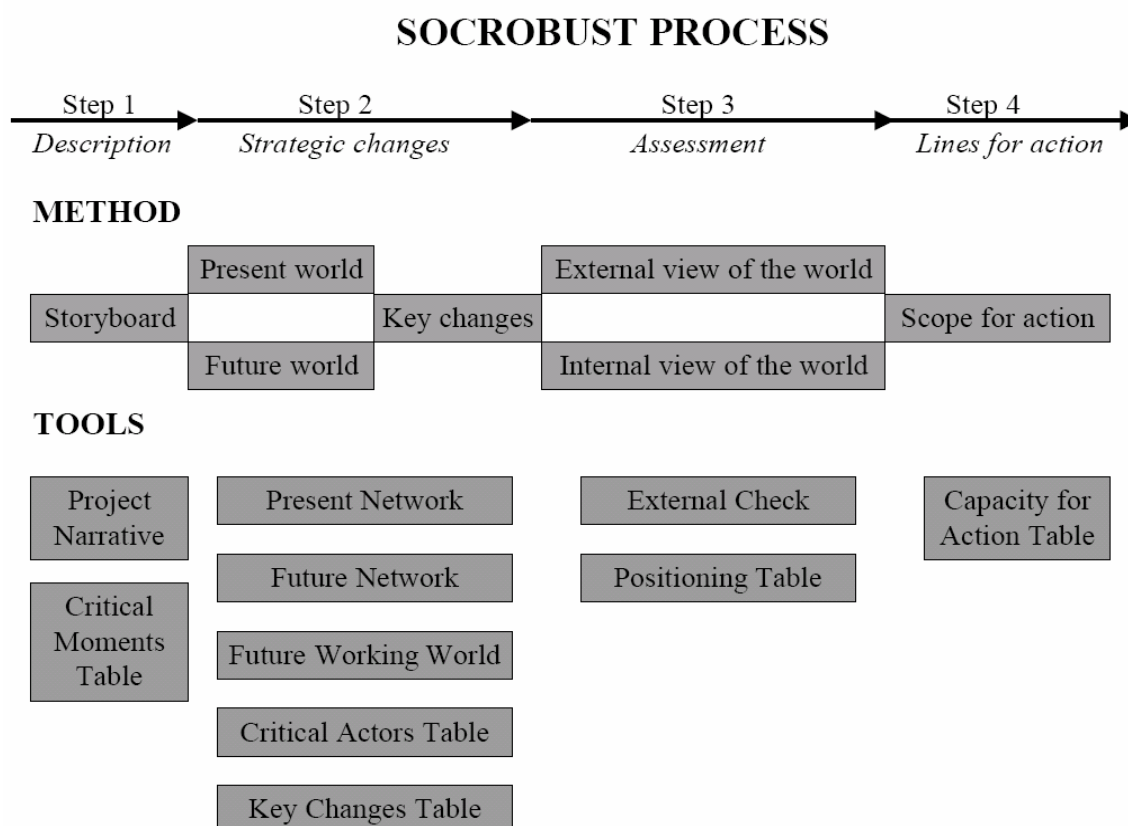


Figure 2.1 *The Socrobust process*

2.1 Project story

The first step focuses on making explicit an innovation's history as a reflexive basis for assessing the project's current social robustness. Two instruments are used for this purpose. The narrative and the critical moments table.

2.1.1 The Narrative

By means of an interview, the innovator or project manager is elicited to express a description of the past, the present and the anticipated future of the innovation under analysis. This interview results in a narrative. The narrative is a chronological story starting with the start of the project until the present and the identification of the critical moments that occurred which led to a 'shift' in orientation and their consequences for future steps. What many narratives showed was that innovation projects have long and changing journeys and can keep something of the original while changing a large part of their constituents. This narrative is used as a basic reference that ensures that both interviewers and managers and any other actor involved in the interaction are in consensus on main details. Main aspects that are taken into account in this narrative are:

- The origin of the research subject (within the organization).
- The very idea and the needs it is addressing.
- The main lines of choices and the difficulties or uncertainties experienced.
- The artifact as designed and its basic principles.
- The present network of users, producers, laws and regulation and technology and science.
- The expected future of the research subject.

The narrative is a written text, but can also be visualised in a flow diagram.

EUROVET: Linear and branching histories

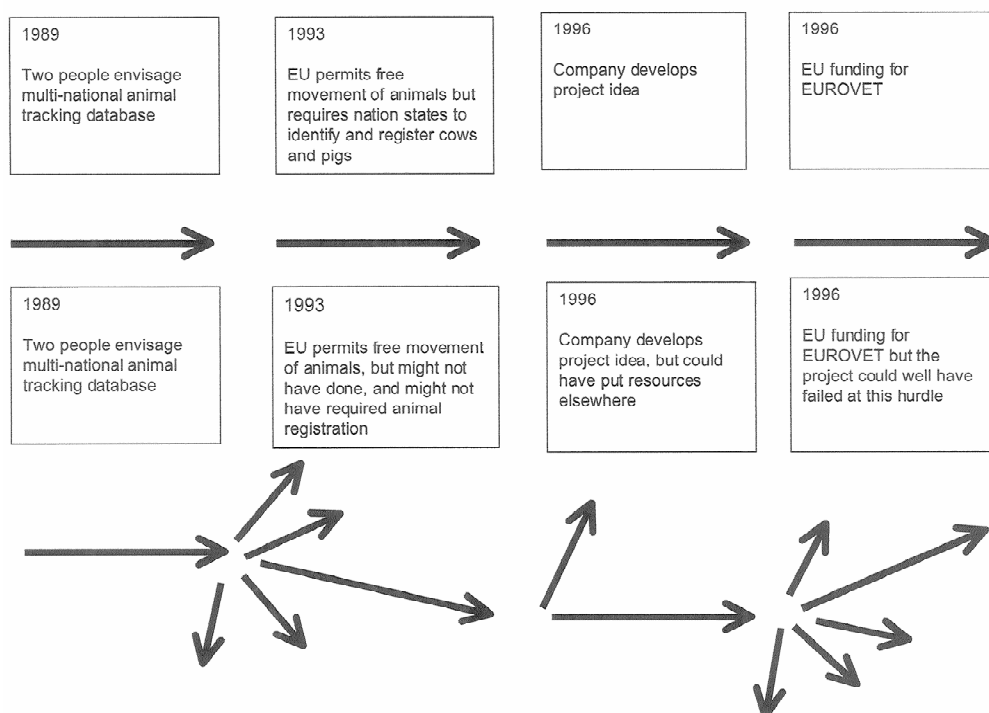


Figure 2.2 *A visual narrative as used in the original Socrobust project. While the first figure implies a linear history, the second figure shows that different paths have also been possible, in particular at certain 'branching points' in time.*

Source: 'Managing breakthrough innovations: the Socrobust methodology'.

2.1.2 Critical Moments table

In a second meeting the narrative is analysed in terms of the critical moments; key turn decisions in the technological development and their consequences for the direction of the development. The critical moments modified the aim, tasks and path of the project, sometimes to the effect that the new path becomes irreversible. These critical moments occur i.e. due to new technical opportunities; problems in the internal alignment of partners; and learning through demonstration and trial activities. As such, the critical moment table highlights the presence of a number of shifts that were not expected in advance and that superpose themselves on the ‘normal’ expected stages of the project.

These critical moments are visualized in a table, which is discussed with the project manager or innovator for validation. The objective of this tool is to help the innovator to reflect upon the proactive and or reactive choices made in the course of the technological development, and thus to identify the possible alternative routes that might have been taken. This knowledge highlights the non-linear character of technological development.

Each critical moment/event is characterized in the following terms:

- The date of the event.
- The description of the event in key words.
- The source of the event (proactive or reactive).
- The implication of the event, the critical choice made by undertaking the event.
- The solution envisioned by undertaking the event.
- The degree of irreversibility of the change.
- The alteration introduced in the R&D program.
- The stage reached by the R&D program in the innovation journey.

Extract of critical moments table

Date	1993
Description	EU permits free movement of animals
Implications	Member states have to identify and register cows and pigs
Next steps	Need for national databases of animals
Source	External to the project-to-be
Irreversibility	Strong - legislation creates a context in which the project can exist
Type of event	Regulatory contexts changed
Type of change	In the potential market for an animal tracking database

Date	1996
Description	Company develops the idea of applying for an EU funded project
Implications	Potential partners are sought and a project is designed
Next steps	A proposal is submitted to the EU
Source	Internal to the project-to-be
Irreversibility	Weak - the project might not be funded and so might never exist
Type of event	The research proposal is submitted
Type of change	An idea is turned into a fully formed research proposal

Figure 2.3 *The critical moments table as used in the original Socrobust project*

Source: ‘Managing breakthrough innovations: the Socrobust methodology’.

2.2 Step 2. Project unfolding

This second steps aims at identification of the Techno Economic Networks (TEN) in which the project is involved at present, the actors relevant at present, the desired future TEN, the changes needed to realise the future TEN and an analysis of boundaries to actions necessary.

2.2.1 The present network: an 'extended' TEN map

In a third interaction the innovator and interviewers compile a present network, which is a visual map of the current relations of the innovator with other actors and important factors to take into account in the following four poles: the regulation pole, the science pole, the industry/producers pole and the user pole. The objective of this tool is to provide the project manager with a visualization of the innovation in terms of the heterogeneous web of linkages that construct and surround it and it helps the innovator to assess the present broader context of the innovation. Content wise, the original methodology aims at the creation of a present network following one perspective (the innovator's) on the present world in which the innovator is developing an innovation.

The present network makes the linkages visible within and between the project and its environment in the domains of: regulation, science, users and producers. Often, the developers used a more descriptive scheme, instead of the classical TEN schemes (with four types of poles, Regulation, Science, Users, Suppliers). The developers often made the TEN specific to the project. For instance in one of the cases studied, the TEN table included: Technology, Finance, Science, Industry, Users, Society, Regulation, Hospitals. The project manager gives the information necessary to draw the present TEN.

Present Network Map

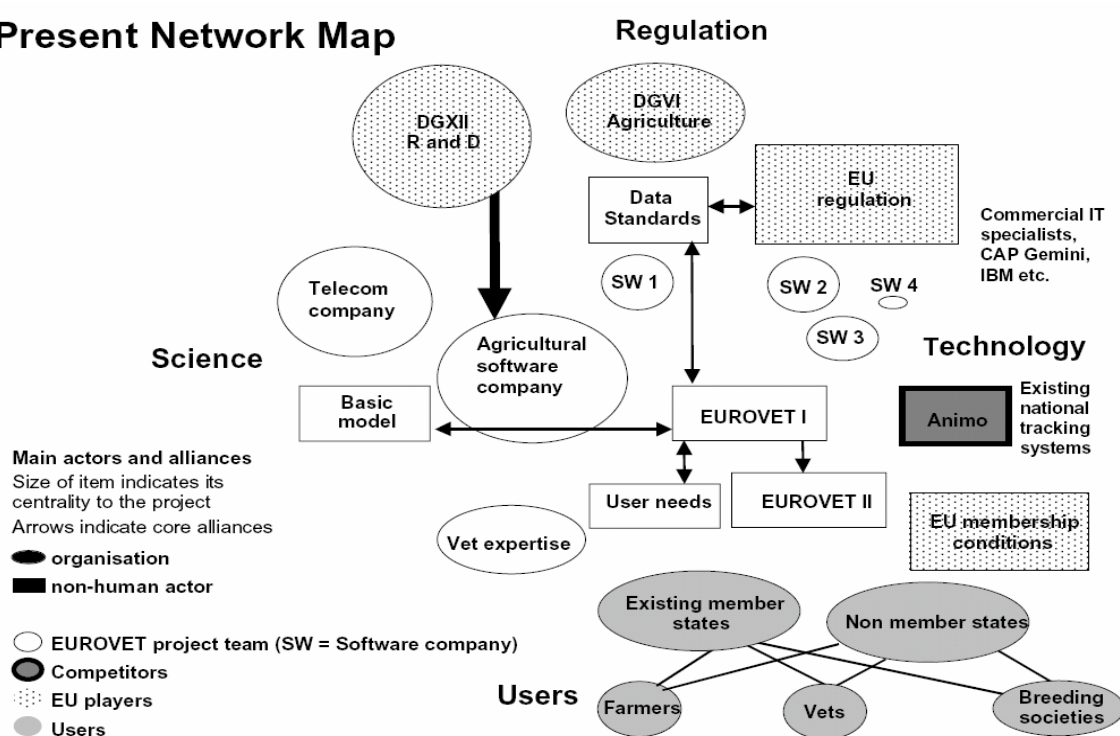


Figure 2.4 *The present network*

Source: 'Managing breakthrough innovations: the Socrobust methodology'.

2.2.2 Key Actors table

The key actors table characterizes actors in terms of their importance (the actor's centrality in the network and in the pole, substitutability and estimated importance) and the actor's involvement (motivation for participating in innovations trajectory, objective for contributing, global strategy (entrepreneur, non-profit), estimated alignment, options for influencing the actor, irreversibility of commitment and estimated involvement) with the innovation under analysis. The objective of this tool is to clarify the role of the actors involved. By defining the actors in terms of importance and involvement discrepancies between an actor's involvement and importance can surface. Possible discrepancies can have significant effects on the chances of embedding of the innovation. For an example of the critical actors table see next figures.

Extract of critical actors table

Actor	Agricultural software company
(1) Motivation to join the project	Promotor and project manager
(2) Goal in the project	Profit
(3) Global strategy of the organisation	Entrepreneurial
Estimated involvement (1+2+3)	Strong
(4) Modes of coordination/intermediaries	Hierarchy/material technology
(5) Strength (frequency and infrastructure)	High
Alignment towards project manager (4+5)	Total

Actor	Software company 1
(1) Motivation to join the project	Research work/instrumental
(2) Goal in the project	EU funding
(3) Global strategy of the organisation	Acquiring work
Estimated involvement (1+2+3)	Medium/functional
(4) Modes of coordination/intermediaries	Hierarchy/fund allocation/task allocation
(5) Strength (frequency and infrastructure)	Medium
Alignment towards project manager (4+5)	Medium

Figure 2.5 *The critical actors table as used in the original Socrobust project*

Source: 'Managing breakthrough innovations: the Socrobust methodology'.

2.2.3 Future network map and future working world

The future network map is a similar tool as the present network map and visualises how the innovator expects the innovation to be embedded in the pools of science, technology, regulation and users. In an interview the innovator is asked to describe the future in which the technology is completely embedded in society. How would the world look like? What would be the role of users, producers and the government? Which organizations and market structures will have to exist in such a future? These questions follow from the implicit acknowledgement behind the construction of the Socrobust tools that a technology or an innovation embeds future user practices and requirements in terms of regulation, institutions, infrastructure and more. The future network map is thus a description of how users, suppliers and regulation bodies relate to each other.

In the original Socrobust project a second tool was added the complement the future network map: the 'future working world' (De Laat, 1996). While the future network map exercise was designed to produce a map describing the main actors, intermediaries and relations, the future

working world is a tool designed to reveal the (institutional) infrastructure needed for the emergence of a market for the new products in question and to articulate the context in which the necessary transactions become possible (Laredo et al, 2002).

Future Network Map

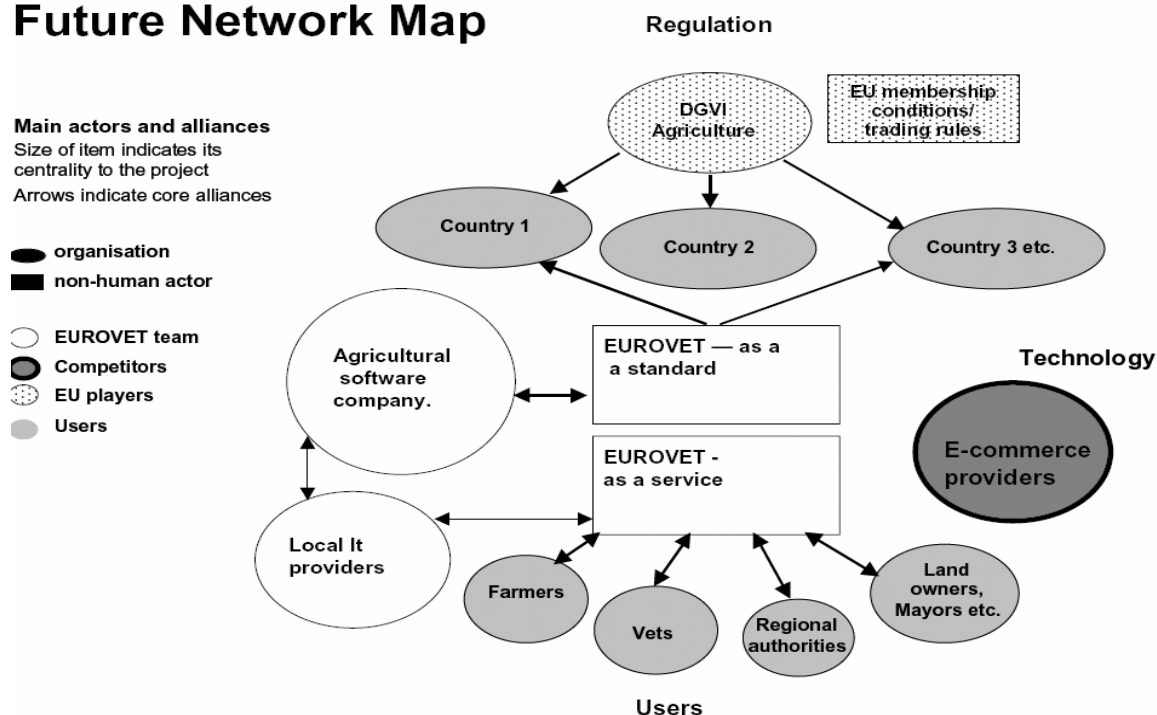


Figure 2.6 *A future network as used in the original Socrobust project*

Source: 'Managing breakthrough innovations: the Socrobust methodology'.

The future working world

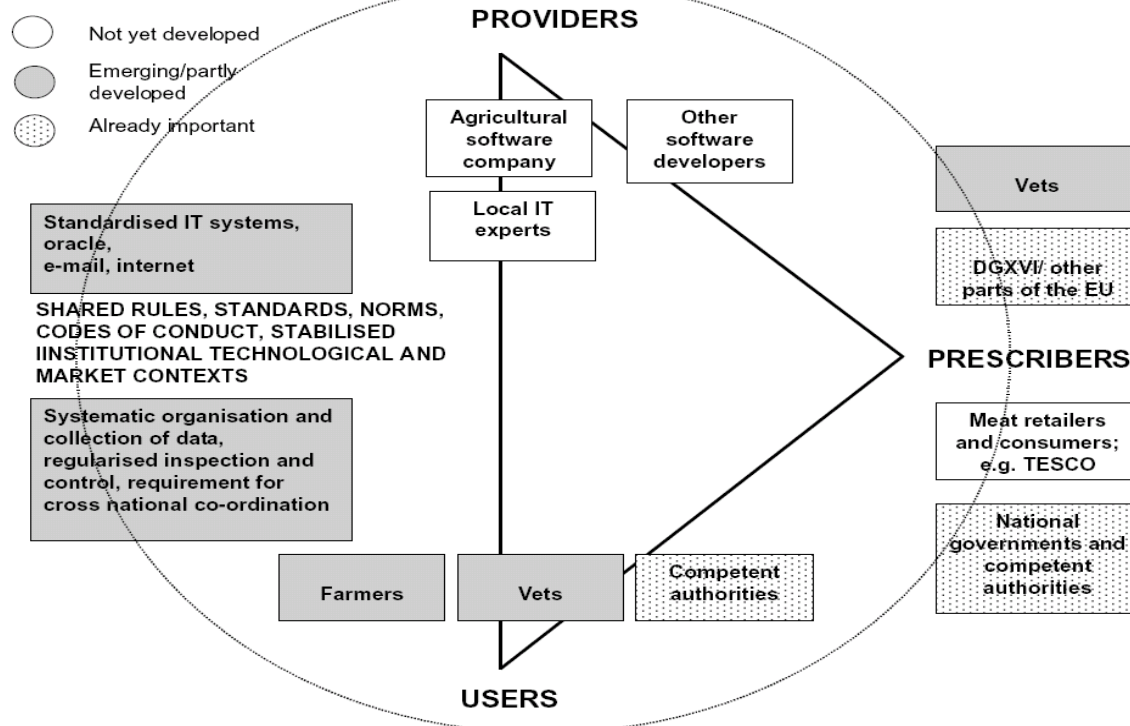


Figure 2.7 *A future working world as used in the original Socrobust project*

Source: 'Managing breakthrough innovations: the Socrobust methodology'.

2.2.4 Key changes table

The key changes table aims at identifying the crucial assumptions, which the innovator makes about the present situation and about the future-working world in which the innovation would be embedded. The tool confronts the present with the future network and distils the changes that are necessary to close the gap between the present and the desired future world. In the original methodology for each change the following characteristics are described:

- The content of the change.
- Related aspects that are taken for granted when the change has occurred.
- The practices that have disappeared.
- The actors most affected.
- The importance of the change for different aspects.
- The rate at which the change takes place.
- Other changes, critical factors necessary to support the key change.
- The most appropriate points of entry, i.e. points to initiate the change.
- The opposition that can be expected.

See for an example the following picture:

Key changes required before EUROVET becomes a service

- ⟨ The data required by EUROVET is routinely available
- ⟨ Non member states become customers
- ⟨ EUROVET builds alliances with local IT providers
- ⟨ EUROVET is actively used by farmers and vets
- ⟨ Increasing interest in EUROVET by retailers

Extract of key changes table

Key change	EUROVET builds alliances with local IT providers
What has become taken for granted?	The need for local knowledge and other forms of IT expertise
What practices have disappeared?	Starting from scratch with each new customer
Which actors are most affected?	The company and its potential competitors
Sources of opposition or trouble	If any, they are within the company
Related changes	Development of related functions, modules and services

Figure 2.8 *A key changes table as used in the original Socrobust project*

Source: 'Managing breakthrough innovations: the Socrobust methodology'.

2.2.5 Boundary Map: mapping project boundaries

The boundary map identifies three types of actors and circumstances: presently involved; to be involved relevant but not easy to be steered or influenced. The boundary map visualizes the different actors and events and the possibility for steering them from the innovator's perspective:

monitoring, motivating or enrolling. Those actors and events that the innovator could not motivate or enrol usually resided on the macro level of international governments, multinationals, economic events, and globalization etcetera. Those actors and events the innovator could possibly motivate or influence often resided on the meso-level, which often corresponds with either the national level and or the level of the socio-technical system relevant for the innovation. However, it is important to mention again that the existing system, for example the electricity system, typically will oppose the introduction of radical energy innovations that might disrupt the existing status quo and threatens vested interests. Those actors that the innovator can possibly not only motivate but also enroll are actors and events that usually operate on the micro level.

The possibilities for steering on the three different levels also are directly linked to the kind of user of Socrobust. Program managers at the level of the European Commission obviously will have more possibilities for steering actors and events on the macro level than innovators and R&D managers. The boundary mapping help to define, in relations to future visions, what the project manager has realized, what he should do and what is difficult to realise: the paths towards an end vision. See an example of the boundary map below.

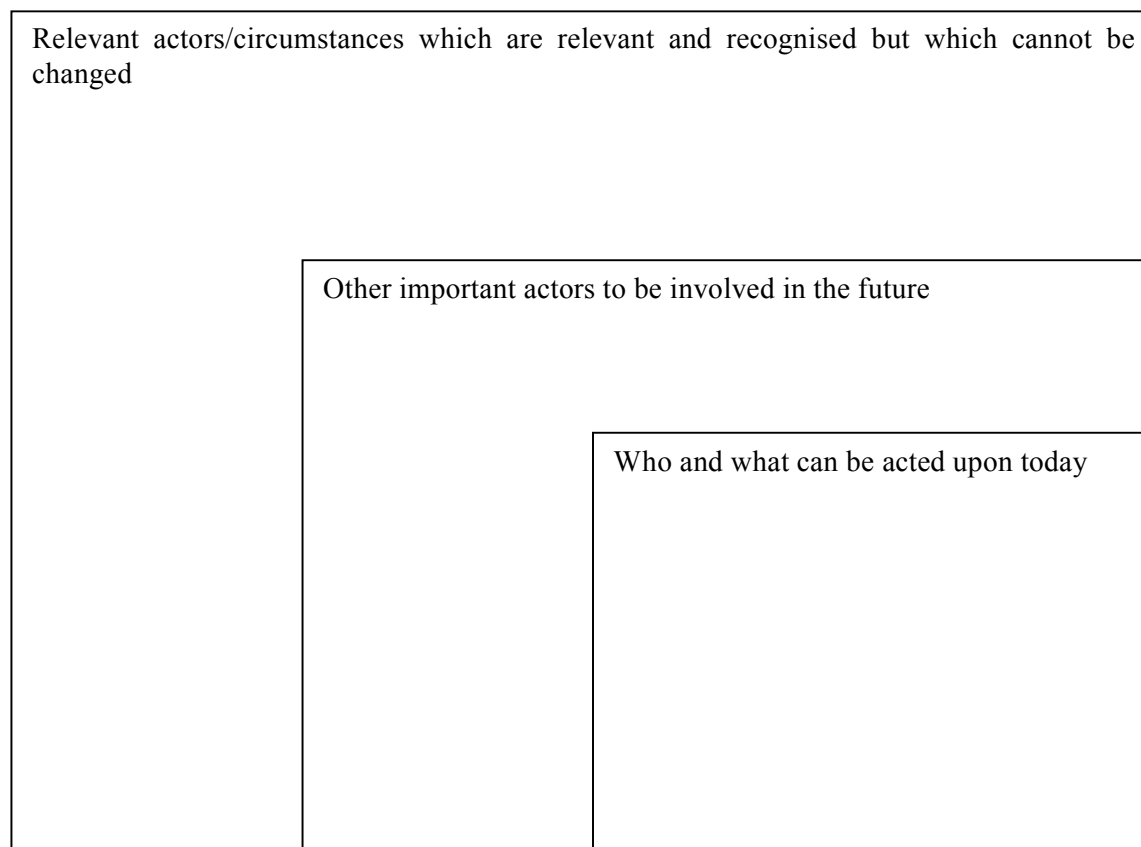


Figure 2.9 *An empty boundary map*

2.3 Step 3: Societal Robustness Assessment

The third step puts the present and future TEN in perspective and identifies alternatives to the desired path and the consequences for the project if these alternatives would actually enter the market. The consultant develops the third step. This step, in a sense tests the consistency of the assumptions made by the manager about the project's future world. In a positioning instrument, the project is positioned with respect to these alternatives and with respect to potential opponents and allies.

2.3.1 External check

The external check, a search on the Internet aims at testing the societal robustness of the main assumptions expressed by the innovator during the prior steps. The innovator's assumptions about the future world are put into perspective by checking their probability by confronting them with notions, perspectives and trends available on the Internet. At the same time alternative views and ideas of the future world as shared by other actors are identified. The web search transforms these assumptions into a set of questions and the result of the external check is a description of the viewpoints of various relevant actors outside the project on the key changes and underlying assumptions. The more assumptions have been tested in line with discussion on the Internet, the more robust the innovator's perspective is.

2.3.2 Positioning Table

The objective of the positioning table is to identify possible alternative for each necessary key change in case the change is estimated unlikely in the external check. These alternatives are first identified and described in general terms independent of their context being economical/market, legal/administrative or technological. In a second table all alternatives are positioned in the three important 'landscapes': the technological landscape, the legal, administrative and regulatory environment and finally the landscape of demand, users and markets. For each of these assumptions, alternatives / competing options, potential allies, and potential opponents were identified. This table provides the foundation for the assessment (alternatives and challenges). The key changes identified in the second step are examined in relation to the wider context, and categorised by means of three issues: technology, institutions/regulatory environment, market or user-producer relation.

Example of positioning table

Project focus	Alternative approaches	Your position	Potential allies	Potential opponents	SOCROBUST view
Position in the technological landscape					
EUROVET is a centralised system of data management but can adapt and change	Decentralised systems of data management; Needs of different systems, e-mail, internet, XML, extranet	Centralised but can adapt and change	Unclear —no links with data gathering technologies, WAP, or with others involved in agricultural IT	IT companies with a greater hold on the agricultural domain	Reliance on centralised data management is risky $\downarrow$, but can adapt if decentralised approaches take hold $\uparrow$
Position in the legal, administrative and regulatory environment					
Focus on central administration, Animal registration, identification, health and fraud	Decentralised styles of management: how nation states relate to farmers; transversal approach from retailers	EUROVET positioned as an aid to central administration	Parts of the EU, eg. agricultural policy, and some nation states that don't yet have their own system	Nation states that do have their own system; advocates of subsidiarity	Unlikely that a centralised harmonised system will be established that requires use of EUROVET $\downarrow$. Aspiring members will still need some system $\uparrow$
Positioning of demand, users and markets					
A product and service to national administrations	Providing products and services to retailers and other actors along the food supply chain, including end-consumers	Still focus on animal administration, registration and movement	Competent authorities and EU agricultural policy	Nation states with their own systems to defend	National administrations will always want to have some control $\uparrow$. This control may take various forms $\downarrow$. Market based systems are unlikely to replace government regulation $\downarrow$. Market-oriented IT companies may produce administrative data as a by-product $\downarrow$.

Figure 2.10 *Example of a positioning table as used in the original Socrobust project*

Source: 'Managing breakthrough innovations: the Socrobust methodology'

2.4 Step 4: Consultant activity

The last step aims at reflecting on the project visions, objectives and implementation with the lessons learned during the Socrobust process in mind. The result a short term action plan.

2.4.1 Capacity for action table

The objective of the capacity for action table is to take the positioning table as a starting point and translate the competing and alternative options described in the positioning table into uncertainties and threats. The next step is to lessen the uncertainties and threats in the three landscapes by identifying plausible lines of action and practical options for improvement to overcome the competition as mentioned in each of the three landscapes in the positioning table. These actions are mainly aimed at debating and participating in forums and attempting to influence the outcome of the debate in such a manner that the future embedding of the innovation becomes less uncertain and the embedding of competing or alternative options becomes more uncertain.

For an example of a capacity for action table see the next figure.

Characterising capacities for action

	Technological landscape	Legal, administrative and regulatory environment	Positioning of demand, users and markets
Building debate	What is the project manager's capacity to join or build relevant fora in which to engage with others over the necessary re-shaping of technical, regulatory, or market/user environments?		
Influencing debate	What is the project manager's capacity to enlist key actors in those fora, to ensure that the project is not marginalised and that its goals are internalised by relevant groups?		

Figure 2.11 *Example of a capacity for action table as used in the original Socrobust project*
Source: 'Managing breakthrough innovations: the Socrobust methodology'.

2.4.2 Recommendations table

The objective of the recommendation box is to provide the innovator with realistic actions that he or she can perform to influence the innovations chances of successfully become embedded in society. Recommendations are given by means of an action vocabulary: each action is introduced by means of a verb. An example hereof is the use of the verb 'monitor' for actions directed towards circumstances that are relevant but can't be changed by the innovator. Other verbs are: reflect upon (the routes not taken), to think about, to explore, to build (a forum), to

prepare, to contribute to, to discuss, and to enroll (other actors). The original Socrobust methodology claims that the recommendations should mainly be focused on the future working world. See for an example of a recommendation box the following figure:

The action vocabulary used for recommendations made Source: the 5 socrobust reports made. Monitor (a given controversy, the emergence of organised groups, the legal environment and the debates about possible change...) Reflect upon (the routes not taken) Think about, Explore (possible other routes, options) Build, prepare, establish, or contribute to/ encourage such actions (a forum, a community, the naturalisation of the project within an identified forum) Discuss (the model underlying the project with other actors in the project) Strengthen (the links between actors in the project) Take care of (the involvement of adequate actors and their participation in the experiment) Exploit (the potential included in the present project avoiding too early choice) Extend, enrol (other actors) Develop (demonstrations, given attributes...) Abandon (a given route or given ambitions).
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Figure 2.12 *An example of the recommendations box.*

3. Recent experiences with using Socrobust in practice

3.1 Experiences with using Socrobust in the original project

Socrobust is a consultancy tool that aims to help project managers and innovators to evaluate and monitor the potential societal robustness of innovations in an R&D phase, by anticipating present and future societal developments and reactions. The actual market entry phase was not the target of Socrobust. The tool was further not developed to work with more than one innovation, and the tool was certainly not developed to work with other stakeholders than the project manager or innovator.

When the original developers analysed the original methodology and its first applications, they already identified recommendations for improvement. Below is a short description of the experience of the developers of the original Socrobust methodology.

The developers of Socrobust preferred some of the tools when they put Socrobust to practice. These were the tools which fitted well in different cases, those which were less time consuming, and the qualitative ones. As to quantitative indicators and tools the developers thought that these tools could induce conclusions with a ‘deterministic view’. This deterministic view should be avoided since “the irreversibilities of today condition the future, they do not strictly determine it. Internal change in an already institutionalised technological field is still possible” (Socrobust Final Report, p. 109).

The core aspect of Socrobust was the analytical description of the project under analysis. Less developed in the Socrobust tool are the instruments that facilitate the exploration of the context (its wider world).

Especially the focus on alignment and reasons for lacking alignment between relevant stakeholders could be improved. A lack of alignment can be detrimental to the project’s successful implementation. Lack of alignment can originate from various problems (difficulty in the division of work, in different style of working, difficulty in transferring tacit knowledge among partners). Actor maps find a large application in the Constructive Technology Assessment approach, where factors influencing stakeholders are explored. The identification of stakeholder attitudes, the factors influencing these attitudes, and by identifying the factors necessary to change the attitudes would have been valuable additions to the key actor table.

Another less developed aspect in the original Socrobust is the final assessment and the orientation on action plans. The capacity for action table and the recommendations box in the original methodology did not comprise well defined plans of actions for implementing critical situations, but contain more generic definitions of action such as: monitoring, enrolling, and aligning. Actions that deal with organizational issues such as network coordination and collective knowledge building, but also communication strategies, exploration and exploitation strategies, absorbing capabilities development, competence creation, organizational aspects and collaboration agreements were only identified as possible actions in the original tool, but it was not stated how to undertake these actions. One dimension that was also less well explored is that of the ‘constraints’ on actions, following from cost and path dependence. Learning and shifting actions represent an investment and have a cost. In a next version of the Socrobust methodology, the cost of learning and shifting actions could be made explicit.

3.2 ECN Experiences with using Socrobust

ECN applied Socrobust to innovations developed by several of ECN's units, i.e. micro CHP, fuel cell vehicles, PV-thermal and Energy management systems for the built environment. In addition, they also used parts of the Socrobust methodology to assist governmental agencies in creating robust end visions.

In this section Socrobust is reviewed in order to determine its usability for the purpose of this project, i.e. developing a multi-stakeholder methodology. Examples from ECN's experiences with applying Socrobust to energy innovations to assess its suitability are used. In the following sections firstly the general aspects of Socrobust will be discussed, followed by a description of ECN's experiences with Socrobust steps in more detail.

3.3 General comments on the suitability of Socrobust

These experiences show that the methodology needs refinement on three interrelated aspects of a more general nature: the intended user of the methodology (innovators, policymakers) the phase of innovation (early versus late in innovation process); and the level of analysis/complexity/uncertainty. In addition, the methodological steps need further refinement.

3.3.1 Type of methodology user (innovator or policy maker)

With respect to using Socrobust with an innovator perspective, ECN made the following observation. Socrobust was developed with a single stakeholder perspective targeting only the innovator. This resulted in only one perspective on the present world in which the innovator was developing an innovation, and one perspective on the future world in which the innovation would be embedded. This one perspective is inherently biased as discussed in the section describing the narrative tool. To improve the mapping and identification process it is important to get other stakeholders to formulate their view on both the present and the future working world since it is very likely that they might possibly have different desirable scenarios about the future in mind, and have a different perspective on the present situation too.

A major question is how to approach the attitude towards the innovation of these representatives of target groups. This mapping of relevant stakeholders is different than the mapping of the future scenario of the innovator since these stakeholders do not develop the innovation but rather are reacting pro or against an innovation. Thus, the interview methods and tools need to be adapted. Adding multiple visions to sketch different present and future worlds could overcome this limitation. However, if all stakeholders would be asked to sketch both a present and a future situation for the targeted innovation, this would prove extremely time consuming.

One of the means that is often mentioned as being of influence on attitude forming and turning an opposite attitude to a more favourable one is early stakeholders involvement. There have been many experiments and reflections about public participation, citizen conference, and there exists much literature on how and when to involve users and stakeholders. One clear result has been to show that one major way to get a new technology accepted is to involve its future users/stakeholders in the design decision making and to have a strategy of early stage diffusion to certain target groups. Typically in project management literature, it is mentioned that opportunities to alter the design of an innovation is often short and is rather at the beginning of the development process.

So although the Socrobust tool focuses on the micro level of decision-making, it does not provide a methodology to involve stakeholders in the innovation process. Another major question that the tool needs to address is certainly how to select representatives of target groups.

When dealing with other practitioners such as governments involved in the implementation of innovations, the Socrobust methodology proved of limited value. ECN assisted policy makers via back casting from the desired future world to the present situation and advised the policy makers about possible pathways. The favourable future world of a certain innovation was also compared with the desired end vision of the governmental agency. With the outcomes of this confrontation, governmental agencies were able to assess which innovations could play a role in their desired end vision, and which not. For example, if in an end vision for the built environment houses are oriented towards all directions for aesthetic reasons, the possibilities for large scale implementation of solar panels and decentralized electricity generation might be limited, since this requires one specific orientation.

A major difference with the innovator perspective is that policy developers do not need Socrobust as a methodology to evaluate a specific innovation. Policy makers on the contrary are more interested in an integral evaluation of the possible contribution of multiple innovations to reaching a specific target, for example a strong reduction of Greenhouse gas emissions. Evaluating one innovation sec has no added value for policymakers, and might even be conflicting with their aim of not picking a winner, but creating a framework to enable innovations that meet specific requirements. More on this topic can be found in following sections.

An additional issue related to the possible different users of Socrobust is, what for the innovator is seen as, the external world (i.e. the institutional aspects and actors), for policy developers is seen as the 'internal' world, while for them the technological aspects of the technology are more 'external'. For the policy developer events such as liberalization of energy markets and emergence of intermediary organizations, privatisation of energy industry and growing competition, reduced government funding, spatially differentiation and new context dependent energy services are easier to influence. 'Internal' and 'external' thus directly correspond with the capacity for action these users have for influencing these aspects. Since the events mentioned above, belonging more to the 'internal' world of policy developers, are strongly influencing the deployment of RES and RUE technologies, enhancing Socrobust tools to encompass possibilities to influence these events, would be very valuable.

3.3.2 The phase of innovation

Another aspect that the new multi stakeholder tool needs to deal with is that different technologies usually are in very different development stages. They can not all be called market ready. Hydrogen is certainly the least developed technology, whereas in the case of wind, there is still a lot of development, but it does not really change the way the technology is used (at least not as far as 'the public' is concerned.) So in some cases the technology can still be shaped, whereas in other cases it is more about increasing acceptance for a pre-defined technology.

When Socrobust is applied to an innovation still in its infancy, several notions are important. Firstly, with respect to the process it should be acknowledged that innovators of a very immature innovation deal with a technology which can still be altered in many ways. Although this is a very fruitful phase to apply Socrobust, because the results of the Socrobust analysis can not be used by the innovator to influence the 'outside' world, the innovator can also be made aware of possibilities for adapting the technology to user needs and requirements. However, for an innovator of such an immature innovation to depict a possible future world, is not an easy task since many future worlds are possible, depending on the technological trajectory of the innovation. Therefore ECN started working with multiple future worlds, all with the same end-date. This adjustment to Socrobust enhanced the possibility for an innovator to deal with the possibilities to alter his option and the possible coming into existence of multiple possible future worlds. This is discussed in more details under the section dealing with the future world.

Another ECN experience is that the ‘outside’ orientation of the project or program under analysis can differ greatly. One of the R&D programs ECN analysed had a strong market orientation, which followed from the phase of the technological development. Consequently, the interviewees paid much attention to user aspects and broader societal issues. Another program that was analysed dealt with a technology that was much more in an R&D phase, and consequently the orientation of the interviewees was much more on the different possible technological trajectories and much less on very uncertain issues such as users and market circumstances of relevance for the innovation.

These different phases have severe consequences for the role of the analysers. When dealing with a very immature technology, the analysers might have to undertake much more effort to assist the innovator in sketching a broad present and future network that takes into account more issues than only techno-economic aspects. In addition, if the technology is very open for alterations, to be able to conduct interviews that are aimed at identifying these possibilities, the interviewers should be familiar to some extent with the technology and possible alterations. When dealing with a technology that is more market ready, the interviewers should be familiar with more societal issues of relevance, such as laws, regulations, relevant actors etc. If this expertise is lacking among the interviewers, the risk exists that the present and future network, that are depicted by the innovator, are very much biased. One question that remains is whether we should intervene and critically reflect on the interviewee’s depiction of the situation or remain as neutral as possible.

3.4 An analysis of experiences with the individual instruments

The descriptions below are based on (Kets et al, 2003; Mourik et al, 2005).

3.4.1 ECN experiences with the narrative

ECN experiences some difficulties with the interviews. Initially, the interviews were conducted with two or three ‘consultants’ who interviewed the expert. One consultant conducted the interview whilst the second consultant took notes and the third observer had the role of observer. The interviews were time consuming, and it was soon decided that one interviewer was more effective, especially since the number of interviews was increased, as will be discussed in a later section. The narrative proved also problematic when dealing with an energy programme encompassing more than one technology. For each technology a narrative should then be written. And consequently multiple critical moments tables, and potentially also other steps need to be multiplied.

3.4.2 ECN experiences with the critical moments table

ECN experienced that the actual completion of the critical moments table proved difficult. Many of the terms, e.g. ‘implication/choice’, ‘envisioned solution’ and ‘alteration’ needed clarification. The outcome of the discussions was that in the ‘implication/choice’ column the direct implications of the described events had to be placed. The envisioned consequences for the program are described in the ‘envisioned solution’ column. The alternative direction of the technological development resulting from the event was described in the ‘alteration’ column. To facilitate the coherence with the other steps, the description of the event was accompanied by a labelling of the event in terms of its nature being technological, scientific, infrastructural, political, institutional, and socio-cultural.

3.4.3 ECN experiences with the present network

These perspectives are inherently biased, explicitly when the innovator chooses not to reveal problems or uncertainties; and implicitly since the narrative is always only one perspective on the situation, and one focusing on relationships and linkages and not on opposition. The innovators will often, at least partly, describe the present network in such a manner that the innovation and the innovator are central, not taking into account their possible marginality in the actual situation. In addition, the innovator often does not mention opposition in terms of both actors and alternative or competing innovations voluntarily, since he does not have relationships or linkages with opposing actors and technologies. To identify these less favourable aspects of the societal and technical context of the innovation, requires strategic interviewing.

The original Socrobust methodology is designed to deal, at least partly, with the matter of protective strategies that innovators may use. By drawing present and future networks, innovators are forced to identify discrepancies between both situations. In addition, the positioning tables discussed in a later section are designed to force the participants to think in terms of opposing actors and competing technologies. To strengthen his position, the innovator can have the urge to give a 'safe' picture of the project. ECN experienced this when an innovator, having already been evaluated in recent history, which turned out to have significant consequences for available budgets, seemed somewhat reluctant to share all the uncertainties and risks he had in mind. Thus, the interviewee can stay close to an envisioned way to success.

To overcome this bias, it is important for the interviewer to attempt to sketch an alternate vision of the present situation, or at least reflect critically upon the position of the innovator/innovation in the relevant network. This does require some expertise in the discipline under analysis from the side of the interviewer. In addition, confronting the innovator with alternative perspectives as formulated by other stakeholders, can lead to a more coherent analysis of the societal context of the innovation. This however is time consuming and has consequences for the other steps of Socrobust, which might then also need to be duplicated. This will be discussed in a later section.

Another enhancement that ECN made to the present network tool was to substitute the four poles with dimensions, and including more dimensions. This was the result of difficulties experienced when the innovator had to sketch the present and also the future network in terms of users and producers and science and regulation. The innovators often felt that these were different categories (human and non-human actors) and felt the need to define both human and non-human actors in additional dimensions such as the socio-cultural and institutional. Adding these dimensions also tackles another gap in the original Socrobust methodology: the identification of opposition in terms of risk perceptions of users. The dominant existing system might also resist the introduction of the innovation, because the innovation might require a radical change in institutional arrangements, material structures and user practices which go against vested interests. By introducing the different dimensions, the opposition can be categorized more easily. This however needs to be worked out in more detail. Both gaps are discussed briefly in the following two paragraphs.

The prospects for the institutionalization of new technologies are strongly influenced by the way the public, the media and other non-expert decision makers frame the technology, often already at early stages of its introduction. But also by how relations between technology developers and stakeholders develop in specific situations. The risk perception literature focuses on how specific risks are elevated or demoted in different cultures, and how different factors influence the perception of risk and the acceptance of new technologies. This literature has been successfully applied to practical issues at different levels, but has not really been integrated with the technology dynamics, energy planning or institutional reform literatures. Integrating this knowledge in Socrobust and translating it into a tool or a questionnaire is one of the elements that need to be undertaken in Create Acceptance.

Another aspect that should be integrated in Socrobust is the emphasis on institutions as frameworks for both governing - and changing or opposing change in - the interrelationship between technologies and users. There exist few systematic analyses of institutional aspects of energy management, and they address only the legal framework and policy instruments at national and supranational level, disregarding organizational structures and informal institutions, as well as regional or local dimensions to institutional change. Finally, to facilitate the expression of the present and also the future network, ECN used a different visualization. A network consisting of six dimensions (infrastructural, technological, scientific, institutional, political, socio-cultural) was used successfully. In this network the innovator could position both actors and factors of relevance for his innovation. For the sake of clarity two networks can be designed; one identifying the favourable network to the innovation, and one identifying the opposition network. This has not been done yet and is a suggestion for the Create Acceptance project. See for an example of such a network the next figure.

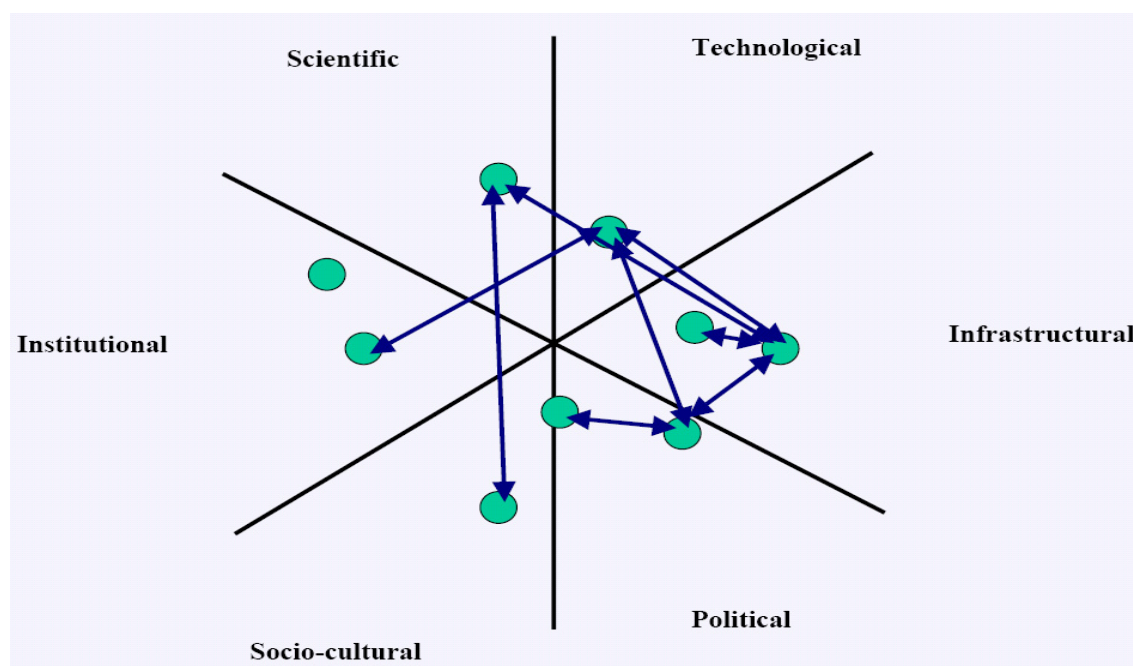


Figure 3.1 *Example of new present en future network as devised by ECN*

Several adjustments are still necessary with respect to this new present network. The definitions of these six dimensions need to be clarified; for example the difference between technology and infrastructure. Also the dimension of the market needs to be included. In addition, the strength of actors and factors with respect to their influence (both favourable and opposing) on the innovator and innovation under analysis could be visualized. And the different linkages between the actors should be identified, since this directly informs the path an innovator needs to travel to motivate or manipulate a specific actor. This information is necessary in order to construct a capacity for action table and recommendation box. Both tools will be discussed in a later section. In the original Socrobust toolkit, the dimension of power and difference in power and steering on socio technical environment were implicitly present, but it was not given special attention. In addition, the original methodology is in a sense a ‘principal-agent’ approach, where the principal agent creates the rules of the game and uses incentives to align the other agents to the rules. However, more attention should be paid to other potentially influential agents that define the rules of the game.

3.4.4 ECN experiences with the future network and future working world

ECN did not use the future working world instrument (the narrative of the future), because it simply took too much time to make a story about the future. ECN only used the future network, and adapted its visualization in the same way as the present network. As discussed in the section dealing with the different phases of a project, ECN experienced that it was fruitful to work with multiple future working worlds. These multiple future working worlds would differ in terms of different technological innovation characteristics when dealing with an innovation in a very early stage of development, since that kind of technology is still open to technical alterations. The future worlds would thus differ with respect to performance of the technology and accompanying different user practices. The fuel cell for example can be implemented in cars, trucks, ships, or static applications. All three implementations will lead to different future networks. The multiple future working worlds could also be made dependent on technical developments in other innovation programs. Typically a fuel cell innovator's future vision is strongly dependent on future technical developments such as i.e. solving of the on-board hydrogen storage problem. Consequently future worlds with and without on-board reforming can be envisioned, with both very different societal issues.

ECN also started to work with subsequent future worlds, in order to make the creation of pathways possible. Often, managers do already have an idea about a path toward their final future-working world, and it was not difficult to have them depict a intermediate future world. As a consequence, a time path in key changes or underlying assumptions was introduced which was considered useful by the interviewers because it helped them thinking about actions needed on the short- and midterm. The time path also made possible the creation of hierarchy in the events that should occur to bring about the desired future working world. Obviously, not all assumptions were as important and not all events that were assumed needed to occur at once for the innovator to further the creation of the future network.

ECN experimented with the creation of different intermediate working worlds towards one shared future-working world, in order to assess whether specific key changes might occur in different pathways. If key changes occurred in more than one pathway, this could be an indication of the robustness of that change. In addition, the identification of multiple pathways also made an assessment possible of potential interrelatedness of these pathways, strengthening the lock-in of the innovation under analysis, or the potential conflict between the pathways.

An accompanying problem with the use of multiple future working worlds and intermediate future worlds, is that for all of these future worlds a separate key changes table is necessary, a separate critical actors table, and finally also the external check, the capacity for action table and the recommendation box need to be multiplied with the number of future working worlds identified.

Another problem arises when enhancing Socrobust to also encompass multiple stakeholders instead of only the innovator or program manager. All these stakeholders could be elicited to identify a present and a future working world for comparison with the present and future working world as depicted by the innovator. Comparison becomes increasingly time consuming and more difficult when delaying with not only multiple end visions for each stakeholder, but also when intermediate end visions are formulated by all stakeholders. In addition the question arises if all future-working worlds should go through the external check, or if the future working worlds identified by the stakeholders other than the innovator are in fact the external check. The above demonstrates that having all stakeholders identify their own (multiple) future and present and even intermediate networks is far too time consuming. ECN therefore proposes to take the present, future and intermediate networks as formulated by the innovator as a starting point. In interactive workshops the other stakeholders can be elicited to react to these networks. If the innovator has identified multiple future networks, the stakeholders can be asked to identify the most plausible and / or most desired future network in their perspective.

Setting up such an interactive stakeholder workshop has not been done yet within Socrobust. The different possible tools to structure such a workshop, identify stakeholders and reach consensus on a (basket) of desired and agreed upon future networks, is a gap that needs to be dealt with. Literature on participatory workshops, consensus conferences and on dealing with multiple perspectives might provide answers.

Furthermore choices have to be made concerning the importance given to the different future working worlds of different stakeholders. If comparison demonstrates great differences, what to do with that assessment? Is the innovator to alter his future working world to resolve the conflicting aspects?

3.4.5 ECN experiences with the key actors table

ECN experienced that the terms used in the critical actors table were in general unclear. A good definition should be available at the start. ECN also felt that the starting perspective from which the table should be filled in was unclear: should the position of the actors be discussed from the position of the innovator or from the position of the relevant network of importance to the innovation. From the position of the innovator a producer of for example solar panels might be very important, because he has prior connections and an accompanying good price. But that same actor may be less important from the position of the network in general because it is one of ten producers. Still some comments can be made with respect to the relative importance of the actor, but it should be made clear whether the actor is weaker in either the pole or the network. Another problematic aspect with respect to the position from which the table should be filled in relates to the fact whether the actor should be described in general terms, or in terms of his position in a specific dimension, or in the case of the original table in terms of one of the four poles. Another aspect that was discussed was that the table could be filled in taking into account the actual situation, i.e. an actor's alignment with the innovation under analysis, or if it should also take into account the potential however not yet existing alignment of an actor in the future. Adding a column asking this specific question solved this. In addition it was unclear if the critical actors table aimed at identifying only present or also future critical actors. Finally, ECN felt the table took insufficiently into account non-involved and perhaps even competitive actors. This was already felt with respect to the identification of the present network, and the same solution was envisaged: the creation of a critical actors table for competitive / opposing actors. The original critical actors table was only described for the present and the future network, but not for the intermediate key changes necessary to evolve from the present into the desired future situation. ECN included this additional table of critical actors, with special emphasis on the possibilities the innovator had for influencing these actors, and more specifically also the arguments or means with which the innovator could undertake this influencing.

3.4.6 ECN experiences with the key changes table

ECN experienced that several aspects were missing from the analysis. First it was necessary to position the change in their respective dimension, for each of the changes it was furthermore necessary to identify the key actor that would need to undertake the change, and describe the motivation for that actor to undertake the change. Also, the probability that this actor would actually undertake the action needed to be assessed. And finally the interrelations between the changes needed to be identified as a starting point for the creation of pathways towards the future end vision. The original methodology focused mainly on key changes very near to the future working world. Since ECN also introduced the intermediate future working worlds, key changes needed to be identified for these as well.

3.4.7 ECN experiences with the external check

ECN had some difficulties while performing the external check. First the check proved extremely time consuming, which poses a problem in a project with limited time. One important aspect of the external check is that one has to choose which assumptions should be checked. In some cases this choice was a hard one. Laredo et al (2002) claim that the external check should be concentrated on the specific areas of uncertainty. However, when dealing with an innovation, which is in a fairly early stage of development, this inherently entails that most aspects, both technical and societal are still very much uncertain. It follows that the external Internet check for a fairly immature technology would be more time consuming than for a market ready innovation. In addition, even if a choice can be easily made concerning the assumptions that need an external check, not all assumptions can effectively be checked on the Internet. ECN therefore decided to complement the Internet check with expert interviews. However, this posed additional and new problems. First the external experts were often stakeholders and thus biased towards the innovation. In addition, if the experts were representatives from competing technologies, their future working world can inherently differ from that of the innovation under analysis since a competing innovation can require a different context to function optimally and be stabilized. One such requirement is that competitors are eliminated. However, experts with possible competing claims might even be reluctant to formulate their own future working world because of the need to keep any information about their competing alternative confidential. Finally, the use of interviews aimed at identifying the future working world of other stakeholders, due to time constraints, inherently means that the opinion of fewer actors could be used to place the innovator's assumptions into perspective. To overcome the difficulties with the expert interviews mentioned above, ECN proposed to interview actors whom the innovator had identified as relevant and responsible for a key change, and ask them for confirmation or denial of their commitment to undertake that change. ECN also asked them under what circumstances and with what incentives these actors might be motivated to undertake the key change.

3.4.8 ECN experiences with the positioning table

The first remark that can be made about the positioning table is that choices needed to be made as many of the assumptions that proved to be non-robust in the external check should be further analyzed in the positioning table. It was decided that only the more important outcomes from the external check should be analyzed. However, how to decide what are important outcomes? The second remark concerns the Socrobust assessment part of the tables. In practice, readers often limited their reading to this last column. However, the assessment was very limited, due to the fact that it had to fit in a table and could easily lead to misunderstandings. A more nuanced assessment was deemed necessary. ECN decided to use an alternative positioning table. The rows indicated the alternative and possibly competing technologies for the innovation. The first column consists of the name of the alternative; the second column gives a short description of the alternative. The third column indicates the circumstances required in the future for the alternative to come into existence. The fourth column identifies the innovator's estimation of the probability of this alternative to come into existence. In the remaining columns, finally the potential allies and opponents for the alternative and the innovators relationship with these allies and opponents are identified. Market competition is less relevant when dealing with the social robustness of a technical (object/system) design at an early phase. However, when the implicit future world is compared with the wider external world, medium long-term evolution is taken into consideration and the exclusion of aspects such as market power and competition could make the assumptions and recommendations less realistic. Probably a more traditional industrial analysis could be complementary in the check on the future external markets, for positioning the innovation and making assumption on its future robust.

3.4.9 ECN experiences with the boundary map

The interviewers considered the boundary map as a very useful instrument although the outcomes of the map were not shocking. The boundary map consists of a series of nested boxes of frames. The smallest frame indicated the actors that could be enrolled, the middle frame indicated the actors and events that might be motivated, and the largest (outer) frame indicated the circumstances and actors that the innovator probably cannot influence. The map explains by its form that the boundaries between the boxes can be shifted; by involving actors the program manager can widen his scope for actions. The boundary map implicitly also incorporates a recommendation for timing, since enrolling actors and events involves less time-consuming activities than motivating or monitoring actions. An addition to the boundary map could be the identification of the intermediary organizations and the possible role they could play in furthering the implementation of the innovation under analysis. Within the debate on sustainable energy management, local and regional energy planning has long played an important role. Local and regional authorities can influence energy use significantly by virtue of their planning and regulating functions, their own energy consumption and their proximity to the end-users; in addition they have traditionally been engaged in energy supply in several countries. However, the literature on local and regional energy planning does not reflect the huge changes in the energy industry resulting from liberalization, the development of a European energy market and the privatization of public utilities. One of the changes relates to the increasing role of new intermediary organizations like energy agencies, contractors, new service providers, energy brokers or user alliances.

3.4.10 ECN experiences with the capacity for action table

ECN felt a bit ambiguous about the usefulness of the capacity for action table. The table was very useful for the preparation of the recommendation box. However, ECN felt that intervention from ECN's side was strongest in this tool, since the identification of relevant debates and forums was totally dependent upon the expertise of the interviewers. This step required analyzers with much knowledge of the existing circumstances, existing debates and forums. The actions that could be discerned followed the characteristics of the debates and forums. In the original capacity for action table, again the three landscapes were used. ECN changed these into the dimensions used in the present and future networks.

The capacity for action box still proved problematic to use. After identification of the possible actions, it still remained unclear what the order of actions should be, which action took priority over other actions, at what level of steering (micro, meso or macro) the action took place, and what kind of action it was: e.g. monitoring a debate or forum in order to timely anticipate changes in orientation and trends; motivate actors to participate in debates on behalf of the innovation, or to motivate participants to take a favorable stance towards the innovation.

3.4.11 ECN experiences with the recommendations table

ECN first choose to discriminate between possible long-term and short-term actions. ECN also experienced that focusing recommendations for action only on the future working world works when dealing with an innovation which is more or less market ready and which has distinctive and stabilized technological design. For more immature innovations, technological options are often very much open for debate, and recommendations therefore should also and perhaps even foremost focus on achieving closure of the design process. For these less mature technologies, early stakeholder involvement is very useful.

The capacity for action table and the recommendation box largely focus on the actions available to innovators. Actions available to other possible users such as policy makers are not yet inte-

grated. An analysis of these actions should be undertaken and translated into an instrument to identify their potential for the specific innovation or program under analysis.

Also, the Socrobust tool does not yet contain instruments that aid in assessing the influence of issues such as trust, costs, vested interests, building infrastructures, capacity and capability to deal with possible negative consequences, and risk communication on the creation of social acceptance. Literature on Science and Technology Studies (STS) and Large Technological Systems (LTS) has established how systems such as infrastructure networks are socially constructed and strongly path-dependent. These theoretical approaches provide important insights into the socio-technical dynamics of infrastructure systems. Related research on actor-networks, constructive technology assessment and hybrid organizations that function as intermediary institutions, highlights the role of developing public trust, facilitating networks and public participation mechanisms for the societal appropriation and embedding of new technologies. These issues should be dealt with in the capacity for the action table and the recommendation box.

3.4.12 Niche workshop

ECN concluded the Socrobust assessment with an additional step: a brainstorm workshop that aimed to identify niches in which the innovator could start the embedding of the innovation. Both market niches and technological niches were identified. Two strategies / mechanisms were distinguished, i.e. niche accumulation and hybridization. Niche accumulation refers to the application of a technology in different niche markets so that technology / market combinations become robust (Raven, 2006). Hybridization refers to the process where 'new' and 'old' technology hook up to form some kind of a hybrid technical design. For example a technology developer can try to link his or her innovation to a specific problem in the dominant regime. He can try to enrol regime actors to adopt the innovation as an add-on element to the dominant design and aim to supply to mainstream markets. Eventually (after a long period of hybridization) the new technology can become the dominant design, while the old technology continues to exist as an auxiliary device for the new technology, moves to niche markets, or distinct completely.

During the workshop, the interviewers, the innovator and selected guests were invited to brainstorm about problems present in the dominant system (in all dimensions) that the innovation might use as window of opportunity because his innovation envisioned a solution to these problems. In addition, the participants were invited to brainstorm about possibilities for approaching relevant and powerful actors (in terms of capacities, capabilities and resources) to either enrol or motivate them to start promoting the innovation as solution to existing problems. The participants were furthermore asked to identify possible cooperation with innovations that either posed a competitive threat or innovations that also experienced difficulties in breaking through to the existing system.

This workshop could be extended to also include relevant stakeholders in order to identify possible user needs and or requirements that the innovation might address.

3.4.13 Repeating the analysis

Within the original Socrobust methodology, a repetition of the analysis was foreseen. ECN did undertake this exercise for several of the innovations that were analyzed. What became apparent from this second round of Socrobust is that the ideal repetition time is strongly technology or R&D program dependent. Repetition of Socrobust after a few months may be useful for a R&D program with rapidly changing internal and external circumstances. For R&D programs with internal or external circumstances that are more or less stable a repetition after a few years may be of use.

The original Socrobust analysis was foremost aimed at assisting an innovator to reflect upon his innovation and the innovation technological trajectory. After a first round of Socrobust, the innovator might have acquired a more reflective attitude, also aimed at double loop (or second order) learning. If the innovator indeed successfully incorporated this attitude, conducting Socrobust a second time after several months might not be fruitful if the analysis is again aimed at reflection. If the analysis is aimed more at an analysis of the perspective of relevant stakeholders, and a confrontation of these perspective with that of the innovator or program manager, the exercise would be worthwhile.

3.5 Recommendations following the use of Socrobust by ECN

ECN felt that Socrobust was a very valuable instrument if the targeted user is a single stakeholder: the innovator or project manager of an innovative project. However, the need was felt to have a similar methodology to facilitate multiple stakeholders simultaneously. Therefore, in addition to improvement more aimed at increasing efficiency, ECN proposes several changes to enhance Socrobust into a multi-stakeholder tool. These recommendations and gaps are given in the schematic overview of adjustments and identified gaps below.

Original tool	Adjustment ECN	Gaps
General aspects		• Early stakeholder involvement lacks • Means for identifying relevant stakeholders lack • Means for selecting stakeholders lack • Tools to structure involvement of multiple stakeholders • Tools to simultaneously analyze multiple innovations or system consisting of multiple technologies lack • Method to measure/determine societal acceptance?
Narrative	• Interviews conducted by 1 interviewer • Narrative difficult when dealing with program encompassing multiple technologies	
Critical moments	• Redefinition of column content • Use of multiple dimensions to categorize moments	
Present network	• Use of multiple dimensions instead of TEN • Need for network identifying opposition • Identification of both human and non human actors	• Clear definition of different dimensions needed • Visualizing linkages between actors necessary • Visualization power relations needed • Countering the inherent bias of single perspective on present situation needed, i.e. by sketching alternative present network • Identification of opposition from existing dominant system: interests, costs, material infrastructure, user practices
Future network	• Use of multiple dimensions instead of TEN • Use of multiple future working worlds • Use of intermediate future worlds • Use of pathways towards either different futures or towards one shared future • Analysis of interrelatedness of pathways towards different future worlds	• Decision necessary on either formulation of future working worlds by stakeholders OR Reaction of stakeholders to future working world formulated by innovator • Clear definition of different dimensions needed • Visualizing linkages between actors necessary • Visualization power relations needed • Need for tools to set up an interactive workshop • Need for tool that enables aligning different perspectives

Original tool	Adjustment ECN	Gaps
Key changes	• Use of multiple dimensions • Key changes table for all identified future worlds and intermediate worlds • Interrelation between changes assessed (time path)	
Critical actors table	• Definitions made clearer • Adding columns to deal with discrepancy between actual and possible alignment of actors • Identification not involved and opposing actors • Tables for all future world and intermediate worlds • Motivation for actor to support or oppose change assessed • Probability of actor undertaking change assessed • Enhancing check by means of interviews to experts identified as critical and relevant	
External check		
Positioning table	• Limitation with respect to assumptions checked • Replacement of landscapes by dimensions • Alternative table aimed at identifying competing options and position of innovation with respect to these alternatives	
Boundary map	• Added time path	• Emphasis on intermediate and hybrid institutions and organizations such as energy agencies, contractors, new service providers, energy brokers or user alliances (because of their growing importance in the globalized and liberalized environment of relevance for RES and RUE)
Capacity for action table	• Landscapes translated into dimensions	• Actions open for innovator different than for policy makers. Different actions should be identified per stakeholder • Action table dependent on phase innovation: for prototype actions more oriented at technological adaptations, market ready technology benefits more from shaping of selection environment • Time path for actions necessary

Original tool	Adjustment ECN	Gaps
Recommendation box		• More attention for relating recommendations to user, and to phase of innovation • Focus on influencing issues of trust, costs, involvement of stakeholders after demo phase, continuous learning, influencing opposition of vested interest, building (knowledge and material) infrastructures, capacity and capability to deal with possible negative consequences, and risk communication
	Niche workshop	• Attention for possibilities for breakthrough as identified in transition theory (niche accumulation and hybridization) and translating this knowledge in instruments for users • Organizing brainstorm sessions

4. Conclusions Deliverable 1

The original Socrobust tool is a method of assessment based on one stakeholder in the relevant position of managing an innovation project. It aimed mainly at reflection and learning and less at action and implementation. The tool was developed to help project managers to monitor the social robustness of architectural innovations and to design such that they take into account fundamental uncertainty on future contingencies. The innovator and his views were the centre of the Socrobust process that assessed the societal robustness of these views. This single-stakeholder centeredness is exactly also the weakness of the Socrobust process. An innovator has no objective knowledge about the future events to come and is thus likely to be biased. It is very well possible that he has to adjust his views and expectations once future events have unfolded. However, shifting the organization, content and or governance of the project once it is fully developed and in the midst of diffusion is more difficult.

In absence of this ‘objective knowledge’ that safeguards the development of objectively correct future visions and action plans, another process should be developed. The ‘activity theory’ of knowledge (Piaget, 1970) states that cognitive categories (perspectives on the world and its future) develop in interaction with the physical and social environment. Multiple stakeholders hold multiple views on the world and have multiple wishes and demands with respect to a new technology.

Therefore the most important necessary change to the original single-perspective Socrobust methodology is the facilitation of the interaction (in interactive workshops) between all relevant stakeholders as a way to correct biased views before the innovation’s diffusion and thus stabilization in society is a fact. Involving these stakeholders would apply both for anticipating the future but also for interpreting the ‘present world’ of the project. This interaction allows at the same time to elicit other scenarios and other perceptions about risk and it allows for an assessment of the stakeholders’ willingness to align their views with those of the innovator. This multi-stakeholder analysis offers the possibility of escaping from the myopia characterizing a single perspective methodology.

4.1 Recommendations Deliverable 1

An overall recommendation is that the original tool is very useful as a starting point to develop a tool that can measure, promote and improve social acceptance of innovative RES and RUE technologies. The original developers of Socrobust already recommend the following improvements to the original Socrobust methodology after the first line of testing the methodology:

1. With respect to all steps the developers recommend to attempt to make the instruments generic and not case specific.
2. All steps should be made less time consuming.
3. The key actor table should be made more descriptive, also focusing on reasons for (lack of) alignment between stakeholders, and identifying all stakeholder attitudes, the factors influencing these attitudes, and identifying the factors necessary to change the attitudes.
4. The power relations between actors should be analysed.
5. The consultancy step, step 4 should be developed into a more action oriented instrument. Not only the type of action should be identified, but it should also be identified how to undertake these actions. The possibilities for explicit mediation processes (through skill formation, communication, collaboration, an intermediary organization role) or competitive disalignment should be analysed.
6. The action table should also discriminate between stakeholders: which actor should undertake what action, and what can be the role of the innovator in steering or motivating these actions.

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- The power relations between actors should be analysed.
- The consultancy step, step 4 should be developed into a more action oriented instrument. Not only the type of action should be identified, but it should also be identified how to undertake these actions. The possibilities for explicit mediation processes (through skill formation, communication, collaboration, an intermediary organization role) or competitive disalignment should be analysed.
- The action table should also discriminate between stakeholders: which actor should undertake what action, and what can be the role of the innovator in steering or motivating these actions.

After a second line of testing the Socrobust methodology by the ECN, the following adaptations to the original Socrobust methodology were recommended:

1. Involve multiple key stakeholders instead of the single key stakeholder the original tool takes into account.
2. Both innovator and stakeholders could be asked to also draw intermediate TENs which describe the paths towards each of the desired future worlds. An analysis of the interrelatedness, competition and cooperation between these intermediate paths can help to find out the more robust alternatives.
3. Broaden the present and future network by working with more dimensions instead of the four poles of producers, consumers, science and regulation. The following dimensions can be important: law and regulation; social; cultural; economic/market; institutional; infrastructural; technological.
4. Broaden the methodology of the external check such that it not only uses a literature and Internet check, but also assesses the 'shades of robustness' of the project by comparing its present network and future network with those 'desired' by the key stakeholders.
5. Make the action table more explicit with timing, priorities and level of actions for different actors at macro, meso and micro level.

Appendix A Theoretical background of Socrobust

Socrobust is a method designed to help project managers or technology developers deal with the societal acceptance of their innovations. Its main principle is to anticipate future possible acceptance/resistance of their innovation during diffusion steps.

The method is based on a set of tools mainly derived from the STS and to a lesser extent from the management literatures:

- a. Innovation is a non linear process.
The identification of possibilities for intervention is based on the understanding of innovation dynamics, i.e. the innovation project journeys, including the non-linear development (branching, alternative solutions) of an innovation and the larger technology evolution.
- b. Technology diffusion depends on the establishment of a favourable value chain and infrastructure- Techno-economic networks.
It assumes that supply and demand of a technological solution are co-constructed, that institutions play a relevant role in the definition of a techno-economic solution.
- c. Major sources of disagreement/conflicts come from 1) non conformation/compliance/ mobilization of stakeholders in the construction of favourable value chain 2) stakeholders non acceptance/ threats to existing practices associated with necessary society change implied by the development of the technology.
- d. Successful projects management rely on 1) properly developing techno-economic-network 2) making sure the associated changes will be feasible and or acceptable for stakeholders.

Tools are organized in a method built along three complementary sequences of actions:

- a. Identifying the value chain and infrastructure (TEN) favourable to the diffusion of innovation.
- b. Identifying the potential 1) non conformation behaviour 2) non acceptance of society change.
- c. Strategically reflecting on the project vision, objectives and implementation.

No ready made recommendations and list of actions were defined in the project. Strong interpretation role was left to consultant /expert assisting the project manager/technology developer. Also, no specific stage of technology/innovation development was specified in order to keep the method adaptable to a wide spectrum of situations. Periodical assessment/review of project's societal robustness were envisaged.

Domain of application of Socrobust was aimed at a 'limited subset of innovation projects', namely breakthrough innovations (or architectural innovations see infra). Architectural innovations are defined as innovations with a strong impact on existing uses and practices. They entail a radical transformation in the social structures in which they are embedded when diffused and used. Projects that do not radically transform practices and society are no target for the Socrobust is a method designed to help project managers or technology developers deal with the societal acceptance of their innovations. Its main principle is to anticipate future possible acceptance/resistance of their innovation during diffusion steps.

If we now turn to the conceptual foundations, we need to mention that it draws on two fundamental conceptual instruments: the techno-economic network (Callon et alii, 1992) and the constructive technology assessment (Schot and Rip, 1997).

A.1 The Techno-Economic Network TEN

A techno - economic network is a coordinated set of heterogeneous actors - public lab, technical research centres, industrial firms, financial organisations, users and public authorities- which participate collectively in the development and diffusion of innovations, and which, via numerous interactions, organize the relationships between scientific-technical research [R&D] and the marketplace. These networks evolve over time and their geometry varies in step with the identity of the actors of which it is composed. A whole set of intermediaries circulates between them. These give material content to the links uniting the actors. They can be written documents (scientific articles, reports, patents...) incorporated skills (researchers (researchers changing lab, engineers moving from one firm to another...) money (contracts, financial loans, orders) or more or less developed technical objects (prototypes, machines, products for final consumptions).

TENs are organized around three main poles, which can be distinguished both by the identity of the actors constituting them and by the type of intermediaries that these actors put into circulation (nature of their production). These are the technical, market and scientific poles. The technical pole (T) is characterized by the conception and development of material objects which have their own coherence (durability, reliability...). We need to take stock of the various categories of intermediaries that lead to the final product: patents, pilots, prototypes, tests, sites, norms, rules of the art and methods... The market pole (M) correspond to the universe of users. Thus we are not dealing with the market as defined in economic theory as the place where supply meets demand, but with the practioner, describing the state of the demand [and uses] - identity of consumers, nature of their 'needs', preferences ranking, purchasing criteria, forms of organizations... the market, and this is the origin of its force as a mode of organization and coordination, is a gigantic machine producing more or less intelligible, more or less explicit information about the identity of users, and their expectations. The scientific pole (S) is characterized essentially by the production of certified knowledge. This knowledge generally takes the form of articles in journals. There is no similarity between certified knowledge and a technical object. Coherence between the two is constructed progressively, step by step, by trial and error. There is a transfer pole between science and technology (ST): a large number of organizations are exclusively devoted to bringing science and technology into relationship. [idem between T & M]

A TEN is a representation of the basic 'economy', the basic ecological unit of modern capitalist societies. It is a network of different actors involved in producing, maintaining, consuming this economy, and the intermediaries that provide basis for their relations. The Techno Economic Network (TEN) is inscribed in the technical object/system to be realized. TEN is the microenvironment of an innovation project, a coordinated system of heterogeneous actors. TEN is an organized combination of heterogeneous actors, but it cannot be represented as an organizational form, it is different from the concept of network in economics of organization, where more stable and homogeneous agreements are envisageable mainly inter-firms. Each actor in the TEN of a project is a spokesperson for a certain group in the social-technical environment of the project and for the capacity of certain technique of answering to given problems. Actors recognize themselves in their interactions, but they are partly autonomous: "actors composing TENs can behave in a predictable way or develop complicated strategies, there may be a number of innovations and these can provoke unexpected consequences. They can separate into smaller networks or they can join other TENs" (Callon, 1992). TEN includes a multiplicity of coordination modes.

The composition of the customer group and the strength of the relation between users and producers is central for the product construction process. Differently from a first version of TEN, where only three poles were included (the scientific pole producing codified knowledge and skills, the technological pole, producing the material objects and the market poles, including users) Socrobust have adopted the four poles version of TEN, including regulations. This intro-

duces implicitly the dimension of power and difference in power, but it was not given special attention to this.

A TEN can be:

- complete or not (all categories of actors are involved),
- long or short,
- convergent vs. divergent ((actors have strong interactions and one actor can mobilise others),
- Stable/irreversible vs. instable (assemblages of actors, institutions and intermediaries are well established and durable).

The role of the public manager is to make sure that the techno-economic network will get established for the innovation desired. Snapshots of TEN state of development relates to stages towards successful diffusion of the innovation and embedding of the technological unit into society. Manager's role in the process is to 'identify and describe the barriers to the deployment of technological innovations. These barriers will exist when links are missing between actors of the TEN, actors are missing, or if only weak links exist between actors - the existing links do not favour the flow of intermediaries and information needed in the process of innovation'.

A.2 Constructive technology assessment

Considering that traditional Technology assessment methods are not dealing with the social dimension of innovation properly, Constructive technology assessment proposes to incorporate social dimensions symmetrically to technical dimensions directly in the design and technology development process.

'proponents of CTA assume that the design process itself is influenced by the interests and values of all individuals, whether technical experts or not, who participate in designing and developing a technology. They also content that end users (as well as other interested parties) make valuable contributions to the design process, even opening up new areas of innovation.'

Stakeholders are invited to participate in the design and technology development steps with technology developers, so that the societal dimension acceptance of the innovation, and the regulatory conditions are build from within the design process. Ideas and values are articulated and negotiated early in the process

'CTA proposes bringing together all interested parties early in the design process [so that] technology is assessed from many viewpoint throughout the entire process of design and redesign, and the interest of all parties can be incorporated in the design from the beginning'

'The actors involved in CTA fall roughly into three or four categories.

First technology actors are those who invest in and maintain technology development programs. Second societal actors are those who experience the impact of the technologies new and old, such as users, citizens or workers.

Third regulating actors are those who develop rules and represent some kind of general interest. Fourth in CTA we often see type of meta-actor, who is responsible for facilitating and modulating interactions between other type of actors.

Three criteria for monitoring CTA practices:

- 1) anticipation
technological development are following a unpredictable, non linear process with branching and possibly path dependence. Anticipation of future social changes associated with technology as a result of stakeholder participation.

- 2) reflexivity
the ability of actors to consider technology design and social design as one integrated process to which they participate and to act upon that premise. Confronting views about the innovation and its consequences and start negotiation and compromise search.
- 3) social learning
technological options, user preferences and necessary institutional changes are not given ex ante, but are created and modified along the way through stakeholder interactions. Stability of the technological regimes and trajectories tend to increase with the successful embedment of innovation. Expectations become more articulated, development process more linear, micro/meso/macro levels better interlocked.

Many of the previous statements have large implications and in order to put Socrobust in a clear perspective, we will start with a discussion of the key conceptual components comprising Socrobust's theoretical background.

A.3 Type of innovation: fields of Socrobust application

Socrobust has been developed for being applied to a subset of innovations, those which are not yet stabilized, where market are not yet well defined. The taxonomy of reference is that traced by Abernathy and Clark (1984), who classifies the innovations on the basis of their environment, assuming that a right combination innovation/environment represents the source of success. Four types of innovation are identified by the authors, on the basis of a two axes diagram, representing on the horizontal axis the (new/pre-existent) market and on the vertical axis the (new/pre-existent) technological competences. The four types of innovation are:

- Regular innovation, a sort of incremental innovation where type of markets and competences are not modified.
- Niche innovation, where existing technologies are used for answering to new market opportunity. In this case the innovation is extended to new applications, the innovation exploitation is reinforced and the key question for a project manager is that of assuring the alignment between the new market and the existing innovation design.
- Revolutionary innovation, where new technological solutions, implying a new set of competences, have to be applied to pre-existing markets.
- Architectural innovation: in this case new or latent technological opportunities have to be adapted to unarticulated users' needs. The challenge is represented by the capacity of linking the understanding of the technical possibilities to insights in new needs.

These four types of innovations could be also taken as steps of an innovation life cycle, going from one to another, but (in the Abernathy and Clark idea, adopted by Socrobust as background) without an unidirectional temporal pattern. Innovation can go from architectural to regular innovation¹ but also from the regular to the architectural path, when, extending the application to new and more distant kinds of market, the range of demands begin to strain the ability of the existing design to meet them and firms move away, not for exploiting again new market niches but to a revolutionary or an architectural phase.

Socrobust has been designed for the application to architectural innovations, i.e. it pays attention to the phase of emergence of a new innovation design, including a new departure after a shift in the innovation journey. In this phase the manager 'must encourage the creative synthesis' of information into user needs with information on technological opportunities. The task is that of 'constantly screening for the technological developments and markets needs and orchestrating the creative, first time combination of resources'. This (new) departure anyway asks for some stabilization, the emergence of a new innovation design derives from the meeting between

¹ It could be intended as going from the 'emergence' of a new industry to a 'regular' situation of incremental product innovation or process innovation

three factors: technological opportunities (deriving from R/D activity or from information from competitors in related fields), market (tastes, needs) and regulation (standards, rules which favours the change).

Architectural innovations can be in different states: in a state of exploration or in a state of market emergence. In the second case changes/jumps in technological design are more difficult, and the core activity for ‘social robustness’ remains that of monitoring for possible destabilization factors. Destabilization can happen also when some irreversibility is established in a project, but competing projects have opened new routes and it is necessary to explore these new routes or even to abandon the present course. Classical approaches in marketing or technology can be put into action when needed. “Different states of development don’t call for a different approach, but a different (a tailored) application of the tool” (Socrobust report).

What Socrobust allows is a description of the ‘innovation journey in context’ that is the evolution of the innovation in the project, using a more general and process oriented approach/language looking at the ‘improving of the process’, instead of the language of the linear innovation model, neither that of the degree of materialization of an object/system (pilot, prototype, industrial development). This is made looking at three dimensions: the actor involvement (TEN), the degree of materialization of an object, the time dimension (irreversibility creation). The mapping of the evolution of the project includes possibility of shifts and even the disappearance of the original project, but also irreversibility creation, crisis and success.

Socrobust gives an intrinsic definition of success related to ‘social construction’ criteria: a project will be successful if it is socially accepted. It means that project managers will be able to combine classical techno-economic factors with societal factors of success. This has in particular strong implications in terms of anticipating the future and promoting a vision of the future society that is both coherent -manager is able to build and share a vision of the world necessary for its innovation to work- and realistic -the vision he carries is plausible considering other actors that needs to be involved strategy and views-.

The project manager must be able to re-configure, to match both social groups associated to the project and technical elements. Then selection can still operate; there is not any assurance of future market success. “Success is more a by product along the innovation journey than an end result” (Rip, 1985). In sum, managing innovation is a problem of combining a highly complex, uncertain and probabilistic process of collective action. Good preparation and anticipation of possible problems increase the chance of success.

A.4 Societal Robustness and Acceptance

Societal robustness is a notion broader than market success and it implies that insertion in business chains, linkages with users, adaptation to regulation are important factors of success, such as marketing action. Societal robustness is characterized by three dimensions:

- Integration: new products have to be integrated in relevant industries and markets (existing practices and cultural repertoires of users have to be included together with suppliers adjustment to new products). Integration is an aspect largely studied in the economics of innovation, when it is recognized that (Rosenberg, 1982) entrepreneurial failure can derive from the under-consideration of the interdependence between the components of a product and the rest of the larger system.
- Admissibility: new products have to be ‘aligned’ with regulation and standards.
- Acceptance: public resistance can cause the failure of an innovation.

Deuten, Rip and Jelsma (1997) propose that a product is accepted when three conditions are fulfilled:

- Societal concern is not overly large.

- There has been sufficient articulation of pros and cons, so that choices can be made consciously.
- New product is actually used.

A.5 The role of learning and that of anticipation

In Socrobust, such as in the resource based theory, learning and the collective learning building is the main route for dealing with variety and selection. Learning is a way for developing competences in a dynamic world, but it is constrained and it entails costs. In the evolutionary economics path dependence and routines limits firm's learning capabilities. Nelson and Winter stress the fact that firm behaviour is not that of a deliberate choice from a broad menu of alternatives; that's why it is very relevant what happens in the early phases. Teece and Pisano (1998) studying the evolution of the firm's dynamic capabilities, claim that firm's previous investments and repertoires of routines constrain its future behaviour. They also stress the risk of a too much large change, because it may attenuate the capacity of firm of conducting meaningful natural quasi experiment. In a dynamic environment learning processes contrast deficiencies in competences to align behaviour with the demand coming from the project environment.

Anticipation on embedment in society during the innovation trajectory, a concept largely used in Socrobust, is a part of the learning processes. Anticipation allows the identification of possibilities for intervention based on understanding the technological dynamics. In anticipation, three types of cluster of activities with different level of embedding in society can be distinguished in an innovation journey, for a trial and learning approach:

- A protected space (such as niches): where only ideas, expectations and learning from prospect users take place.
- A stepping out in the wider world (such as demonstration projects), with a real world learning and subsequent modification of the project: An experiment through which one can learn about technology and its impact.
- Changes at sectoral level, where many actors in many places have to be involved.

Socrobust should be positioned in the first level of a project embedding, where a present/future scenario is built for the product definition and positioning in the market. An 'anticipation dilemma' can be envisaged, since with a definite product design is easier to make a detailed forecast or to interact with external actors, anticipation can be more precise, but it will be less effective because the costs of change increase during the new product creation. If 'anticipating' is seen as a process it offers a way of overcoming the dilemma.

A.6 Management action for social robustness

Irreversibility and the mutual adaptation of the social and the technological aspects is a problem for project managers, since they imply inflexibility. How to go about this problem? How to solve the trade off between good adaptation in a certain moment and openness to future choices? The same dilemma is worth for a policy maker: is it possible to intervene when technology is not stabilized, but at that time the available information is only limited. How to face the problem?

- External consultancy action (foresight can be viewed as a type like).
- Involvement of users before the project is locked into a dead end.
- The project collective represents implicitly the hypothesis on the future social embedment. All that is necessary to do is making these hypothesis explicit and verifying how much these have been realized, i.e. how much they correspond to reality. Socrobust follows this line, developing instruments and indicators, which allow project managers to assess their own societal embedment.

Actors (societal actors, government agencies) are not involved in the decision making processes of a firm, but the relation between them and the firm is relevant from the 'societal quality' point of view. Firm can try to influence the actors; in presence of controversies firms must have 'hopefully' an audience, create a dialogue, showing that it is ready to listen to other stakeholders and that it is trustable. The controversies can be treated in terms of communication strategies or collective learning building; firms could also be proactive and explore the possibility of a double-loop learning, where experience and reflection lead to reconsider one's goal: but controversies could also take place as strategic games, which are not included in the tool-kit of Socrobust. Learning and shifting actions represent an investment and have a cost, which should be made explicit. In the Constructive Technology Assessment view "actor strategies don't determine outcomes, it is always the interaction and the indirect effects that are responsible for a technology to be embedded and two types of interactions are preferred: anticipation of what happen at collective level and creation of action at collective level". Socrobust has not strictly used this line.

A.7 Alignment

Alignment is an instrument for action, since it helps to reduce the risk of failure and uncertainty of an innovation project: "While there is always contingencies, there is also links creation, increasing alignment and therefore a certain amount of predictability" (Rip and Schot). It is a wide, a little fuzzy, concept indicating actions on factors, which impact on collaborative orientation among different interests. It includes mutual adaptation with other actors and products and an articulation of acceptability. In Socrobust alignment has been used in the Actor table and in the Capacity for action table, but it has not been more clearly developed.

Deuten, Rip and Jelsma (1997) dealing with the process of product creation introduce the following considerations: in a business vision there is a sort of 'web of alignments' which can be gradually filled: first and more relevant for firms is the alignment with the business environment; then follow the alignment/links with institutional environment; less taken into consideration is the 'wider society' that can be identified with the public concern. This last 'layer' has been taken into consideration in the Socrobust future market description, and will be even more relevant in create acceptance.

It is possible to identify an 'internal' and an 'external' alignment. This last asks for a 'stakeholder analysis': who are the main actors, which are their concerns and interests, what choices are they probably going to make. Stakeholder analysis is a technique that has not been fully developed in Socrobust, but it has been introduced through the Actor maps. The Constructive Technology Assessment has also developed heuristic advice on the alignment building.

A.8 The innovation trajectory and its network: role of the early stages and of the path dependency

Socrobust embeds a fundamental concept of the evolutionary economics: the presence of 'process dependence' in an innovation journey and therefore the relevance of the first steps for the successive configuration of an innovation. This is a specific aspect of the literature on the co-evolution (Nelson, 1994): in technological competition (between firms or projects) being first in the process of technology adoption and diffusion can bring relevant advantages. This is given to the creation of irreversibility (due to the process of learning by local experience, the actors interaction and the network externalities) and to the connected increasing returns. The application of the 'path dependence' concept in Socrobust concerns the project evolution, instead of the industry or the technologies related to the project. This is an important aspect: Socrobust doesn't deal directly with the evolution of sectors, neither with a full process of diffusion of the innovation produced by the project. Socrobust is not directly related with the analysis of an innovation

life cycle and with the emergence of one ‘dominant design’ (which, furthermore, in the economics of innovation is not the rule, but a case, mainly concerning mass products). What is relevant in Socrobust is the more general aspect that an innovation starts in a fluid situation, open to many variations and branching and progressively the number and quality of options decrease. The flexibility of the innovation and of its actor network is ‘internally’ delimited, by its paths, its process, its choices and this is also the reason why the role that the various actors can play, in giving some configuration to the innovation, is higher at the beginning, in the early stages. From the point of view of the project manager the question is that of finding a balance between assuring an internal coherence to the project, extending the area of applicability and keeping open a window for changes.

The ‘innovator dilemma’ is a variant of the flexibility-stability dilemmas (Meeus and Oerlemans, 2000): how do firms reconcile the need for persistence in the pursuit of organizational goals and the need for change in the aim of organizational survival. Indeed innovation is a trade off between competing risks: that of changing product and that of organizational decline or even death.

A.9 Internal and external to the TEN worlds: variety and selection

The innovation is a process of creation and of association/transformation of different technologies and knowledge. In Socrobust and the Actor network theory the process of variety creation is at the same time the process of production of a new product and of its environment. This co-creation activity is the basis of the stabilization process, which allows the emergence of an innovation. The emergence means the capacity of being adopted, recognized/accepted by a first group of adopters. Socrobust accompanies a project until its fulfilment, looking at the fact that it embeds many of what will be important in the future, but without following the evolution of the innovation in its diffusion paths.

The dynamics of a TEN can be studied by comparing the configuration of the TEN of a project in different points in time; one motor of the dynamics can be the ‘anticipation’ practice and the consequent adaptations to the project manager changing visions of the future world. A project’s TEN produce its environment of selection, but since the project’s TEN cannot enroll/align all the actors, a relevant question remains open: what is the place of the TEN in a wider world. Therefore the problem of the external selection (which is not to be identified only with market selection, but with context selection) remains open. Where, how is it decided what configuration will gain or if a configuration will survive? An answer/solution to this critical question is given by the Constructive Technology Assessment and by organization management theory when they look at the better strategy for survival in a rapidly changing context. The solution is given in terms of action (and not in terms of an alternative explication of trajectories), which doesn’t assure the success but reduce the risk of failure. The solution is the necessity of anticipation/adaptation and, from an organization point of view, that of a strategic prospective thinking and decision making and of the necessity of combining exploitation (combining and managing already selected resources within neat organizational boundaries) and exploration (scanning, analysis, reasoning and foresight).

A.10 Static and dynamic: monitoring in different states

The dynamics of the project was traced back and forth through storyboard and documentation. The dynamics is examined in the past. The transformation induced by Socrobust cannot be verified in real time: the project ‘under observation’ has a relatively short life. But if the innovation in the project is in a really initial state, changes can be frequent also in a short term and Socrobust is a flexible toolkit which can be used for repeated re-examination of the state of the project, for making decisions on the next step. In this case the dynamics can be represented by a comparison between different configurations of the project in different moments.

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