PROTEE

PROCEDURES DANS LES TRANSPORTS D'EVALUATION ET DE SUIVI DES INNOVATIONS CONSIDEREES COMME DES EXPERIMENTATIONS COLLECTIVES

FINAL REPORT
FOR PUBLICATION

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- October 1999

CONTRACT N°ST-97-SC.2093

PROJECT FUNDED BY THE EUROPEAN COMMISSION UNDER THE TRANSPORT RTD PROGRAMME OF THE 4th FRAMEWORK PROGRAMME

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EXECUTIVE SUMMARY

Research on the technological innovation has identified two very different kinds of innovations: the first kind is the development of existing technologies and their uses: it can be termed "incremental" innovation. For these innovations, one can identify risks and establish the probability of success. This kind accounts for 80 to 90% of the R&D of major European companies.

It is the second kind, accounting for the remaining 10%, which is considered here. These are innovations that economists call "radical" or "break-through" innovations. The management and evaluation of such radical innovation projects has always proved problematic because the uncertainties surrounding them prevent the application of traditional project management methodologies to measure risk and the probabilities of success. The question posed to the PROTEE team was simple: can their management be organised at all and if so how? This question is all the more important since radical innovations are at the core both of public sector research programmes and in situations where they form a significant part of R&D activity (e.g. biotechnology firms). It is also a particularly difficult question since, in energy or transport, the "paradigm" change arising from a radical innovation may be spread out over several decades, involve a multitude of participants and cost hundreds of billion rather than million Euros.

The review of existing methods undertaken in a previous project (STEMM) had convinced the industrial promoters of PROTEE of the need for a radically new approach, not based upon the conventional methods such as cost benefit analysis or multi-criteria analysis. A feasibility study undertaken within the frame of the French transport national programme (PREDIT) which aimed at introducing the lessons of the sociology of science and innovation in the evaluation of projects was also influential. Out of these two elements, a consortium was progressively built which gathered industrialists active in developing new freight intermodal systems and university teams in “science studies”. The work programme was based on a four step process.

(i) A first set of indicators was exposed to critical analysis in a series of workshops, to develop an improved set for testing in the second phase.

(ii) A trial was then developed using four retrospective cases of intermodal innovations, one for each industrial partner.

(iii) The third phase was devoted to clarifying the procedure, the learning pact being a crucial feature, and to stabilise the indicator set.

(iv) A final stage of preliminary tools’ development: the paper manual has been developed into a software aid for tracking successive project descriptions.

This report focuses on two main dimensions of the project: the principles underlying the PROTEE approach and methodology (Chapter 4), and the lessons derived from the case studies (Chapters 5 and 6). Lessons learnt and perspectives are developed in the conclusion.

Background

Research in history, management and sociology of technology has shown that innovations fail to explore their environment in a way that ensures a positive learning process for four basic reasons:

- lack of realism;
- lack of strategy;
- lack of falsifiability;
- lack of innovativeness.

It is around these four pathologies and their associated indicators that a relationship between an “innovator” and an “evaluator” is built. The methodology encourages the two to engage in a learning process to analyse and discuss the project in these “PROTEE" terms. It provides tools to assist this process and analyse the results. To achieve this, PROTEE establishes a paper trail that provides a principled description of the project by documenting the successive meetings between the innovator and the evaluator in terms of PROTEE indicators. This paper trail allows for the progressive build-up of a file allowing the innovators and evaluators to assess the quality of the exploration trajectory of the innovation. The comparison of the indicators over time makes it possible to grade the quality of the learning curve and to decide whether or not to continue the exploration.

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Research background

PROTEE’s methodology depends on research which can be summarised into the following eight propositions.

Proposition 1: The interaction between innovators and evaluators aim at diagnosing the quality of the learning trajectory that the initiating of the project is about to start.

Proposition 2: The interaction between innovator and evaluator begins with a distance between the two which may be maximal, but aims at producing at the end a common description of the project; at which stage, the project is said to have completed its exploration and the research is to be provisionally closed.

Proposition 3: Innovators and evaluators agree to enter into a learning pact and to begin a collective experiment in order to test the quality of the project trajectory.

Proposition 4: The learning pact in which innovators and evaluators accept to be engaged consists in accepting to evaluate the project only through the quality of the trajectory, which means that PROTEE is limited to procedural indicators only. Later, at the end of the exploration phase, normal indicators and methods will be used.

Proposition 5: At time zero, when the learning pact begins, the innovator should be able to describe the world in his or her own terms, and there is nothing yet that make the evaluator able to do his or her own job, except listening.

Proposition 6: After having heard the innovator, the evaluator prescribes a redescription of the project to make sure that he or she can qualify the learning trajectory at the next encounter, by entering the minutes of the meeting in the protocol book and by coding the differences according to a set of procedural indicators.

Proposition 7: The result of the evaluator's prescription will be to elicit from the innovator, at the next encounter, a more risky description, by opposition to the smooth description usually requested. It is this risk that will allow the evaluator to pass judgement on the quality of the innovator, and to help evaluating the evaluator in the eyes of his or her colleagues or superiors: has he or she been able to elicit risky description in

Proposition 8: The evaluator, when asking for a risky redescription of a given project, will make sure that four grave pathologies be avoided, so as to maximise the chance of navigating the project through its learning trajectory. Against each pathology, an explicit indicator will be devised so as to make sure the project does not succumb to that disease.

On what type of innovations has PROTEE been tried?

For historical reasons, PROTEE has been devised by an international consortium mixing academics and industrialists for use in the transport domain, more specifically combined or multi-modal transportation. The complexity of transportation systems was well adapted to testing the principles of PROTEE and producing a first outline of the procedure but there is no reason why it should be limited to transportation systems per se.

What has been done to test PROTEE?

The procedure has been tried on several projects either completed or in the process of finalisation by trying to mimic as far as possible the situation of the learning pact envisaged by PROTEE.

- Tecnicatome's COMMUTOR project.
- KRUPP's Fast Handling System.
- The ECT innovation on the automatic handling and transport of containers in Rotterdam.
- The ETTC platform in Frankfurt (Oder).
- A "Container Inter Modal Project" (CIMP).

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How should the PROTEE results be developed?

The above tests were successful enough for members of the consortium to enter in a "scaling up" process. This was initiated along three complementary directions. Further development is only possible by working on on-going innovation projects. Two such trials are in progress at the time of writing. Formalisation of the principles and the know how gained through devising a preliminary user electronic manual.

Dissemination

Finally, PROTEE is also a way to facilitate the dialogue among evaluators, administrators and project managers with different constraints to those of the usual set of progress reports and technical annexes. The procedure for writing minutes, organising meetings, comparing outcomes and implementing risky descriptions, is certainly the most important outcome of PROTEE but also the one in most need of experiment. It represents a new skill and a new

know-how, at the junction between the academic world, engineering companies and public administration.

I- INTRODUCTION

Research on the technological innovation has identified two very different kinds of innovations: the first kind is the development of existing technologies and their uses: it can be termed "incremental" innovation. For these innovations, one can identify risks and establish the probability of success. This kind accounts for 80 to 90% of the R&D of major European companies.

It is the second kind, accounting for the remaining 10%, which is considered here. These are innovations that economists call "radical" or "break-through" innovations. The management and evaluation of such radical innovation projects has always proved problematic because the uncertainties surrounding them prevent the application of traditional project management methodologies to measure risk and the probabilities of success. The question posed to the PROTEE team was simple: can their management be organised at all and if so how? This question is all the more important since radical innovations are at the core both of public sector research programmes and in situations where they form a significant part of R&D activity (e.g. biotechnology firms). It is also a particularly difficult question since, in energy or transport, the "paradigm" change arising from a radical innovation may be spread out over several decades, involve a multitude of participants and cost hundreds of billion rather than million Euros.

The review of existing methods undertaken in a previous project (STEMM) had convinced the industrial promoters of PROTEE of the need for a radically new approach, no longer based upon approaches such as cost benefit analysis or multi-criteria analysis. A feasibility study undertaken within the frame of the French transport national programme (PREDIT) which aimed at introducing the lessons of the sociology of science and innovation in the evaluation of projects was also influential. Out of these two elements, a consortium was progressively built which gathered industrialists active in developing new freight intermodal systems (TECHNICATOME, KRUPP, ZIV, MONDRAGON SYSTEMAS) and university teams in “science studies” (CSI/ARMINES, MAASTRICHT and BRUNEL universities). The work programme was based on a four step process.

(i) A first set of indicators, derived from ERANIT and STEMM by the academic teams, was exposed to critical analysis by the industrialists in a series of workshops. This gave rise to an improved set for testing in the second phase.

(ii) A trial was then developed using four retrospective cases of intermodal innovations, one for each industrial partner. For each cases study, an industrialist-academic pairing was formed, where the academic teams, after a traditional “science technology and society” (STS) study, reconstructed the past history and discussed with the industrial partners the ways issues had been dealt with at the different turning points identified. This proved very helpful both in better defining the indicators and in discussing the conditions for fruitful interaction between innovators and evaluators.

(iii) The third phase was devoted to clarifying the procedure, the learning pact being a crucial feature, and to stabilise the indicator set. In parallel, it has been decided not to undertake, as initially planned, a fifth retrospective case study but to test the methodology on an on-going innovation project within TECHNICATOME.

(iv) Results were positive enough to undertake a preliminary stage of tools' development: the paper manual has been developed into a software aid for tracking successive project descriptions. This aid is an internal tool to be used to support further experiments with on-going innovations, a stage we consider necessary for it to develop into a useful and usable software tool.

1.1- WHAT IS PROTEE

PROTEE's answer to the question of how to deal with such projects was to propose to develop the relation between a project leader (i.e. an innovator who knows all about his project, its contents, its problems and its difficulties but also its potential) and a decision maker (i.e. an evaluator knowing little or nothing about the project but who is experienced in evaluating projects and has confronted both their problems and potential dangers many times). This relationship covers the early and very uncertain phase of a "rupture" project's life before it is either finally abandoned or matures to the point where more traditional project management methods can be employed.

This involved developing a methodology and indicators starting from the lessons which had been drawn from many case studies undertaken in the field of intermodal transport, from past radical projects but also from a project financed and monitored by European Commission. These developments were undertaken jointly with academic and industrial partners from a number of European countries (France, Germany, Holland, Belgium, Spain and England), and resulted in the characterisation of three pathologies - realism, strategy and falsifiability - on which were founded three classes of indicators. PROTEE also identified a summary class of four questions which provided a synthetic way to approach the future of projects as well as summing up their overall prospects: they comprise our fourth class – the indicators summary or innovativeness.

It is around these pathologies and indicators that the relationship between the "innovator" and "evaluator" is built. The methodology encourages the two to analyse and discuss the project in these "PROTEE" terms and provides tools to assist this process and analyse the results.

Research in history, management and sociology of technology has shown that innovations fail to explore their environment, and thus gain a positive learning curve for four basic reasons:

- the project has been conceived in "ballistic" term, that is as something that goes from an original idea to reality without learning in the process what should be done: something which can be very different from the initial idea;
- the project has been unable to generate a coherent picture of its opposition and has considered opponents as obstacles instead of taking them strategically as occasions to entirely renegotiate what the project is about;
- the trials that have been devised to test the project are so biased or irrelevant that decisions are taken which do not modify the quality of the exploration and are thus carried out in vain;
- the projects are managed without taking into account the various degrees of innovativeness, thus resulting in the dilemma of research management: eliminating the good projects too early ("wiping out the hopeful monsters") or continuing projects which no longer learn from their mistakes ("white elephants").

Box 1 presents the indicators that have been developed to cope with these four issues: lack of realism, lack of strategy, lack of falsifiability and lack of innovativeness.

Box 1: The PROTEE Indicators

Class 1: Realism or "anti-ballistic"
The whole class makes sure that innovators have not started with a project and then looked for a world in which to implement it with as little deformation as possible (the ballistic pathology) but are able to first describe a future world and only then search out elements that render their innovation more realistic.
The evaluator will then grade the description given of the project at hand:

I,a): by its richness;
I,b): its heterogeneity;
I,c): its uncertainty;
I,d): its contingent.

Class 2: Strategy or "anti-paranoia"
This second class makes sure that the project is now thought of in strategic terms, that is, considers every opposing view as an opportunity to modify the project and entering into a negotiation as to its character, goal and functions. The evaluator will grade the description according to the following indicators:

II,a): opposition;
II,b): justification;
II,c): specification;
II,d): negotiability.

Class 3: Falsifiability or "anti-manipulation"
The third class of indicators makes sure that the trials proposed by experts, politicians, technicians, public etc. for assessing various aspects of the future project are themselves relevant, useful and quality controlled. Without this double checking of the relevance of the trial objectives, the trials would be carried out in vain.
The evaluator will grade the research PLAN proposed by the innovators according to the following indicators:

III,a) arbitrariness;
III,b) openness;
III,c) proof of proof;
III,d) criticality.

Class 4: Innovativeness or "anti-monsters"
The fourth class of indicators makes sure that the process of exploration itself should not be continued without good reason, either because the project should be discontinued (it is a "white elephant") or because, on the contrary, it is a very innovative and long-term risky project (a 'hopeful monster") or, finally, it has matured so that other project management techniques are applicable.
The evaluator will grade the description given by marking the following indicators:

IV,a) retroactivity;
IV,b) reconciliation;
IV,c) risky diagnosis:
IV,d) limit conditions.

PROTEE cannot guarantee that every project will succeed once managed according to its procedure, but it can make sure that at every of their regular meetings innovators and evaluators eliminate, as far as possible, those four pathologies of innovations.

1.2- PROTEE PROCESS

The core idea of PROTEE is to evaluate not the technical feasibility, or economic profitability, or political acceptability of a given project but to consider a project as an exploration of alternative possible worlds. Whereas most of the other methods try to gain as much information as possible on the states of the world (an impossible achievement for really risky innovative projects although it is always repeated), PROTEE is based on the idea that projects can be ranked by the quality of this exploration itself. Such is the main originality of PROTEE: what other methods fail to register because of the fluidity, complexity, immaturity of research projects, PROTEE can follow because it does not rely on knowledge but on procedure for exploration.

PROTEE does not rely on the a priori knowledge or wisdom of innovators, evaluators, experts and politicians, but only on the abilities of all those actors to learn as quickly as possible from the collective experiment on which they have embarked without making irreversible mistakes and committing inordinate amounts of money to the learning process. The key idea is that if, by definition, we lack knowledge of the innovation which cannot be calculated, we can in contrast improve our collective ability to describe the project.

To do this, PROTEE establishes a paper trail that connects innovators and evaluators who have engaged in a learning pact in order to provide a principled description of their projects. This paper trail allows for the progressive build-up of a file allowing innovators and evaluators to evaluate the quality of the exploration trajectory of the innovation they have collectively begun to analyse.

PROTEE documents the successive meetings between innovators and evaluators by asking them to fill in the same questions leading to the same indicators at each meeting. It is from the comparisons of those indicators that it becomes possible to grade the quality of the learning curve and to decide whether or not to continue the exploration.

The Interview Guide conceptualises the Innovator and the Evaluator as having separate, but complementary competences. The Innovator is an expert on his or her own project. The Evaluator is an expert in developing PROTEE type analysis and evaluation of an innovation project. The PROTEE process is conceptualised as comprising five distinct and non-overlapping steps, or moments. The five steps are described in Box 2. The five steps incorporate a complementary division of labour and competences.

The key basic material of the PROTEE analysis is the production of the project descriptions, with a tension between the requested open and risky character of the description (a description of a world as a heterogeneous ensemble of actors, entities and elements in the innovators terms) and the highly standardised evaluation sheets with which the descriptions are assessed. To overcome this tension, it is suggested that the production of the description is done in two phases. In the first phase, the Innovator gives an account of the project ‘in his own terms’ (when the first time point is being chosen at the beginning of a project, the technical proposal might be a suitable document to work from). In the second phase (which might in practice be on the same day) the Innovator and the Evaluator work on a more structured description in which elements that are to be judged by the indicators are already present. This structured second phase description should be negotiated and agreed upon.

Box 2. The PROTEE 5-Step Plan

1. The Innovator's Story. The Innovator tells a story to the Evaluator. This is contained in the documentation and other material supplied to the Evaluator prior to a project meeting. The subsequent procedures, described in points 2-5 below, take place at the project meeting itself.

2. The Consensus Story. The Evaluator retells the story of the project to the Innovator in the form of a summary - a chronology of events. Through this process they agree on a Consensus Story - an agreement about what has happened on the project since it started, or the last meeting.

3. The Socio-Techno-Therapeutic Dialogue. The Evaluator and the Innovator enter into an analytic dialogue structured by questions formulated by the Evaluator to encourage the Innovator to make risky descriptions of the project. This dialogue is designed to lead to a PROTEE redescription of the project.

4. The Redescription. The Evaluators and Innovators each make a record of the PROTEE redescription. The PROTEE redescription would be a record of the quality and quantity of the descriptions of the project made within the framework of the PROTEE Indicators. The Innovator and the Evaluator do not have to agree on the project's redescription, but their respective redescriptions should address the same points. At the Working Group in Maastricht we proposed a method for making the PROTEE redescription which involves the completion of Project Description Summary Sheets.[1] The Sheets would record a summary of how the parties redescribed the project at the time of the meeting with respect to the quality and quantity of its descriptions.

5. The Evaluation. The Evaluation is the outcome of the comparison of project redescriptions made at two consecutive meetings. Clearly, it is not possible to make an Evaluation at the first meeting. At the second and subsequent project meetings, however, the Innovator can compare his two redescriptions and the Evaluator can compare his. What is important for the Evaluation is the difference between the two redescriptions.

[1] McNally, R. *PROTEE Methodology: Project Description Summary Sheet and Project Learning Curve Summary Sheet*, Presentation at the PROTEE Working Group, Maastricht, 14 January 1999.

II- PROTEE PRINCIPLES: THEORETICAL BACKGROUND

The authors of this report have considered it important to give a detailed account of the results arrived at in science studies so that to help a reader unfamiliar to them and interested to understand how the indocators have been developed.

2.1- PROTEE PRINCIPLES: WHY FOLLOWING PROCEDURAL INDICATORS?

Introduction: PROTEE consists in the principled documentation of a series of exchange between an innovator and an evaluator about a project.

1- An innovator is defined as anyone who comes to ask for an evaluation about a project he or she knows well and tries to promote.

2- An evaluator is defined as anyone who is in a position to offer an advice on the continuation of the project. He or she can be someone inside an administration, a firm, someone who has a hierarchical relation with the innovator or someone who has no organisational connection and who is an outside consultant; it can also be an expert who accept not to know but to experiment in common with the innovator.

3- A series of exchange implies that innovators and evaluators are not going to settle the matter on the first round but need to engage into an interaction.

4- A documentation means that the result of the PROTEE methodology is an archive, a file, that should be readable by the participants during the course of the interaction and also by outsiders in charge of taking over the project or evaluating the evaluators' work.

5- This documentation is said to be principled meaning it does not imply to gather complicated quantitative information but it is not done haphazardly either; some key principles are maintained throughout the interaction.

6- Innovators and evaluators are said to interact about a project, which implies that they are not talking about an existing state of affair - an object - but about a future possible but uncertain state of the world; it also means that from the start it is not taken as a "technical" project, and it thus can be an innovation about usage, control, accounting, practice, law as well as about pieces of machinery or composition of existing machinery (Bijker, 1995, Latour, 1996).

Comment: It is voluntarily that the word innovation is not defined a priori; it will be one of the results of the PROTEE evaluation - especially the class IV of indicators - to settle how innovative a given project is. This is to avoid the temptation either to eliminate risky project or, on the opposite, to consider as a routine procurement something that will turn unexpectedly to be major innovation triggering fierce oppositions.

Proposition 1: The interaction between innovators and evaluators aim at diagnosing the quality of the learning trajectory that the initiating of the project is about to start.

1- The project is not conceived, as it is so often the case, in "ballistic" terms, that is something which, once launched by an initial kick off, undergoes no other modifications and becomes real through a displacement from plans to objects.

2- The project is conceived as a learning process aiming at the progressive discovery, by innovators and evaluators alike, of what the states of the world are.

3- To become attentive to the learning trajectory means that neither innovator nor evaluator begin in a state of knowledge: they don't know, that's why they have to learn.

4- This is in contradistinction with most others methodologies which assume that there is a state of knowledge that should be reached before the project begins to take shape, or that somewhere, some other people, called the experts, would know; PROTEE makes a minimalist assertion on the quality of human nature: nobody knows, everyone is like a blind fumbling into the dark; this is why learning is so important and is to be clearly differentiated from the myth of total knowledge.

Warning: the use of the word "learning" does not mean that the project aims at satisfying only one variable only, that is knowledge, as if only publishing papers about states of affair in academic journals was the only goal of innovation; this would be a serious misreading of PROTEE. One can learn about any of the identity whose make up is necessary for the existing project: market relations, technical feasibility, management's intention, political will, etc. Learning is applied here to all the variables - academic knowledge included - but it can be learning about clients, learning about costs, learning about social acceptance, learning about unintended risks, etc; the reason we use learning trajectory is thus not to transform all innovations into academic undertakings but because we want a term that clearly sets at the beginning that no one knows, and that PROTEE does not require expert to occupy their usual role in evaluation: those who dispense evaluators and administrators from the risk of following the project.

5- This learning process throughout time has a trajectory which PROTEE aims at reconstituting through the documentation in the file that it constitutes on each project.

Comment: One way to envisage this trajectory is to recognize what could be called the innovator's dilemma: when I can, I don't know; once I know, I no longer can change any thing. This is the opposite of common sense who claims that one should know before doing. In innovation, one should do first in order to know more about what is feasible. But every move to learn is paid in loss of money, time and thus freedom of manoeuvre. At the end, one knows if it is feasible or not, but it is too late to start all over again, there is no degrees of liberty left. PROTEE is the adjustment of organization practice to this very simple innovator's dilemma (Midler, 1993).

6- Speaking in terms of learning trajectory does not mean that there is no ground for judgements and normative decisions, since learning curves can be good, average, bad or terrible, in other words there is a quality of the learning curve, and it is this quality that in PROTEE may be used for deciding upon further engagement in a project.

7- This quality can be the object of a diagnosis that anticipates not the fate of the innovation, unknown by definition, but the chance to learn more if the project is continued.

Proposition 2: The interaction between innovator and evaluator begins with a distance between the two which may be maximal, but aims at producing at the end a common description of the project; at which stage, the project is said to have completed its exploration and the research is to be provisionally closed.

1- Since we are dealing with innovations and not with routine objects, there is no common world, at the beginning, nor shared understanding between innovators and evaluators; thus their distance can be as great as possible.

2- It can only be surmised that at time zero, the innovator will be fully conversant into the details of his or her project, but wholly ignorant of the right way to explore a learning curve with his or her project, while the evaluator will have a long experience in evaluating projects but absolutely no knowledge of what this specific project is about; there is thus an important and useful asymmetry between the two at time zero;

3- To evaluate the learning trajectory, PROTEE relies over the key notion of description, that is the ability of various participants into the projects - promoters, evaluators, administrators, but also opponents, competitors, lead users, end users - to redescribe the project according to features that PROTEE will render visible.

Comment: To remember that the word description is a technical term, one can underline the notion of script that is dormant in its etymology: a script is a possible scenario for many state of affairs; a project is always a scenario that attributes role, actions, volitions and functions to different entities humans or non-humans; a de-scription is thus the extraction of the script. "The crane will grab the containers and shift them to the trucks waiting on the deck" is a script attributing functions, movements, actions to cranes, containers and trucks, and implying actions and movements from other unnamed entities: truck drivers, boats, crane engines and cables etc. Description, thus means that what was implicit in the first sentence, becomes explicit in the second (Akrich, 1992 & 1993).

4- The feature that is going to be used in order to qualify the learning trajectory is to decide whether or not innovators and evaluators, who had started with completely different worlds, are able to zoom on a common description, this does not mean that they agree, but that they share a common reference to situate their disagreement.

5- The end of the project is defined by the production of this common description, which means that the file has been filled in and the documentation satisfactorily completed.

6- This is an essential feature of PROTEE that a project be defined by the " paper trails " that it leaves behind and not by any other judgement about the feasibility or unfeasibility of the project; this means that all projects leave a trace that is usable by others later to articulate explicitly their own subsequent projects.

7- This means that PROTEE is going to treat all project as research (Latour, 1998) which does not mean that knowledge will be its only goal - see comment above - but that the same logic of enquiry will be applied to projects and to experimental science;

8- A good project is thus the one whose accumulated learning curve is easily accessible to later users - innovators or evaluators - in order to decide whether or not this state of affairs is plausible or not; this is in contradistinction with the usual relearning after each hidden mistake which is so often the rule in organisations.

<u>Proposition 3:</u> Innovators and evaluators agree to enter into a learning pact and to begin a collective experiment in order to test the quality of the project trajectory.

1- Since innovators and evaluators begin with widely different interests and no common language, and since there is no way to shift the burden of responsibility to other authorities who would know (see comment below), the only solution to complete their interaction is to agree on learning together how good is their procedure[2] to navigate the project, what we call here a <u>learning pact</u>.

Comment: There is no way to use the normal procedure that is to delegate to experts the task of evaluating the project in place of the evaluator; PROTEE implies an evaluator which is neither omniscient nor a coward hiding his or her own irresponsibility behind experts; the result of the normal procedure is to rely on experts who either pertain to the same technical lobby and approve only the projects least critical of their habitual procedures, or, if they don't pertain to the same lobby, and disagree too much, who will chose the least divisive project ; in both cases, relying on experts, although it seems commonsense, is source of waste since the worse projects will be systematically selected out ; it is perfectly possible, however, that experts equip themselves with a PROTEE methodology, in which case they stop playing the role of experts intervening to stop evaluation and become thus <u>evaluators</u> in the sense specified above in proposition 1.

2- The minimum they agree upon is to begin an <u>experiment</u> according to the model offered by the experimental science, that is a series of trials in order to acquire the knowledge they don't have yet.

3- Contrary to most experiments in the natural sciences, however, this is a <u>collective</u> experiment which, in the case for instance of major innovations or big infrastructures, may include many participants.

4- PROTEE is not interested in all the elements of the experiment but only in those that allow the evaluator to <u>qualify</u> the trajectory of the learning process and to test its virtue.

5- To speak of a collective experiment is important because it makes more clear that we are not dealing with a "ballistic" process by which perfect but non-existing plan become real without any transformation. Users along the line of a TGV are participants in an experiment as well as those who are in white coats inside the laboratory (Lolive, 1997, Latour 1999).

<u>Proposition 4</u>: The learning pact in which innovators and evaluators accept to be engaged consists in accepting to evaluate the project only through the quality of the trajectory, which means that PROTEE is limited to procedural indicators only. Later, at the end of the exploration phase, normal indicators and methods will be used.

1- The key feature of PROTEE (and the one that will trigger most difficulties) is that projects are not evaluated according to costs, feasibility, social acceptability, plausibility, coherence,

[2] A very big role has been given to procedural morality and procedural democracy by Habermas, but what we do here is to extend the notion of procdural democracy to the very place of what Habermas thought was the domain of what he calls 'instrumental rationality' (Habermas, 1987 & 1992). In that sense we have mixed Habermas with the work of Lakatos (Lakatos 1978).

etc. but only through the quality of the procedure used to learn more about cost, feasibility, social acceptability, plausibility, coherence, etc.

2- This is essential if one wants to be able to select projects which are innovative. By definition, the world in which those projects could become viable is hard to describe and harder to know: they can only be explored. If they are judged through normal means, the most innovative propositions will inevitably be selected out. If, on the other hand, only wild projects are selected, an enormous waste will ensue. The only way to reconcile innovation and strategy, is to start with no preordained state of affairs and to learn experimentally how to zoom down to one more coherent common description.

3- To use the expression of procedural indicators means that PROTEE deals only with the "delta" of the project as it is identified by the evaluator, and does not rely on common sense or common knowledge, which are not good guide for innovations which, by definition, are new and made up of a string of unexpected events for which common sense is useless.

4- This of course does not mean that the innovators as well as the evaluators do not rely on a lot of rules of thumb acquired by experience, but these rules are not the basis of PROTEE indicators.

Comment: The confusion generated in the consortium for many months, was due to the mix up between knowledge acquired by the participants of what could be called "rules of prudence" - for instance, a project that has no identified lead-user is bound to fail - with PROTEE procedural indicators. STEMM (a previous project on transport infrastructure investments) was built by trying to draw lists of most often encountered rules of prudence. This is useful, but should be clearly differentiated from what is attempted in PROTEE. History and sociology of technology have shown that every time you find a rule to tell apart successful from failed project, the very next case succeeds or fails against that rule! Hence the shift we felt necessary from substantial list of indicators to procedural ones. This does not mean however that PROTEE will not help accumulate more effectively many rules of prudence, but that the store of acquired rules should be kept distinct from PROTEE's core. It is obvious however, that the more expertise all participants have - including the opponents - in having tasted and tested many innovations, the more articulate they will become.

5- Thus PROTEE is not in competition with the usual tools of project management which are based on operational research, the tracing of critical paths, the setting up of multi-entry matrices, the calculation of optimum, but it deals with moments when none of these tools are usable yet. Most difficulties in handling innovative projects come from trying normal tools over innovations whose very nature is to drift in definitions; hence the enormous waste generated and the ill feelings triggered against wasteful innovation by those who claim that innovators and evaluators "should have known better".

6- Once PROTEE will have completed the documentation of the file, it will be perfectly possible to use normal tools: calculations will have become possible; matrices will be set; critical paths defined and optimum envisaged. What is totally impossible is to start with those tools before the world of the innovation has been explored.

Proposition 5: At time zero, when the learning pact begins, the innovator should be able to describe the world in his or her own terms, and there is nothing yet that make the evaluator able to do his or her own job, except listening.

1- The expression world[3] is central to PROTEE, since it means that no innovation is about an object, a process, a technique, a machine, a device taken in isolation but always also about a context which may imply the requalification of a very large an heterogeneous array of entities – e.g. people, things, but also, affects, legal dimensions, social customs, time and space, hierarchies.

2- The PROTEE evaluator, even he or she has acquired already a large database of rules of thumb about failed and successful innovation, is not, and should not try to be, in an expert position and to point out to the innovator how implausible his or her world is. It is absolutely crucial that the first encounter opens the possibility for the innovator to describe the world in the most open fashion possible.

3- The basis for the evaluator's judgement is not in the first description but only in the next description, since he or she passes judgement only on the delta of the learning process. To use a Darwinian theory metaphor, at time zero all innovations are recognised as "hopeful monsters" that is they are by necessity "monsters" since they do not resemble inhabitants of the present state of affairs, but they are "hopeful" in the sense that they should be judged by their far away descendant, which would have been transformed beyond recognition.

4: PROTEE aims at avoiding two usually made mistakes: kill the hopeful monsters because they are monsters - which means weeding out all innovative projects because they are innovative - and keeping indefinitely alive projects because they are hopeful - what the Americans call "a white elephant".

Without a PROTEE methodology, it is impossible to learn how to prolong innovative projects because they are hopeful, in spite of the fact that they are monsters, or to kill projects that are monstrous, in spite of the fact they are hopeful. What has been called "inapplicable applied research", RANA in French, is the epidemic pathology of research innovation; the diagnosis is easy to make in terms of PROTEE, applied research is treated in ballistic terms and research is treated as what should be freed from any scrutiny under the pretext that it is "basic". Exactly the opposite: the more basic a research is the more strategically it should be treated; the more applied a project is, the more it should be treated as a research process. Here again, PROTEE simply draws the organizational conclusion of the mass of work done in science and technology studies (among others Callon & al, 1991, Callon 1994, Callon, Laredo et Mustar, 1995).

[3] Two traditions are here fused together, one in semiotics (Akrich et Latour, 1992), the other in philosophy of what could be called constructionism (Goodman, 1992).

Proposition 6: After having heard the innovator, the evaluator prescribes a redescription of the project to make sure that he or she can qualify the learning trajectory at the next encounter, by entering the minutes of the meeting in the protocol book and by coding the differences according to a set of procedural indicators.

1- The word protocol book is coming from the laboratory bench and is used to designate what trials have been set up by the experimenter in order to learn more at the next round of experiment; it is thus an excellent term to name the document that is the result of the learning pact between innovators and evaluators.

2- The key item in the protocol book corresponding to a given project is the minutes of the interaction between innovators and evaluators after each encounter. It is the aim of PROTEE to provide principled guidelines to the writing of those minutes.

3- Of the innovator first proposal, the evaluator can say nothing except that it is a script or a story about hopeful monsters; the work of evaluation may begin only once the innovator redescribe his or her project according to a prescription made by the evaluator.

Comment: The word story is in no way pejorative; it is a synonym of script and has the added meaning that it defines a whole possible world that is implicit in every project. This point has been rehearsed in many forms, see for instance Basalla G. (1988), Bijker W. (1995, Latour B. et Lemonnier P. (1994), Lemonnier P. (1993), or MacKenzie D. (1996). Most innovators at first will present a completely convincing story which will take the form of the "eight marvel of the world" literary genre, that is the project has no defect, it is profitable, modern, acceptable, revolutionary, rational and will be the outcome of a smooth development that only complete idiots could oppose, etc, etc. which is of course totally implausible since a revolutionary project will naturally be opposed and thus cannot possibly have a smooth development. PROTEE aims at weeding out of administration and firms what American called "technical hype", which should become, after evaluators have been used to PROTEE, as abhorrent to everyone that a breach of due process in matter of civil rights.

4- This prescription is not made according to a prescient knowledge the evaluator has of what is plausible or not, but on the knowledge he or she has of the PROTEE evaluating process itself.

Comment: Even though it is perfectly possible that the evaluator shares some technical knowledge with the innovator, but this sharing, so frequent for instance in the French system of "corps", is a liability for PROTEE since it might interfere with due process and triggers collective delusion between evaluators and innovators who begin to connive over solution whose learning trajectory can no longer be tested. This is a frequent source of pathology in the cases we studied. PROTEE requires a much more involved evaluator than is usually the case - since he or she cannot delegate to experts the adjudication of claims - but a much more detached evaluator since he or she does not share the complete immersion of the innovator in his or her technical project and sticks strictly to the quality of the learning procedure.

5- The evaluation will begin by comparing two descriptions of the same project and qualifying the difference between the two; in the margins of the protocol book, the evaluator will enter grades or codes made according to PROTEE methodology that will allow him or her to articulate a motivated judgement about the quality of the learning trajectory.

6- Thus the file composing the protocol book will be made of the minutes to which would be added the grades provided by each of the indicators.

Comment: It is considered very bad in PROTEE methodology to give always the same description for a project. It means the work of evaluating its learning curve has not even started, although according to the traditional style of presentation, repeating over and over again the same presentation will be taken as a quality and a proof of the robustness of the project.

Proposition 7: The result of the evaluator's prescription will be to elicit from the innovator, at the next encounter, a more risky description, by opposition to the smooth description usually requested. It is this risk that will allow the evaluator to pass judgement on the quality of the innovator, and to help evaluating the evaluator in the eyes of his or her colleagues or superiors: has he or she been able to elicit risky description.

1- To elicit a risky description of a project from the innovator is the key innovation of PROTEE and what puts it most at odd with normal procedures; normally, the administrators want to make sure that the project they fund has the smoothest description possible, that it is treated as a necessity that cannot possibly encounter any difficulty on its way from non-existence to existence. It takes only a second to realise that this smooth description can only occur for something that is not an innovation, that is, something that rely on the existence of an already present context of shared experience; apart from the rare cases of pure routine - and this is precisely not what is handled by a method to evaluate innovations -, a smooth description is a tantamount to an outright lie, or to put it more politely, to a contradictio in terminis. We can make it a matter of principle that it is impossible for a description to be at once about an innovation and smooth.

Comment: This is the quickest way to summarize 25 years of technology studies over the relation between technical innovations and context. Smoothness - that is rational accounts over efficiency, profitability and accuracy - are the results of a successful innovation and not the causes of its success. It is in the nature of hopeful monsters to succeed only later once the complete ecology in which their defects will have become quality has been built. Hence the utter impossibility of judging innovation by their profitability, rationality, efficiency, etc. at the initial stages. The only way is to slowly ponder through experiment their future delicate ecology by trying out many successive and alternative outlines. Probably the best source is in MacKenzie D. (1990) and in the work of Petroski H. (1994, 1995 & 1996).

2- PROTEE will wipe out, at the second encounter, all projects that have the following characters: inevitability, unanimity. All of those will get a bad grade since they do not offer a risky redescription of themselves but try to pretend that a project can innovate and live smoothly, thus denying the very nature of hopeful monsters which characterises research project: they may be hopeful, but they are monsters.

3- Evaluators can themselves be evaluated by others in order to check their performance in navigating the project (remember that a "good" performance does not mean that the project has been "realised" but that the learning process has been optimal).

4- The evaluator is not evaluated on his or her ability to know in advance what the innovator is and what the project is worth, but only on his or her ability to elicit more risky descriptions than what would have been the case without evaluation; in other words PROTEE is fully reflexive.

5- The difference between the beginning and the end of the process will have become visible once one compares the first part and the last part of the files. The project becomes more and more articulated and it becomes easier and easier to evaluate it; that is, it has now more and more handles to render it disputable, it is less and less a black box that should be taken as a whole. This feature will be enough to eliminate as badly managed most of the project studied since the evaluators are either never evaluated or evaluated on questions wholly irrelevant to the success of the project - success according to PROTEE -, that is on question of funding, deadlines, etc …

Proposition 8: The evaluator, when asking for a risky redescription of a given project, will make sure that four grave pathologies be avoided, so as to maximise the chance of navigating the project through its learning trajectory. Against each pathology, an explicit indicator will be devised so as to make sure the project does not succumb to that disease.

1- These four pathologies are not dependant on the rules of prudence accumulated over the fate of innovative projects in the domain of transportation. It took the consortium a very long time to agree over them because they are only the most common pathologies of the learning process itself: each of them makes impossible to learn from the project and thus to evaluate it.

2- To avoid them does not mean that the project will end being successful in the classical term, that is going from non existence to existence, but that the learning trajectory will be optimal, that is innovators and evaluators will converge on a shared definition to decide over its continuation or end - which again does not mean that they will agree.

3- The four classes of indicators of trajectory have been defined so as to anticipate the four types of most frequent pathologies encountered in the literature and in the case studies done under ERANIT, STEMM and PROTEE. There might be more, they could have been grouped differently, but so far we have found that these classes were relatively independent of each other and that each allowed us to capture the quality of the trajectory according to one crucial aspect.

4- The word pathology and disease might seem exaggerated but given the present state of evaluation in the domain of transportation it might be a fair rendering of the situation; also, it is in keeping with the Darwinian metaphor of hopeful monsters: these are the most frequent difficulty one encounter to pick hopeful monsters out of hopeless ones!

2.2- COMMENTS ON THE INDICATORS

2.2.1- The first class of indicators used by a PROTEE equipped evaluator will compare a description to the n+1 description to make sure that the innovator is conscious that he or she produces an outline of a world and that this outline will be followed by many outlines before existence. Existence will be dependent on many different relays, which should be identified, it is from the presence or absence of those relays that a script will be judged realisable or unrealisable.

1- By reusing the word realisable we run into the risk of being confused with the common sense meaning that a script is workable, easy to make. We wish to stick to the word because, once PROTEE becomes common-sense enough, it will be clear to all that a project that has not identified its relays in order to come into existence is completely unrealistic, whereas a project which is very innovative, but which explores its relays well, is much more realisable than many routine alternatives even though it looks more daring.

2- Remember that the interaction between evaluator and innovator is not based on knowledge but on experiment; it is not an exam but a learning pact; thus the interaction could be simulated by the following dialog:

"We know that it is impossible to fully describe the world in which the innovation you just presented will survive; you are fully aware that I, as an innovator, am in no position to decide now if your innovation is feasible or not; we both know that no one else know and that there is no expert group that could adjudicate your claim without due process; what I want to make sure though, before we meet next time, is that you are aware that you are describing the outline of a world and that you are not imagining a project that would come into existence simply because it is rational".

3- What this first class of indicators wishes to weed out fast, are the innovation that envisions their passage from non-existence to full blown reality "ballistically", that is, as if some indisputable element, no dependent on context building, could bombard society and come into existence without deformation nor transformation. What is eliminated in effect are all the projects that pretend to be "just technical" projects.

4- PROTEE wants to make sure that the innovator produces, instead, outlines of heterogeneous worlds, in which one encounters outlines of a future economic accounting, future lead users, future users, future state of technology, future regulations, etc. Naturally, none of these elements is more than an outline (an "ébauche"), but there are already many different, contradictory and varied ones; it is the only way for a project to become a hopeful monster, that is to anticipate the niches in which its mutations would turn from defects into qualities.

5- The evaluator tries to ascertain whether or not the innovator is aware that a project never goes from plan to reality but only goes from one hopeful monster to a next generation of hopeful monsters through a delicate operation, that requires to establish relays which will

never be fully predictable; those relays - humans or non-humans -, will have to be mapped more and more precisely at each interaction between the innovator and the evaluator.

If the innovator populates his or her script with relays - enthusiastic users, generous bankers, timid competitors, faithful supporters, working piece of technology, reliable software - that are going to pave a smooth way from plans to reality, this becomes a highly suspicious description for a PROTEE evaluator; so will it be if an innovator outline only one element of the world as if an innovation was only a technical piece of hardware without any context; so will it be if the innovator describes in too much detail economic calculations - impossible to render precise at this stage - while user's reaction are only sketched.

2.2.2- The evaluator, after asking the innovator to outline again the project, will compare the innovator's new description and grade its changes according to the first class of indicators

- **richness: is the description richer than before?**
- **heterogeneity: is the description more heterogeneous than before?**
- **are the levels of uncertainty distributed in a more contrasted way than before?**
- **variability: does the description allow for more alternative paths than before?**

1- Remember that we are not trying to evaluate the project - which is impossible as yet - but only the differences between two successive descriptions of the project in order to ascertain that it is not thinking of itself "ballistically", so as to avoid the most frequent cause of pathology in project management, that is what could be called the "mad technician" or "mad scientist" disease: if it is efficient, profitable, rational, modern, it will win over all competitions.

2- The prescription by the innovator after the n-1 interaction could be phrased in the following way: *"You insist that your innovation is highly innovative, so we are going to place ourselves in a future situation where the innovation is fully established and we are going to do a thought experiment, working backward from the time in the future to now; could you outline the relays necessary for transforming the present plan into the future full blown reality? What sort of world is necessary to navigate the project from position A to position B"?*

3- Each story or script will be made of the following components:
- entities undergoing an action of transformation
- obstacles that may be encountered
- borders, that is, other preoccupations that are known to exist but are left outside for now
- boundary objects, that is, elements that require the collaboration of others.

If for instance I, as an innovator, say that I propose to invent an automatic subway made up of independent vehicles that works like cars able to recognise one another, the evaluator should make sure that I can outline not only the principle of the guided cars, but also the negative reactions of cars and subways specialists, the domains and disciplines that I will not feed on, and, by opposition, the specialists of software, automation, radar recognition whose expertise is crucial for the task to be carried out.

We recognize in these elements of an outline the predecessors or antecedents of what will become later in a project respectively the specifications, the obligatory passage points, the limits and the division of labour of the project. For now, we only deal with outlines, that is, we don't know yet what are the specifications, we don't know yet what is going to affect the critical path, we don't know yet what sort of domain can be safely ignored, and we don't know yet how the division of labour and the negotiation around the boundary objects is going to turn, we can only make hypothesis on each of those features of the story (Vissac-Charles, 1995).

4- The evaluator is now in position to "taste" the n+1 description by contrasting it with the first and to ask the following questions - which a later phase of PROTEE will fully operationalise:

a: Is it a poorer or a richer description? If it is made of ten, or hundreds of entities it is not the same; if each entity is endowed with specific properties, reaction, track record, documentation, it is not the same than a landscape where each entity is simply sketched and has no depth; the grading here is somewhat similar to literary criticism.[4]

b: Is the description more homogeneous or more heterogeneous? This is somewhat easier to test, since a description that will carry the same type of entities than the first one, will be said to lack in diversity; only one type of elements arise outlined - technical, or economical but not the others.

Comment: The metaphor of ecology can be of some help here: given that a project implies the implantation of a whole world, the more diverse ecosystem one outlines the better the description. But this is not to be confused with matrices made up of many lines and columns; the innovator is allowed to build one's own categories, so we are not here asking the innovator to always make sure that he or she has filled in all the possible elements - environment, technical, social etc.- , but only that the description he or she has chosen is more heterogeneous at the n+1 encounter. PROTEE does not rely on lists but on differences in establishing list of actors.

c: Since PROTEE aims at fighting the danger of excessive rationalisation, it is especially important to grade the description for the way it builds necessity or contingence. A necessary story is a tale of inevitability where things spring to existence simply because they are better, more efficient, more rational. Contingency, on the other hand, means that the innovator is aware that things could go wrong, allies could betray, supporters could change their minds, alloys could break down, computers could crash, markets could modify the exchange value of currencies and so on.

d: The following grade seems very similar but is not. What is evaluated here is the distribution, throughout the features of an outline, of level of uncertainties. This means that the evaluator checks that the innovator is aware that portions of the outline are so different in their type of uncertainty that they should be treated completely differently. The final element to test the quality of the learning trajectory consists in comparing the embranchments leading from the present state A to the final full blown existence B (remember that it is a thought

[4] There exist many "quali-quantitative" tools to analyze full texts. It is not impossible that, at later stages, those tools be made accessible to the evaluator, thus imagining an electronic protocol book. For now, the grading can be made by qualitative means only

experiment, the innovator describing through what sort of tribulations it is moving from one point to the other).

What is tested here is the ability of the innovator to imagine alternative paths; it is not only the difference between necessity and contingency which is tested, but the proliferation of alternatives - which will form a crucial element again of class III; many embranchments means that the innovator begins with a large margin of negotiability which will be important in class II and that the innovation is not going to be a “take it or leave it” affair (Callon, 1992a and 1992b, and Foray et Freeman, 1992).

5- Research has shown that here are elements which can be treated as having only a probabilistic type of uncertainty - that is we don’t know what the outcome will be, but we know what the states of affairs are and a probability can be attributed to each of them (Grade III). There are elements, which have to be treated as more uncertain, that is, although the list of states of affair can be drawn, no probability can be attributed to each of the possible outcome (Grade II). Finally there are elements which are proteiform, that is not only is it impossible to attribute probability to them, but it is also impossible to set up the list of state of affairs.

It has been shown, especially by Véronique Vissac’s work, that probabilistic research management tools are useless for Grade I uncertainty since there is not yet any basis for calculation since the discrete elements which are part of the list of state of the world cannot be set up. The most frequent pathology of research projects is thus to treat a Grade I aspect as if it was a Grade III, for instance to consider with what sort of soap Aramis cabins are going to be washed when the very principle of immaterial links is not stabilized. The method of critical path is not usable at this point, since no one knows yet what will or will not be on the critical path. Hence, the importance of drawing outlines of each of the future elements.

We expect innovators to be able to distribute these three levels of uncertainties throughout their innovation so that they make sure to treat the Grade I components in the same way as the Grade III components, which can be surprising but not that much.

6- A good grade for all of those variables, would mean that, in the eyes of the evaluator, the innovator has listened to his or her prescription and made sure that the project is not going to be navigated “ballistically”, that the relays have been identified, their different grades of uncertainties recognised and that alternative paths are possible. This does not mean that the project is realisable in the classical sense of the word, but only that it is learning about which state of the world will make it realisable or unrealistic. It is realisable in the PROTEE sense of the expression.

2.2.3- The evaluator wants now to make sure that the project which has identified outlines, relays and uncertainties, can now pass from one outline to the next. For this, it is necessary to make sure that the n+1 description makes room for a complex negotiation between allies and opponents, programs and anti-programs and that this negotiation will retroact on the very definition of the project at hand (class 2).

1- The second cause of pathology most frequently encountered in the management of innovative project, has to do with the inability of the innovator to absorb opposition to the project other than by saying that opponents are irrational. The good reasons that opponents - humans or non-humans - could have not to cooperate, are thus ignored and the project remains as it is, without learning anything new from its environment. This inability to learn is a sure recipe for disaster and is one of the features that the evaluator must weed out, if he or she wishes to qualify the learning trajectory.

2- The evaluator thus ask the innovator a question that can be simulated in this way: *"Now that we both know that your project is not going to come to existence through a ballistic trajectory, but has to be relayed by elements which will transform it beyond recognition, we want to make sure that you are aware that you are going to have to pay each of the relay's faithfulness by some sort of negotiation that may even touch the core of your project. Could you reconstruct for us the map of allies and opponents? What sort of good reason can you imagine for the antiprograms to be in place? What sort of bargaining chips are you ready to give up in order for the project to be accepted? How far are you going to go in the redefinition of the project to win over the opposition?"*

3- If the first class of indicators can be described as "anti-ballistic" - that is, making sure that the project is not simply launched by an initial kick off and then goes smoothly from plans to reality - this second class could be described as anti-paranoia. It makes sure that the innovator is not surrounded by hostile irrational enemies whose good reasons remain uninterrogated.

4- Research has shown that to fight paranoia in project management, it is best to imagine that every association - that is every recruitment of an antiprogram into a program - should be paid by some amount of substitution that is, some transformation of the project. As we said above, what is impossible is to claim to deal with an innovation and to define it as something that goes into existence without encountering opposition and without paying by many deformations the passing into existence; this is what we call here negotiability.

Comment: It is convenient to imagine a space made of two dimensions: AND for association and OR for substitution. A project is defined as being real once its association increases, that is it goes further in the AND dimension. If it is innovative, however, it is utterly impossible to gain in the AND dimension without paying some price in transforming the initial list of elements forming the project, thus moving along the OR dimension. Each project, for this second class of indicators, can thus be defined as a movement through this two dimensional space. An easygoing project pays a lot of AND with a few OR, a circuitous project pays in a lot of transformation the acquisition of associates, humans and non-humans. For PROTEE a bad project is neither the first type nor the second, but the one who is unable to formulate its

evolution in terms of AND and OR, that is who is unable to formulate its own trajectory as a bargaining space (Latour, Mauguin et Teil, 1991 and 1992).

2.2.4- To make sure that the project has a good negotiability, that it will learn from experience, the evaluator will grade the redescription according to the following variables from negative to positive:

- **Has the redescription the same small number or the same large number of expected antiprograms, at version n+1 than at version n?**
- **Is the project incoherent from the point of view of those antiprograms or are there more good coherent reasons to oppose it at version n+1 than at version n?**
- **Is the project impossible to negotiate without any difference between core and periphery, or is it more highly negotiable and differentiated in adjustments, variables and alternatives, at version n+1 than at version n?**
- **Is the project impossible to describe in terms of association and substitution or does it become easier to describe at version n+1 than at version n?**

1- The first thing to test once the innovator has redescribed his or her project, is the absence or presence of antiprograms, that is, of entities which can be human or non-humans whose behaviour may jeopardise the project or be indifferent to its destiny.

In a smooth description, by definition, there is no opposition whatsoever so that the evaluator has the feeling that the world of the project has no outside, no context, that it is wholly described by the inner components of the project itself; a risky description, by definition, should spend as much time on the outside as on the inside.

This is similar to the variable “rich or poor description” in class I, except that, here, we are not only checking for the presence or absence of entities, but for their ability to put the project at risk and render it critical; a project which cannot describe its anti-programs is as good as dead.

2- An innovator may be aware that there is an environment to his or her project, but immediately fall into a paranoid definition of this environment made of idiots, of irrational, of unfair opponents, of envious competitors, of archaic workers, of unstable users, etc.; it is crucial that the evaluator test the ability of the innovator to recreate the logic of his or her opposition; if not, the innovator will be unable to learn and will simply try to force his or her innovation on an hostile environment without learning nor modifying anything.

To force one way through opposition might not be a bad strategy. PROTEE does not reject those force solution, but only the ignorance by the innovator that it is a strategy, and a very costly one. PROTEE wants to make sure that the innovator does not engage oneself in the following pragmatic contradiction: forcing the consent of those whose willingness will be necessary at the next stage, for instance imposing another subway line without asking anyone – “passage en force” as the French say – but then asking consumers to voluntarily come to the new line. This contradiction, although obvious, is endemic in most of the cases we study. Most innovations die from an ill-analysed network of opponents and for misplaced use of force. What we are here checking is the minimum of machiavelism necessary for an engineer or a scientist to survive (Latour 1988).

What is tested here is thus the ability of the innovator to shift point of view and to describe his or her own project from the point of view of outside opponents and in a coherent way, instead of providing a caricature of the reasons why anyone would be against it; this is in effect an application of the military principle not to underestimate one's adversary.[5]

3- It is not enough to populate the world with antiprograms, nor to redescribe the project according to a coherent but opposite view, it is also necessary for the evaluator to make sure that the innovator knows what to do with this opposition, that is, how he or she is going to negotiate the project by making opposition retroact on its original definition.

4- What is tested here is the ability of innovator to distribute the project in various types of negotiability; four are obvious: adjustments, variants, alternatives, and total transformation. It has been shown many times that innovators do not know what is important and secondary in their own project, what sort of minor adjustments would be enough to win over large opposition, or, on the contrary, are not able to overhaul the definition of their project because they have narrowed down too fast the range of alternative definition.

5- The aim of such a variable is not to make every project constantly change every time a new antiprogram is made salient, but, on the contrary, to make sure that hopeful monsters have been tried out in all the niches where their monstrosities may become adaptive advantages; for this, a very flexible and open negotiable space is necessary; this is what the evaluator should test for.

6- Finally, the innovator should demonstrate his or her ability not to lose allies when opponent's specifications are taken into account; if it were the case, then any new obstacle will blow away the project which would have no way to maintain its own inner core and will end up being entirely driven by antiprograms. What is tested here by the evaluator is the logic of the bargaining in which the innovator enters; the innovator should be able to articulate sentence of the following form: *"if I wish to take into account this antiprogram, which programs should I have to abandon? But if I abandon this, is the project still worth maintaining?"*. This highly diplomatic skill is what is most often missing from innovators that tend to think in ballistic and paranoid terms but also maintain a strict difference between social and technical factors and thus are left with no margins of manœuvre.

7- If a redescription gets good grade according to each of those variables, the evaluator will be satisfied that whatever happens the innovator has learned from its project and thus it is not in

[5] It is much easier in military matters to do this, since the two positions of adversaries and allies are easily substitutable (as is visible in war games where the "blues" can instantly take the place of the "reds") ; but in innovation, this is much harder, since there is no front line, no clear opposition, and the very problem of what are the stakes are in question ; this is why although it sound common sense, this antiparanoia weapon is so useful to weed out bad projects. Let us remember that the underestimation of adversary, in innovation, can also be true of non-humans : an obsolete technology may resist better than expected, etc. On all this, see Aramis, op.cit.

vain that money has been spent on this project: a much better description of the world is now available to both innovators and evaluators

2.2.5- Since neither the innovator nor the evaluator are in a situation of full knowledge, they cannot decide whether one description at time n, is better than a description at time n+1 without a trial which is part of the experimental protocol decided in common at the n-1 encounter. It is crucial, however, that the evaluator be convinced that the trial is representative, otherwise the innovator' script becomes an empty story, a fiction (class 3).

1- Remember than to test a story, that is a script or an account, neither the evaluator nor the innovator are able to compare the copy to the original that consists in reality pure and simple; if they are dealing with an innovation, there is nothing to compare it with except a future state of affair which is, as of now, purely virtual, and it is the common business of the two to test whether or not this ecology can become real or not; so nobody can make the distinction between a realistic plan and a fiction, simply by inspecting the project ; it has to be tested progressively.

So to distinguish a story that is the outline of a future state of affair from a fiction that will always remain an utopia there is no other way than to experiment, that is to imagine a trail of trials that will confirm or falsify each of the hypothesis of the scenarios; this is why innovators and evaluators have contracted a learning pact, and this is why they hold in common a protocol book.

2- The major difficulty, however, is to make sure that those experiments - pilot study, questionnaire, panel of consumers, expert opinion, audits, field tests, etc. - are representative of the difficulties the project is going to undergo; it is thus dependant on the quality of the answers provided by class II, negotiability.

Comment: It should be clear that although PROTEE tries not to delegate to experts the task of evaluation, it is not against expertise, which will be absurd. Expert opinions are simply one type of trials among many, and should not be taken as the ultima ratio of evaluation behind which the evaluators could safely hide to avoid the hard task of conducting the learning pact to its end. Remember that the evaluator may be an expert, but if he or she is a PROTEE equipped evaluator it has to shed his or her expertise to shift to an experimental mode. We leave aside of course the case when the expert is expert in evaluation.

3- Many things can go wrong in a trial that make it entirely unreliable to test the difference between a story and a fiction: the expert group may pertain to the same lobby which implies that the resulting consensus proves nothing about future difficulty; the pilot may be so unrealistic that nothing can be drawn from it, etc.

Comment: Considerable amount of work has been devoted in science studies to the difficulties of demonstrations, to the implausibility to complete replication, and to the extreme unreliability of experimentum crucis. So PROTEE cannot rely to make sure that the two other

classes of indicators are filled in, on a naive definition of a trial that would reintroduce through the back door the notion of expert expulsed through the front door (Collins, 1985, MacKenzie, 1990). This is why a third type of indicators has to be devised about the quality of the trials themselves. This is especially true of the economic calculations which too often try to parade as the principle of reality that is going to determine choices of projects. Economic calculation is another type of trial whose representativity has itself to be put to the test according to the class three indicators. No bottom line will simplify the evaluator's job.

4- This is the third type of pathology most often encountered in innovation research, that is the premature closing down of variants and alternatives through a process of manipulation of expertise which render all subsequent trials worthless because their information value - to use economics of information terminology - is purely redundant. Although less frequent, the opposite pathology is also to be guarded against, namely the constant delay in scaling up the trials and thus in having no new occasion to learn at a more realistic scale what sort of world the innovation will live in. In both cases the result is the same: lack of learning trajectory. One is left with hypothesis about states of the world that cannot be falsified, and thus one is left in the dark without the pale light of experiment.

5- If the first class was anti-ballistic, the second anti-paranoia, this third one can be said to fight manipulation, that is the tendency of the innovators and their patrons to avoid all circumstances where their accounts could be reliably falsified. Hence the name we chose for this class, falsifiability which is here to remember that PROTEE tries to apply to research management insights and procedures coming from the experimental sciences.

Comment: We are not here trying to use the Popperian falsifiability which has been shown to be largely unworkable; on the contrary, hopeful monsters, in many cases should be protected against all sort of disproofs, since they are monsters and have against them all of the existing state of affairs. We have here in mind Lakatos' very useful and very PROTEsian definition of "degenerative" versus "productive" research programs (Lakatos, 1994).

6- We should remember that the evaluator is not in a position to judge the trial itself, that would put him or her in a position of expert imposing an examination on the innovator or making them decide the fate of an innovation over an experimenta crucis which could be completely irrelevant to the project; so the innovator should be able to define by him or herself which trial are significant; what the evaluator is asked to judge is whether or not the proposed trail of trials gain in representativity, certainty and falsifiability ; again, we rely on the delta of a trajectory not on substance.

2.2.6- To make sure that the trail of trials set up by the experimental protocol is representative of the real world that the innovation will confront, the evaluator will use the following variables to qualify those trials —from negative to positive- and use them to compare the description n with the following description n+1:

a) arbitrariness: are the trials devised to test various aspects of the project more fully specified than before?

b) openness: are the experts and methods mobilised to evaluate the project more varied and more independent than before?
c) proof of proof: is the protocol of trials justified by the gain in information it offers compared with the outcome of the previous round of trials?
d) criticality: are the trials able to test out more heterogeneous aspects of the project than before?

1- Most of the pathologies of innovations come because experts pass judgements on the feasibility or unfeasibility of projects whereas there exist no way to check the quality of the reason why those experts converge on one solution; in other words, most decision are taken by lobbies for which there is no official means of detection; [6] this lobby may not be technical only, but it can be political, economical, and can also concern militant, unions, consumer' organisations, etc.

2- Against this danger that would vitiate the whole procedure, since the judgement to stop the project or to proceed with it would be arbitrary, it is essential that an indicator be devised which judge the diversity of the judges; if they are all for instance coming from the same schools, the same nation, the same interest group, and zoom very fast on the same solution, it is probably a bad sign.

One way to build it up is to encourage controversies by drawing on more heterogeneous set of judges, and to learn more about the track record of those who are said to have decided over earlier projects. The legal sphere, on that respect, is much more advanced than the technical sphere in handling expertise through due process, since juris consultes have imagined many procedure to fit expertise into the contradictory principles of the law. In technology, contradiction, due process, and doubt about experts is still new, and to our knowledge, PROTEE is the first method to explicitly feed on scientific controversy in order to make sure that a project is well managed (Hermitte, 1996).

This again is in complete contrast with usual procedures which are happy to conclude when a consensus is formed fast; a fast consensus, for a PROTEE equipped evaluator is a source of deep suspicion!

3- One of the most frequent diseases encountered in our inquiries is that experts are unable to motivate at length the reason of their rejection or acceptation of one given project. The arbitrary rejection (or acceptation) is mostly silent or rationalised a posteriori by using elements like costs, quality of paperwork, size or other irrelevant details. This is not surprising since not only experts do not know, the fact of sitting in panels or committees do not make them able to learn either; so they can go from one project to the next without ever learning to check or "taste" projects.

[6] The legal sphere, on that respect, is much more advanced than the technical sphere in handling expertise through dur process, since juris consultes have imagined many procedure to fit expertise into the contradictory principles of the law. In technology, conctradiction, due process, and doubt about experts is still new, and to our knowledge, PROTEE is the first method to explicitely feed on scientific controversy in order to make sure that a project is well managed. Hermitte M.-A. (1996), Le sang et le droit. Essai sur la transfusion sanguine., Paris, Le Seuil

4- We thus need to make sure that every decision of acceptation or rejection of a trial be fully motivated and that this motivation be fully articulated in a way that may be understood by the innovators and the evaluators alike. The relative publicity of explicit motivation, will make the PROTEE methodology traceable and will thus help curing the "disease of silence"[7] that is so frequent in failed (but also in successful) research project.

5- The greatest difficulty in tracing the trail of trials that will allow an innovator to gain some certainty on his or her project, is in allocating the closure and opening of alternatives and variants. If alternatives are closed too early, there will be no way to learn new solution into a highly variable environments. If closure is indefinitely delayed, fuller scale tests will not be developed and no learning will occur either, since the project will remain as realistic as a toy.

To this problem there is no easy solution and the evaluator is not in position to offer one full proof method. The only thing he or she is able to make sure is that the argument developed by the innovator to explain closure and reopening are formulated in terms of the information value that is expected.

6- In most cases that we studied this indicator should be enough to weed out premature closure and delayed closure since most decisions to stick to one solution are not seen as decisions, but simply as routine drift or unexpected consequences of arbitrary "undecisions". Here again due process comes from being able to motivate, in technological questions, the exploration curve in terms that are understandable by innovators and evaluators alike.

7- It is not enough to have a heterogeneous set of judges who do not form a lobby. It is not enough to be able to document explicitly the decision those judges take in order to avoid arbitrariness. It is not enough to ask the innovators to place their closing down and opening up of alternatives according to how much they are going to learn about their project, those trials have to be relevant that is critical.

8- Criticity is a very important feature of PROTEE and is at the heart of what we mean by risky description (by opposition to smooth description). By criticity we do not mean simply that a project should be criticised —in a normal state of affairs they all are— but that the criticism be relevant, that is come to jeopardise in advance key features of the project so as to anticipate the future critical paths.

One should remember that in the earlier period for which PROTEE is developed there is not yet critical path traceable because there is no path yet and thus no identified obstacle! It is not a reason to think strategically. Quite the contrary. But thinking strategically at this juncture means that one should be able to anticipate the outline of what will become later a critical moment. There is no other way to proceed than by making sure that the redescription is done

[7] Everyone who has studied a research project knows that at every corner someone says that "those things cannot be said", "we knew but we were not allowed to say so", "if it were said the whole thing will blow apart" and so on. The idea that an innovation could become real with so much repression going on is naive, because it means that all the occasions to learn about the project have been lost. This is why it is so important to render the project tracable and documentable and to distinguish calculability from descriptibility.

by testing the very core of the innovation according to as many different point of views possible. This is to avoid the common way to do an audit of the project and that consist in separating out the technical, legal, financial, marketing, etc. elements one by one. Although this is legitimate at the end, once the project is manageable as a procurement procedure, it is utterly ill adapted in a research project at the earlier stages. One should ask on the contrary how the legal aspects could become obstacles on the future path of the technique; how the financing could become obstacle on the future path of the marketing, and so on. This is a way, the essential argument of PROTEE.

9- Once those four indicators have been completed and made favourable, the evaluator still does not know whether or not the script offered by the innovator is a fiction or not, but they both know that the trials decided in common for the next stage will be representative enough to make a decision on whether or not the project should be continued. The fallibility of the project is good, that is the project knows exactly what will put it to death. Any temptation to come back to a smooth description is thus guarded against.[8]

Comment: One can wonder why an innovator would be mad enough to begin with a PROTEE type risky description whereas all his or her competitors are still relying on smooth descriptions which purport to provide a ballistic, paranoid, technicist, scientistic and narrow minded view of their project. The answer is that the innovator by nature will start with a smooth description. It is only by encountering in the learning pact a PROTEE equipped evaluator that things might begin to change. Again we are not talking about a situation of examinations like those at schools here since the evaluator does not know either. The more the PROTEE type of evaluation practices spread the easier it is for good projects to emerge since they share a common world —in that case a common definition of the pathologies of technology— with a wider community. The tragedy of the present situation, is that administrators, politicians and innovators share a view of technology which is often completely obsolete and that makes difficult their evaluation and their learning from experience.

2.2.7- After having asked the innovator to redescribe the project and graded the quality of this redescription according to the three classes of indicators, the evaluator is now in a position to summarise the assessment of the learning trajectory and to recommend an nth+1 iteration of the process or its suspension.

1- Remember that the evaluator is not in a position to know but only to specify the learning trajectory. This is not to say that he or she is limited to a purely formalist process of

[8] One can wonder why an innovator would be mad enough to begin with a PROTEE type risky description whereas all his or her competitors are still relying on smooth descriptions which purport to provide a ballistic, paranoid, technicist, scientistic and narrow minded view of their project. The answer is that the innovator by nature will start with a smooth description. It is only by encountering in the learning pact a PROTEE equipped evaluator that things might begin to change. Again we are not talking about a situation of examinations like those at schools here since the evaluator does not know either. The more the PROTEE type of evaluation practices spread the easier it is for good projects to emerge since they share a common world —in that case a common definition of the pathologies of technology— with a wider community. The tragedy of the present situation, is that administrators, politicians and innovators share a view of technology which is completely obsolete and that makes impossible their evaluation and their learning from experience.

bureaucratic procedure: on the contrary, evaluators should be able to pass judgement and if they are in a position of authority —over the money, or the time, or the resources of the innovator— their decisions might be crucial.

2- The decision, however, is not made over the technical feasibility of the innovation but on what could be called its learnability and it could be simulated by the following sentence: "*We have learned, through our interactions, that at the n+1 description of your project it could reliably compose its environment, that you were able to negotiate its composition with all the major opposition, and that the trials to reach those conclusions were reliable. We can now come to a common decision concerning the continuation of the collective experiment in which we are engaged. My conclusion is that it is an excellent project in terms of its learnability and thus should be stopped*".

This conclusion is surprising only if we use the normal procedure: "excellent" obviously means that it should be funded. Not so with PROTEE which tries to wipe out a fourth type of pathology. The drama of research management is that " bad" projects are maintained too long because no one has the courage to stop them, and "good" projects are cut too early because no one has the courage to maintain them over long periods and make risky decisions! So the aim of a good methodology is to cure two diseases at once by weeding out fast projects which are bad and maintaining over long period projects which are good.

Comment. As our experience shows the two diseases are actually one single spreading disequilibrium: an administrator who has funded too long a white elephant will make sure that the next one is cut off early. Bad luck, because this one was a hopeful monster whose quality required a very long term strategy to be visible. Thus administration and firms alternate between "basic" unstrategic research with ridiculous few strings attached and "short term applied" projects with equally ridiculous set of constraints. It is this imbalance that PROTEE aim at stabilizing (Callon, 1994).

3- This is why it is so important to redefine "bad" and "good" projects. For PROTEE, a bad project is one whose learnability is nil; it can be profitable, it can be hopeful, it can be fabulous, it can be the eight marvel of the world, but it is impossible for anyone around the project to learn about its context, its opponents, its redefinition, its renegotiability or about the relevance of the trials made for it and about the representativity of the experts requested to give their opinion; it is always redescribed in the same way the same smooth description being rehashed from one glossy magazine to another glossy pamphlet ; this type of project should be cut, no matter how "good" they could be according to all the other evaluation methods.

A good project for PROTEE is a project whose learnability is excellent, that is each description produces a new array of entities, whose good reason to oppose the project are coherently displayed, which feed back on the definition of the project which is highly negotiable and the trail of trials proposed is well laid out and properly documented.

4- Now here is the trick: such a type of project does not need necessarily to be continued; on the contrary from a project which has a good overall learnability one can say very quickly: *"Fine, we now know that there is no way to learn more about this project, there is no innovation that can swallow such a contradictory environment; we are not dealing with a hopeful monster, but with a hopeless monster; we stop it"*. But it is also possible, to use learnability to conclude that a project that is still learning regularly about its environment, etc.

should be continued, no matter how costly, no matter how far from practical application, no matter how innovative and risky is the path from the present outline to the next.

Comment. In all the cases we study, engineers or managers who failed are ashamed of this failure. This shame has no sense in PROTEE, it would be like a scientists doing an experiment and being ashamed that it failed. It is quite normal for an experiment to fail. What is not normal is for an experiment to fail and to provide no information on how to handle the next one. Technology and research management can be compared to a laboratory with no protocol book where scientists would try haphazardly experiments, will thrown in the waste basket failed experiment and start all over again another one without any learning curve... With PROTEE both the innovator and the evaluator may congratulate one another after saying: “it was a good project, we stopped it quickly.”

2.2.8- the evaluator will now come to a decision to continue or to discontinue the learning pact with the innovator; his or her decision will be based on the reading of the three former classes of indicators and the result will be compiled:

a) reactivity: are the innovators able to convince the evaluators that the project is more able to learn from its environment than at the previous evaluation stage?
b) reconciliation: is there, more than at the previous stage, at least one project that is able to reconcile all or most of its contradictory supports?
c) risky diagnosis: is it now possible, with a safer margin of error than before, to discontinue projects that have been going for no other reason than their prior existence (“white elephants”), and to pursue risky but highly innovative projects which are learning well?
d) limit conditions: is it now more possible than before to detect the degree of innovativeness of the project and to manage it accordingly?

1- The main innovation of PROTEE is to be independent from the notion of project. A project is the consequence of applying PROTEE methodology and not its starting point. So if there is no convergence, once the map of allies and opponents, judges and worlds is made, there is no reason why one should stick to a project at all. It might be possible to redistribute the cards and to speak of several projects, of no project or to imagine from the project the program in which it should have been integrated. This is the main difference we discovered, in the course of the research, between PROTEE and the normal project management methods.

2- The other innovation of PROTEE is in the indicator IV-3, that deals with risky descriptions this time on the part of the evaluator; this is the great advantage of descriptibility over calculability; it is now the evaluator, which at the end of one PROTEE equipped procedure, gives its own description of the project taking all the risks of failures which are usually taken by the innovator.

3- As in every instrument, it is important to know when it is useless to apply it. Once the states of the world have become describable in terms of probability, one can use the normal management tools. PROTEE could thus be restricted either to certain highly innovative projects or to certain parts of projects otherwise managed according to normal procedures.

III- THE LESSONS DERIVED FROM THE RETROSPECTIVE CASE STUDIES

PROTEE is designed as a real-time management tool for ongoing innovation projects. The historical nature of some of the projects used as case studies limited the extent to which they could be used to test and improve PROTEE indicators and procedures.

3.1- INTRODUCTION

This section is based on lessons from the four retrospective case studies undertaken in PROTEE: the ECT, the ETTC, and the KFHS and Commutor.

PROTEE aims to develop an instrument which can record the learning curve of innovation projects in intermodal freight transport. The method used in PROTEE to develop this instrument is a case study approach. PROTEE has undertaken four retrospective case studies on intermodal freight transport projects. These case studies are not conventional case studies in that their primary aim is to develop the PROTEE instrument rather than to investigate the transport projects per se.

It is in the nature of the methodology used in the PROTEE project that what is tested in later case studies is derived from lessons learned in earlier case studies. In other words, the lessons reported in later case studies are from the experience of testing the PROTEE instrument as developed through lessons derived from earlier case studies.

3.2- THE DEVELOPMENT OF PROTEE INDICATORS AND THE CASE STUDIES

3.2.1- THE RETROSPECTIVE CASE STUDIES

The four retrospective case studies in PROTEE are in two groups. The difference between the two groups is that the case studies in the first group do not have an industrial partner in the PROTEE Consortium, whilst those in the second do. The case studies without an industrial partner are those on Commutor and on the Europe Combined Terminals Delta/Sea-Land terminal (ECT). These case studies were undertaken by an academic or analyst partner alone.[9] The case studies with an industrial partner are on the Krupp Fast Handling System (KFHS) of which the industrial partner is Krupp Fordertechnik, and the European Transport and Trade Centre (ETTC) where the industrial partner is the Zentrum fur Innovative Verkehrslosungen. The partners responsible for each of the case studies is summarised in the Table below. It should be noted, however, that more partners than just those directly responsible played a part in developing all of the PROTEE case studies.

[9] With respect to the COMMUTOR case study, Technicatome functioned as an analyst partner rather than an industrial partner.

Table 1: Partners responsible for the PROTEE case studies		
Case Study	**Industrial partner**	**Academic/Analyst partner**
Commutor	(SNCF)	Technicatome
ECT	(ECT)	Maastricht University
KFHS	Krupp Fordertechnik	Brunel University
ETTC	ZIV	Maastricht University

6.2.2- THE ROLE OF INDUSTRIAL PARTNERS

The inclusion of industrial partners provided several benefits to the case studies. These include:

a) The industrial partners are experts on their own innovation projects and provide access to important source material for the case studies. They are therefore an efficient way of collecting data on an innovation project.

b) The collaboration of both academic/analyst partners and industrial partners on a case study provides the opportunity to model the key PROTEE relationship which is the relationship between the Evaluator and the Innovator. It seems to us that a close cooperation with an industrial partner (as in KFHS) comes closest to the situation of the 'learning pact' between innovator and evaluator, and would in retrospect have been preferable.

c) The presence of industrial partners in the Consortium helped to make the descriptions of the PROTEE instrument itself risky. This was both through the critical feedback they provided on individual case studies involving their own innovation project and in the Working Groups where the case studies and the PROTEE instrument came under discussion.

6.3.3- THE LIMITATIONS INTRODUCED RETROSPECTIVE CASE STUDIES

PROTEE is designed as a real-time management tool for ongoing innovation projects. The historical nature of some of the projects used as case studies limited the extent to which they could be used to test PROTEE Indicators and procedures. This was for two main reasons.

The first reason is that a PROTEE evaluation is the outcome of comparing two redescriptions made at different time points in the project's history. What you have in retrospective case studies is a snapshot of the past taken from the present. It is a description from a single time point and it is not possible to evaluate the learning curve of a project from a single time point. This is the reason why case studies were done in sequence, rather than in parallel. It was then decided to apply a full analysis of the indicators developed through KFKS and ECT to Commutor at four key times during the life of the project. This was possible since the project was terminated and the full documentation available. The modified indicators and procedures were then tested on CIMP, the sole on-going case undertaken in the PROTEE project, see later.

The second reason is that it is extremely difficult, if not impossible, to make a judgment in the present about what difference it would have made had certain decisions been taken, or not been taken, in the past. This makes the evaluation of the retrospective thought experiments

that were attempted in some case studies difficult because both parties to the case study - Innovators/industrial partners and Evaluators/academic-analyst partners - have the benefit of hindsight. In the case of the Innovators, hindsight might lead to a tendency to produce 'Whig histories' or 'Just So' stories whereby the present is portrayed as following logically and unavoidably from the past. In the case of the Evaluators, with the benefit of hindsight they might see possibilities and risks which were simply not visible at the time the decisions were taken. This risk is even greater when the project has been terminated for many years, as was the case for Commutor. However, the aim was not to study the well known management problems of French state owned companies, it was to test the feasibility of using the indicators for describing the dynamics of the project and to make a set of " thought experiments " at given turning points to see what such descriptions could have brought to the fore.

6.2.4- THE EVOLVING PROTEE INSTRUMENT

The starting point for developing the PROTEE instrument was STEMM, a set of Indicators and procedures developed for transport infrastructure projects. STEMM was available to the Consortium as a set of documents produced by Technicatome in March 1998. The aim of the PROTEE project was to arrive at a new set of indicators relevant for innovative projects (and no longer for infrastructure development). The first set of PROTEE Indicators was written in November 1998.[10] Therefore, most of the work on the first case studies was an evaluation of and adaptation of STEMM as a stepping stone towards the development of PROTEE.

The set of STEMM Indicators from the March documentation comprised four Classes with three or four Indicators each. Most of these were further subdivided into two or more Variables. For each Variable, a set of options, corresponding to possible features of the project, were described in the documentation. Each such feature was given a value which was colour-coded. The colours used were shades of red, orange and green, their symbolism being taken from the colours in traffic lights.

The concept in STEMM is that the Evaluator (Administrator) should use the documentation as a framework for organising and evaluating features of the project. That is to say, he or she should organise the various features of the project in relation to STEMM variables so that they can be colour coded. The result would be a visual guide to the state of the project at a particular point in time. A large number of red codings would be a warning signal for the project at that time. What STEMM had to commend it was clear guidance on how it was to be applied to a case study or project. If anything, it was over comprehensive and over prescriptive. In STEMM, project evaluation was a task undertaken by the Evaluator (Administrator) using predetermined values. Through the experience of the case studies, the concept of PROTEE started to diverge from STEMM in at least three respects.

Firstly, there was a move away from the comprehensive use of the STEMM Indicators towards a more intuitive use;

Secondly, in PROTEE, project evaluation was conceptualised as a joint enterprise, involving both the Evaluator and the Administrator; and

[10] Latour and Martin, *PROTEE Interview Guide: Being a Presentation of PROTEE's Principles and* Indicators (18 November 1998), pp. 13-27.

Thirdly, PROTEE moved away from the provision of an a priori evaluation of concrete features of a project to the contextualised evaluation of the learning curve of a project.

These were the lessons that had been learned by September as a result of testing and adapting STEMM on the case studies. These lessons informed the drafting of the first set of PROTEE Indicators and Procedures in November 1998 in the Interview Guide. In turn, the second round of exchanges with industrial partners in the case studies were focused on discussing with them both the results arrived at by the academic teams in a format which reproduced the new proposed interview guide. This gave rise to further clarifications about the indicators (these have been included in the theoretical approach described in Chapter 0) and to further developments of the PROTEE process.

The two following sections address the issues of the translation of PROTEE indicators into a set of shared questions, and of the PROTEE process.

6.3- DEVELOPING THE PROTEE INDICATORS

With regard to the Indicators themselves, the feedback was that the way they were presented in the Interview Guide made them hard to apply to innovation projects and case studies. It was suggested that what was needed was a set of questions which mediated between the type of question one might ask in an interview situation and the sort of information required for the Indicator. The PROTEE Indicators needed to be expressed in a way to allow them to be used in an interactive interview situation without becoming an obstacle.

For Class I (Realisability) Indicators, which are about the Innovator's description of the realisability of the project, such questions would be:
- What is the project about?
- What is the project going to become?
- How is the project going to progress?
- What is the progress of the project dependent on?
- Why is the project the way it is?
- What could change the project?
- What are the uncertainties of the project?
- How many ways ahead are there?

With respect to Class I Indicators, it was observed that care has to be taken because the quality of the Innovator's description is directly dependent on the quality of the questions asked by the Evaluators. The lesson here is that it is important that the Evaluator is PROTEE-trained. It also points to another feature of PROTEE which is that the interaction between the Innovator and the Evaluator is central to the PROTEE evaluation process. Indeed, one observation is that the roles of Innovator and Evaluator interchange (see below).

For Class II (Negotiability) Indicators, the Evaluator might ask questions such as:
- Who are your opponents/customers/allies?
- Why is there opposition/controversy?
- Could you change your project to enrol your opponents/potential customers?
- What are the pros and cons of changing your project for the sake of negotiation?

In the KFHS case study, it was also suggested that it should be made clear that this is the Class that analyses whether the Innovator has considered strategies to exclude competitors.

The ECT case study did not have an industrial partner in PROTEE. However, Maastricht University organised a Round Table discussion of the ECT case study with some of the people interviewed. Feedback from this Round Table was that some participants had difficulty in understanding the difference between Class II Indicators (Negotiability) and Class III Indicators (Falsifiability).

Class III Indicators are about objectiveness. This Class was included in the light of European Commission feedback on an early draft of the Indicators document. It was suggested that PROTEE Evaluators needed an in-built safeguard against Innovators who tried to manipulate the PROTEE process by producing false project descriptions in order to achieve good PROTEE evaluations. Questions an Evaluator might ask in order to analyse the project's falsifiability might be:

- How are decisions and judgements about this project made?
- What are they based on?
- Who makes them?
- How many interests are represented among the decision-makers?
- What interests are excluded from the decision-makers?

Finally, in addition to the material in the Interview Guide, there was demand for a manual giving clear guidance and a standardised set of rules to produce descriptions of the projects. One move towards this was the reformulation of the Indicators themselves in the three following ways so that they could be used as part of the PROTEE methodology:

- as questions
- as part of a Project Description Summary Sheet;
- as part of a Project Learning Curve Summary Sheet.

These new formulations of the Indicators have been central to the building of the preliminary version of the manual, developed later.

6.4- THE PROTEE PROCESS

In he *Interview Guide,* the Innovator and the Evaluator are regarded as having separate, but complementary competences. The Innovator is an expert on his or her own project. The Evaluator is an expert in developing PROTEE type analyses and evaluations of innovation projects. The KFHS case observed this division of labour by exploiting the fact that the work was a collaboration between an academic and an industrial partner, recreating the roles of Innovator and Evaluator within the case study. In the KFHS case study, the PROTEE process was conceptualised as comprising five distinct and non-overlapping steps, or moments. The five steps are described in **Error! Reference source not found.**. The five steps incorporate this complementary division of labour and competences.

The ECT study pointed out that since the descriptions at t_0 and t_1 are the key basic material of the PROTEE analysis, the production of these accounts deserves much attention. There is a tension between the requested open and risky character of the description (a description of a world as a heterogeneous ensemble of actors, entities and elements in the innovators terms) and the highly standardised evaluation sheets with which the descriptions are assessed. To overcome this tension, it is suggested that the description is produced in two phases. In the first phase, the Innovator gives an account of the project 'in his own terms' (when the first time point is being chosen at the beginning of a project, the technical proposal might be a

suitable document to work from). In the second phase (which might in practice be on the same day) the Innovator and the Evaluator work on a more structured description in which elements that are to be judged by the indicators are already present. This structured second phase description should be jointly agreed by the Innovator and Evaluator.

Box 3. The PROTEE 5-Step Plan

1. The Innovator's Story. The Innovator tells a story to the Evaluator. This is contained in the documentation and other material supplied to the Evaluator prior to a project meeting. The subsequent procedures, described in points 2-5 below, take place at the project meeting itself.

2. The Consensus Story. The Evaluator retells the story of the project to the Innovator in the form of a summary - a chronology of events. Through this process they agree on a Consensus Story - an agreement about what has happened on the project since it started, or the last meeting.

3. The Socio-Techno-Therapeutic Dialogue. The Evaluator and the Innovator enter into an analytic dialogue structured by questions formulated by the Evaluator to encourage the Innovator to make risky descriptions of the project. This dialogue is designed to lead to a PROTEE redescription of the project.

4. The Redescription. The Evaluators and Innovators each make a record of the PROTEE redescription. The PROTEE redescription would be a record of the quality and quantity of the descriptions of the project made within the framework of the PROTEE Indicators. The Innovator and the Evaluator do not have to agree on the project's redescription, but their respective redescriptions should address the same points. At the Working Group in Maastricht we proposed a method for making the PROTEE redescription which involves the completion of Project Description Summary Sheets.[11] The Sheets would record a summary of how the parties redescribed the project at the time of the meeting with respect to the quality and quantity of its descriptions.

5. The Evaluation. The Evaluation is the outcome of the comparison of project redescriptions made at two consecutive meetings. Clearly, it is not possible to make an Evaluation at the first meeting. At the second and subsequent project meetings, however, the Innovator can compare his two redescriptions and the Evaluator can compare his. What is important for the Evaluation is the difference between the two redescriptions.

6.4.1- TIME 'ZERO'

Academic partners, playing the role of evaluators, found it difficult for the Evaluator to elicit a risky description of the project at the same time as allowing the Innovator to talk about the project in his or her own words. This led to a clear separation of the two in the 5-Step Plan. The Innovator's story is Step 1, whilst the risky description is not attempted until the Step 3.

In Step 1 the Innovator describes the project from his own point of view and the Evaluator just listens. This is also repeated at each subsequent PROTEE project meeting.

The aim in Step 2 is to establish a common story before commencing the analysis. This Step involves the Evaluator retelling the story of the innovation project before commencing the analytic dialogue and was strongly endorsed in the KFHS case study. Indeed, the feedback from the industrial partner was that in order to assist the orientation and further discussion by the various people involved in a project such structuring is mandatory for analysing projects retrospectively. In preparation for Step 2 of the 5-Step Plan, the Evaluator summarises the Innovator's Story in the form of a chronology of events. The experience of the KFHS case

[11] McNally, R. *PROTEE Methodology: Project Description Summary Sheet and Project Learning Curve Summary Sheet*, Presentation at the PROTEE Working Group, Maastricht, 14 January 1999.

study was that it was possible for the industrial and academic partners to agree on a consensus story starting from a chronology prepared and presented by the academic partner. As mentioned above, Maastricht experienced difficulty in writing a neutral description. However, neutrality is, of course, in the eye of the beholder and is not what is aimed for in Step 2. Step 2 aims for consensus rather than for neutrality. Formatting the project summary as a chronology of events may be less controversial than other narrative formats in arriving at a consensus.

This last comment is also relevant to feedback from Maastricht (ECT) about the suggested lack of useful previous knowledge during the innovation process. For pedagogical purposes it may make sense to highlight this 'state of total ignorance' on the possible outcome of the project, but it should not be overdone. Project managers and engineers do know quite a lot already at the beginning of a project. The question is: how do we operationalise this knowledge about the technology and its context, to the project's management and research? Almost all the ECT-interviewees underlined the fact that the DSL-innovation did not start at a point zero in terms of knowledge and experience. On the contrary, at various places and times during the process, known technology proved to be of decisive importance.

This feedback is useful because it reminds us that time zero is just a convention. As was explained in the KFHS case study, it is a point mutually agreed upon as the basis for dialogue. The Evaluator selects a time zero on the basis of material supplied by the Innovator. At the beginning of the first project meeting they then clarify that this is an agreed time zero for PROTEE purposes.

There will of course always be prior knowledge, competences and technology. Whether they are brought to the project by the Evaluator or the Innovator, these are brought into the description via the dialogue. What is redescribed at the end of the dialogue is what is known about the project at time zero in the light of both what was known at the start of the dialogue and what was revealed through it.

Commutor was developed without any interaction with its industrial promoters, apart from traditional interviews. The a posteriori redescription thus ignores the problem of a shared description between evaluator and innovator at T0. The question is however whether an evaluation is needed at this first encounter or whether it is mainly focused on the project description, and on the questions it is going to explore. This questions the necessity of having two summary sheets, an "absolute" one evaluating for instance the richness per se of the project's future world, and a "relative" one focused on the transformations of the hoped for future world between two interactions.

It is only from Step 3 onwards of the 5-Step Plan that Indicators and project story are put together. These Steps are a joint exercise involving the Innovator and the Evaluator. This collaboration addresses ZIV's concerns about the amount work required of the Innovator and the Evaluator in mastering each other's expertise and competences. Under the 5-Point Plan, the application of the Indicators to the project is a collaborative effort in which the Innovator is an expert on the project and the Evaluator is an expert on PROTEE. Steps 3-5, the processes of project analysis, redescription and evaluation, employ a division of labour where the Innovator and the Evaluator benefit from the other's skills and knowledge.

6.4.2- STRUCTURING THE PROTEE INTERVIEW

In the 5-Step Plan, analysis, redescription and evaluation are three separate activities. Case study lessons on these three Steps are described below.

The aim of PROTEE project analysis is to move towards a PROTEE redescription of the project and is the result of developing Indicators from the project material. In the case studies, a PROTEE methodology for analysis has been developed, where this analysis involves an interaction between the Innovator and the Evaluator rather than one undertaken by either party alone. Partly for this reason, step 3 emphasises the dialogue between the Innovator and Evaluator. It takes the form of an interview in which the Evaluator asks the Innovator questions about the project.

The question is, what should guide the way in which the interview is structured? The ETTC and the KFHS case studies structured their interviews/dialogues through an internal knowledge of STEMM and selective use of the STEMM Indicators. Both these case studies found STEMM useful in an adapted form, and Brunel suggested that the STEMM Indicators, which cover more substantive issues than the PROTEE Indicators, could be a useful adjunct to PROTEE. This is not to suggest that the STEMM Indicators should measure the learning curve of the project. The STEMM Indicators would be used at the analytic interview stage to transform the Innovator's Story to a riskier description of the project. Subsequently, the PROTEE Indicators would be applied to this riskier description resulting in the PROTEE redescription of the project.

Having experienced the STEMM approach, those involved in the ETCC project seem to favour drafting a new set of questions specifically for PROTEE as in Section 0. ZIV proposed providing for every PROTEE class a set of questions to be asked by the Evaluator. Based on the answers, descriptions of the project emerge which are helpful for the evaluation. ETTC thus suggested the need for a standardised set of rules to produce descriptions of projects.

However, feedback from the ECT project, which did not use STEMM, seemed to go in the opposite direction. Maastricht (ECT) commented: 'It is clear that the description should be pre-structured along the lines of the Indicators, but not too much since the whole operation would then become circular (a description based on certain Indicators is judged in terms of these Indicators)'. We shall see in Chapter 0, dealing with CIMP, that a description solely based upon PROTEE indicators was tested and judged sufficient for initiating a discussion of the description between the project promoter and the PROTEE "investigator".

6.4.3- CHOOSING TIME POINTS

Maastricht (ECT) stressed the problem of choosing time points. The core of PROTEE methodology is the comparison between descriptions produced at two different points in time. Assessing this differential might lead to some practical problems, some of which were brought up during the Round Table. One participant asked how the two time points are actually chosen? What should be the time interval? If this is not arbitrary (as was suggested in the meeting held in Mondragon), what should then be the criteria for picking the two time points? For Commutor, turning points were chosen because they corresponded to major decisions to be taken. Deciding to build a prototype or not offers a before and an after which are radically different. Selection was thus never a problem. PROTEE, aiming at being a

management tool for real time monitoring of projects, will have to be inserted into the time frame of the wider decision making process in which the projects will be embedded. For example, in 'real' projects, interim reports are due every six months or so, at dates determined by the starting date of the contract. These reports would be the Innovator's Story of the project at the date of the interim report, covering progress between the present and the previous report. The reporting period would settle the time points question.

6.4.4-THE PROTEE REDESCRIPTION

An outstanding problem is that a redescription judged favourable within one frame may be regarded as unfavourable within another. For example, standardisation and globalisation may mean more transport, but may be problematic for different criteria such as the project's contribution to environmental and sustainable growth? Thus, a project thought to be innovative in one sense (standardisation) might be judged conservative in another context (sustainability).

A further, more complicated issue is that there may be hidden or unexpected virtues in imprecise descriptions. For example, a definition of the situation which is knowingly ambiguous may have the distinct advantage of enabling protagonists the flexibility subsequently to connect to different networks. In these circumstances, the innovativeness of the project might be overlooked if too much weight is given to the precision of the initial description. This however should not be a major issue since PROTEE is about learning and the quality of the learning curve. Whatever initial description, it is the differential between descriptions that will provide the basis for a joint agreement about future relevant actions.

6.4.5-PROTEE EVALUATION: DIAGNOSTIC AND PROGNOSTIC POSSIBILITIES

PROTEE aims to detect the learning curve of innovation projects and advocates rewarding projects with a steep learning curve.

PROTEE sees stabilisation and learning potential as being inversely related. At the beginning of an innovation project, while there is a lot of flexibility, the uncertainties loom large so the learning potential is high. At the end of the project, the innovation has stabilised but the learning potential is correspondingly low. From this it follows that, as the innovation stabilises, the learning potential detected by the PROTEE instrument will decline. This points to one central issue: when PROTEE should be abandoned as a monitoring tool in favour of conventional quantitative methods?

Some of the Innovators commented on this aspect of PROTEE. Consider PROTEE's valorisation of branched paths, number of alternatives, and maintenance of flexibility, for example. In the private sector, what is valued is focused concentration and maintaining schedules. Retaining a substantial degree of openness and flexibility until the very end of a development runs the risk not achieving any concrete objective. For example, starting with a High Rack system and ending up with a gantry crane was not an acceptable outcome for a large plant making company, even if the process generates a lot of learning and collaboration which may meet the concerns of public sector sponsors (KFHS).

On the same point, ECT felt that risky, heterogeneous descriptions were not good in all phases of the project. There comes a point where something has to be built. The question is how to get from risky descriptions to a more stabilised structure without losing the openness of the initial phase? Learning can be very important in one phase, but a threat in another (ECT).

During the Round Table, A similar point was put forward when the fact that learning and risk are good at some times was stressed but there has to be a moment when the project stabilises. In this view, PROTEE was not well addressed to identifying that point because it focuses mainly on the learning part of an innovation process (ECT).

These elements have been well illustrated by the Commutor case study, where the issue was not to maintain all variants open at any time, but to weigh the pros and cons of closing variants, and entering into a scaling up process through prototypes and demonstrations. What PROTEE should help at is in valuing the relevance of the choices made by comparing the information acquired with the capabilities introduced and risks taken (new opponents, etc.).

Can the PROTEE instrument only provide lessons on the learning curve, or is there scope for some prognostic possibilities? In other words, can it be used to suggest a certain strategy? This might spontaneously from the production of the description as this process forces the Innovator and Evaluator to identify elements in the process that would otherwise have gone unnoticed (ECT). In a real time case, this is vital: for PROTEE to be useful to project managers, the evaluation of the learning curve must help in identifying the next stage of exploration.

6.4.6- THE ROLES OF THE INNOVATOR AND THE EVALUATOR

ECT pointed out that within the PROTEE methodology the learning pact between Innovator and Evaluator is essential. During the Round Table, one participant underlined the fact that Innovator and Evaluator should, at least in theory, be able to change roles. Both Innovator and Evaluator are subject to a ‘double inclusion’ within the networks they are assessing. This means that they are acting within and without their respective networks at the same time. To be successful, the Innovator in some way or another has to relate to the network of the Evaluator and vice versa. The key implication is that the traditional roles of the Innovator as a subordinate of the Evaluator do not match the requirements of a PROTEE assessment. In this double inclusion of Innovator and Evaluator, the ‘willingness to be influenced’ on both sides is more important than the hierarchic power structures.

The fact of double inclusion is clear. After all, PROTEE is a learning pact. The PROTEE redescription and evaluation are collaborative activities involving the Evaluator and the Innovator. But, on the basis of experience of KFHS case study, this does not have to entail a change of roles. They have different competences and there is a division of labour based on this difference in competences. Also, whilst the process of deriving the PROTEE evaluation is ‘therapeutic’ for the Innovator, in the way described in the KFHS case study, the relationship remains hierarchical. The Evaluator does have a different role to the Innovator, and the fate of the Innovator will depend on the opinion of the Evaluator.

6.5- THE PROTEE CONCEPT OF INNOVATION

6.5.1-SOFTWARE AND HARDWARE INNOVATION

The original project proposal aimed to assess if PROTEE was suitable for both software and hardware innovation projects and to identify any differences between the use of PROTEE on these two types of project. However, ECT in particular, reported that it was difficult make a distinction between software and hardware components in the project and it was not very useful in the context of the ECT-DSL. In this latter project, the hardware and the software developments were inseparable and co-ordination of the software and the hardware innovations appeared to be one of the most difficult tasks in the project. ECT also reported that it was unclear whether innovations in terms of a changing labour organisation (seen by some of the interviewees as the most important and difficult innovation) should be categorised under 'hardware' or 'software' or both.

6.5.2-THE UNIT OF ANALYSIS

A project, in which there are several different innovations, raises key questions about the unit of analysis for PROTEE. Could (or should) there be several different learning curves?

Some of the interviewees in ECT said it was possible to identify many learning curves during a project with the complexity of the ECT-DSL. What seems to be a useful learning curve for one actor in the project, might be regarded as a draw back by another. Rijsenbrij (project leader for the construction of the DSL) highlighted the discrepancy between the need to build a functioning terminal by the deadline on the one hand and the perceived need for a more flexible automation concept among the software developers on the other. A full development of the latter option would take more time and money. What actually happened was a compromise. The criteria for success are not only the amount of innovation that goes into the new terminal and the quality of the learning curve; but also the effectiveness of the innovation process in terms of meeting the specifications (including the deadline) that were laid down in the technical proposal/annex. The development of the software took much more time and money than had been expected. Seen from the PROTEE point of view, one might argue that there was a better learning curve in the software innovation trajectory because there was less proven technology to start with and therefore the differential between any t_0 and t_1 was bigger.

The same general question arose with respect to the ETTC case study. What should the unit of analysis be when applying the PROTEE instrument to an innovation project? Innovation projects are complex, and that means that PROTEE could be applied not only to the whole but also to sub-projects. Maastricht/ZIV decided to describe the ETTC project as a whole, and then focused on one particular part of it, the terminal technology.

One possibility is that the effects of this are more exaggerated when considering a case study problem than they might be with a 'real' problem. When PROTEE is used in 'real life' the unit of analysis may be clearer. It is, simply, whatever the Innovator seeks support for from the Evaluator. This pragmatic argument is, of course, complicated by the point made by Maastricht (ETC) about the learning curve. The result of the comparison of two descriptions at two time points is a statement about the learning curve of a project. One of the problems already mentioned in Maastricht's comments on the Interview Guide relates to the learning curve. Does it make sense to talk about one learning curve? Are there not as many learning curves to be distinguished as there are, for instance, relevant social groups? Even if the user of

the instrument decides to single out one learning curve, an explicit choice at the start of the assessment process is more in line with our own view of the innovation process.

Another way to phrase the problem, as shown in the Commutor case, is to consider each indicator or groups of indicators as a learning process per se. The issue is then not addition but aggregation. This poses a set of questions about class 4 and the conditions under which a difference can be made between a “hopeful monster and a “white elephant”.

6.5.3-TECHNOLOGICAL ESSENTIALISM?

Individual technological innovations are parts of systems that may contain other technological innovations. The unit of PROTEE analysis, as in KFHS, may well be the entire system rather than individual components. Thus, for example, a key lesson from the KFHS case study is that PROTEE considered the innovation to include both the technological and market sides of the KFHS. In this case study, PROTEE seemed to consider that new technology was not an innovation until it is introduced into commercial or social activity. Technology is only part of the innovation process.

However, does there have to be a technological component at all? One definition of innovation is: “The first introduction of a new product, process or system into the ordinary commercial or social activity of a country”. Under this definition, is PROTEE only applicable to innovative systems with a new technology element or is it also applicable where no new technology is involved?

The case study which poses this question very clearly is the ETTC case study. Both ZIV and Maastricht argue that the ETTC is an innovation project. One argument they make for this is that a system which requires an innovative combination of elements but which does not include a new technology is a risky project in the PROTEE sense. The ETTC-project was not concerned with innovation in a technological sense. The protagonists have deliberately chosen a conventional, well-known, widely used transhipment system, because it was a less risky choice, easier to implement and investors would be more readily convinced. But this is the opposite of what PROTEE sees as innovation, as characterised by not knowing and taking risks. If a less risky choice is made, less will be learnt and thus PROTEE will be less capable of improving the learning curve. On the other hand, PROTEE not only focuses on the ”technical” part of projects, but also on innovation ”about usage, control, accounting, practice, law, as well as pieces of machinery or composition of existing machinery”.

According to the innovators themselves, the innovative part of the project consists of connecting different functions with one another: normal freight transport for the Oder region, border freight transport centre (FTC) for traffic with Eastern Europe, integration of a centre for combined intermodal transport, planned as gateway and supplemented with a conception for city logistics. Others point out that while there has not been so much risk in the choice for the terminal technology, it is still uncertain how the city, the region and the companies using the system will react after the FTC has been built. Moreover, the precise form of the mobile system and crane technology has not been yet decided on. There is also innovation going on at that level, for example in the field of automated portal cranes. There is always a lot of uncertainty in complex projects like these on different levels. In this case, uncertainty does not relate so much to the technology chosen, but more to economic aspects, the support received from citizens, policy makers and companies, the growth or decline of freight transport etc. Thus the PROTEE methodology applies to projects such as the ETTC.

6.5.4- INNOVATION *VERSUS* DEVELOPMENT

The Innovators on the ECT project made an important distinction between innovation projects and development projects. It was thus said that there are two kinds of projects. Some are true innovation projects in that they are indeed aimed at some learning curve and thus subject to PROTEE evaluation. However, other projects might be explicitly and consciously formulated in terms of the final result, and thus not assessable by the PROTEE instrument.

During the Round Table, it was suggested that the ECT-case was more a development rather than a research project. In other words, there was very little open and risky research, because it had been decided beforehand that the terminal would have to be built, at whatever cost, thus independent of any learning curve and without an alternative (of course there was the alternative of the standard terminal, but that option was politically ruled out). However, within the Delta terminal project, several sub-projects would have been PROTEE-assessable: the AGV, the ASC, the operating systems, etc. This relates to the more or less implicit definition of an innovation within PROTEE, where a high quality learning curve suggests an innovative project. It might be interesting to try to differentiate between the research-elements and development-elements present in any innovation project (ECT).

6.6- WHAT THE INNOVATORS THINK

6.6.1-'WHAT DIFFERENCE WOULD PROTEE HAVE MADE?'

KFHS reported that they did not think the analysis revealed any major additional aspects. The decisions taken would have been similar, they said, if they had been PROTEE-equipped.

ECT asked several interviewees if having the PROTEE-instrument rather than the conventional quality control techniques would have made a difference at the time. It was argued that the specificity of possible future failure could of course not be detected by the conventional instruments. Without exception, all participants at the Round Table were enthusiastic about the possibilities of using PROTEE as a real time monitoring instrument.

ETTC reported that they already used a partial PROTEE like approach in developing the project. This had not happen haphazardly but derived from logical connections and from the development process itself. Essential items of the PROTEE working method had been applied to the review of planning development phases of the ETTC. The argument was decisively influenced by the high demand for information that exists in the case of evaluating freight transportation centres like ETTC. But there would have been three main advantages from using a total PROTEE approach from the start:

1. The internal project structure would have been noted more conclusively and more deliberately. Necessary tasks and decisions could have been clarified sooner. The development process would have been shorter and more continuous. More innovative processes would have emerged. PROTEE could have reduced the planning period to 3 years instead of 5.

2. The project would already have included in its basic concept alternative developments as well as a gradual extension of the ETTC. Alternatives and the modular extension were taken into account only as a result of the PROTEE assessment.

3. The description of the project would have made it possible to represent risks openly from the outset, thereby shortening the decision-making process. In the ETTC case, risks were recognized and made known to the Evaluators (ETTC/ZIV).

ZIV thus sees immediate benefits to using PROTEE. With knowledge of PROTEE, their present work could be done more efficiently, particularly as regards understanding and decision making in the field of the know-how of transhipment technics, and in negotiations with supporters and opponents.

6.6.2- WILL THE INNOVATORS USE PROTEE?

As we indicated in section 4.9, the concept of 'therapy' is at the heart of PROTEE. Through interaction between Innovator and Evaluator, construed as a form of socio-techno-therapy (STT), Innovators are encouraged to enrich their description of the project - to entertain riskier aspects of the project in their descriptions and to imagine other possibilities. It is evident that the success of the therapy depends crucially on the interaction which, just as in any form of counselling, depends in turn on the relation between Innovator and Evaluator.

The advantage of PROTEE for Evaluators is that they learn more about innovation projects. Instead of just knowing that a project succeeded or failed, the Evaluator will also know more about the process of innovation. In addition to the benefit of the acquisition of information per se, use of PROTEE could mean a saving of resources if the information gleaned meant that a project were terminated sooner rather than later.

The interests of the Innovator may well differ from those of the Evaluator. For the Innovator, a successful project is one that continues to receive support until it becomes a successful product. In general, a risky description of a project might result in its not receiving support. KFHS observed that it is not usually in the Innovator's interests to provide risky descriptions, either internally or externally. Internally, the aim is to give the impression of low risks by not mentioning them or highlighting positive effects. Externally, the project description has to strike a balance between confidence and risk, if it is to be supported. ETTC similarly noted that their experiences lead them to believe that only "smooth" descriptions of the progress of projects would be welcomed by an Evaluator. Especially in times of scarce financial resources, a risk-oriented description has little chance of being accepted by an Evaluator attuned to market acceptance. This difference in interests between Innovators and Evaluators makes the advantages for the Innovator of using PROTEE more ambiguous.

PROTEE rewards rich descriptions which include risky descriptions. However, if PROTEE becomes the instrument used by public bodies which support innovation projects, then Innovators seeking such support would come to provide risky descriptions. Indeed, in this circumstance, providing risky descriptions would be less risky for the Innovator than providing non-risky descriptions. Both KFHS and ETTC concurred that if this were the case, then Innovators would provide PROTEE like (risky) descriptions.

6.7- CONCLUSION FROM RETROSPECTIVE CASE STUDIES: PROTEE AS PUNISHMENT OR AS DISCIPLINE?

The lessons from the available case studies are encouraging. Unfortunately, the absence of 2 of the 5 case studies makes these lessons difficult to generalise with great robustness. However, there is perhaps enough to conclude that PROTEE provides a fresh take on a long

standing and difficult problem. Its freshness is that it is an instrument based on alternative criteria of innovation, risk, learning and networks.

The available evidence from the case studies highlights a number of key reservations, notably about the process of identifying the unit of analysis, the applicability of the instrument and the determination of time frames. It is nonetheless very valuable in moving our understanding of innovation to an entirely new footing. In particular, we suggest the implementation, successive application and eventual institutionalisation of the PROTEE instrument would free the concept of innovation from its current over bureaucratisation. This in turn would give rise to and encourage new and more daring forms of innovation which would be judged against more relevant criteria.

As is suggested by our remarks above, a key to the acceptance of PROTEE is the institutionalised relationship between Innovators and Evaluators. If Evaluators were perceived as agents of a consensually adopted form of discipline. The discipline would comprise the internalised acceptance, by Innovators and Evaluators alike, of risk as an intrinsic element of innovation. The role of Evaluators is not just to articulate the agreed fundamentals of innovation, but also to advise, guide and assist Innovators through a principled dialogue.

PROTEE was designed as an instrument for the evaluation of innovative projects in the field of freight transport. Yet its design and testing suggests it is eminently applicable to a wide range of different fields involving innovative development.

IV- THE LESSONS DERIVED FROM ON-GOING CASE STUDY

4.1- OBJECTIVES AND DESIGN OF THE TEST UNDERTAKEN

When a better understanding of the PROTEE process had been gained from the retrospective case studies, a "full scale" test was organised in an on-going project. A project was selected in "intermodal transport" in which the coordinator of the PROTEE network is involved. As the project is confidential, it will only be referred to here as CIMP, standing for "container intermodal project". The objective of the test was not to develop the indicators further, but to apply them in an on-going project where nothing is yet known about its outcomes and to retroact with project partners in this application, about PROTEE's "usefulness" and about the effects generated by the interaction between an external "evaluator" and project promoters.

The PROTEE lessons from the retrospective case studies suggested a five step process for the interaction. While the test devised took these elements in consideration, it was decided to apply them partially. We considered the first step to be the set of documents developed by the project (proposal, justification, background literature, meeting minutes, internal notes circulated, sketches). In common with the retrospective studies, we discovered that this material lacked much of the necessary and relevant "background" and "contextual" information. As a result, it was decided to undertake interviews with players involved in the preparation of the project but not in charge of it within Technicatome (TA) in order to engage in a degree of interaction with the manager and team of the CIMP project.

Instead of undertaking a face-to-face second and third step, it was decided to test the feasibility of writing a PROTEE story. A report was then issued on a PROTEE analysis of CIMP[12]. Following the PROTEE principles, this description dealt with three questions which had been developed to address the main pathologies that innovation projects are faced with: is the project realisable, is it negotiable, is it falsifiable? It was the first experiment with a project solely described in a PROTEE format. The aim was to see whether a PROTEE description could be produced from readily available material, how readable it was, and what were the conditions, especially from the evaluator's side for entering a "rich" third step. This report and its "risky" project description aimed thus first at testing the "understanding" of the evaluator about the positioning and proposed dynamics of the project. The objective was also to characterise further the conditions under which a useful relationship can be built between an evaluator and an innovator. Too distant or too close a relation might cause problems. In the present test, the PROTEE investigator could be considered as a "generalist" with background information on the world of transport. Would that be enough to enter into a useful relationship? Is such a background already too much, with the investigator being biased by his own views of the situation? By identifying points not clearly understood or those too rapidly related to views other than those of the project team, the test aimed at gathering information about this first issue.

An interaction was then organised under the auspices of the PROTEE coordinator which brought together the CIMP project management, a senior manager of the research directorate of TA and members of the commercial directorate (including its director). None of the TA staff (other than the 'evaluator') had knowledge of PROTEE or had been given the PROTEE description of CIMP. The PROTEE investigator had thus both to introduce PROTEE to the

[12] It was only distributed after the interaction took place.

audience[13] and to present his PROTEE description of CIMP to them. This description only dealt with the first three PROTEE classes, enabling each of them to be tested in terms of the accuracy of the description (how well did it relate to the ways the CIMP team considers its project). It was also intended to start a debate about "risks taken" or issues "overlooked". The TA managers were then asked to act as PROTEE evaluators and jointly participate in the building of the fourth class, i.e. considering the question about the future continuation of CIMP. This enabled an assessment to be made of one company's potential interest in using PROTEE for the on-going monitoring of its "radical innovation" projects.

Two elements were important in this second aspect of the test: we wanted to check whether or not conclusions different from the ones indicated in the formal project documentation would be arrived at. In particular, whether the discussion changed views about the nature of the trials to be undertaken and on the company's senior management vision of the relevance of the present trials or on the nature of the next round of trials. If so, what were the essential elements in the PROTEE description which caused such changes, and how did this relate to more conventional arguments.

4.2- LESSONS DERIVED FROM THE PRESENTATION OF CIMP BY THE PROTEE INVESTIGATOR

The presentation of the PROTEE approach was focused on two points: (a) differentiating between "incremental" and "radical" innovations and (b) stressing the main characteristics of PROTEE: a periodic and "pro-active" evaluation based on the descriptibility of projects. It was then agreed to proceed class by class with first a justification and presentation of the indicators and then a presentation of CIMP.

The PROTEE investigator derived three main lessons for this presentation, concerned with the required background knowledge of a PROTEE evaluator, the role of PROTEE in generating new questions and the need to rethink our rating of the learning curve.

THE REQUIRED BACKGROUND KNOWLEDGE OF THE EVALUATOR

Clearly, for an "evaluator" to be in a position to question the innovator requires some general knowledge about the "domain" of the project. It is however important to insist upon the dual nature of the general knowledge required. First, the project is concerned with the "future world" envisaged and this required some background knowledge about the container chain and its operators, the global trends in shipping and the problems arising from the situation of the rail industry in Europe. These issues were not apparent in the project argumentation. In contrast, the technical contents of the project, provided the evaluator could follow the innovators' argumentation, were fully present and well developed within the project. Again it is interesting here to note that these arguments gave rise to different analyses and questioning from the innovator's and the evaluator's side and this leads the second issue.

PROTEE AS A GENERATOR OF NEW QUESTIONS

It was clear from the interaction that focusing on the three pathologies brought many **new elements** to the fore. In this first encounter, it brought out some key issues in each class that probably had not been coherently addressed previously in the project. Retrospectively,

[13] A specific 10 page presentation for engineers and managers was prepared and is available in French.

looking at the discussion, five elements were central: identify the key "relays" for a first full scale realisation, what are the major uncertainties, what are the potential antiprogrammes and what do they say about the issues to address, what is the "core" which cannot be touched compared with what can be adjusted and how critical is the demonstration in relation to these previous aspects.

New and very concrete questions were thus posed. The outcome was to focus the debate on the logic of the project, its components, its potential supporters or opponents, and its potential customers. This illustrated the value of a "risky description". Descriptibility was not taken as something "soft" but as a way to identify the "non technical" actions that should take place **at the same time** as the technical ones. It became apparent that such non-technical issues should not be left for later, once the technical problems had been solved. It also made it apparent that, before the demonstration takes place, an inter-action between both sets of issues could very well result in a partial redefinition of the demonstration itself.

RETHINKING THE APPRECIATION OF THE LEARNING CURVE?

This "first encounter" was thus instrumental in identifying "risks" or "blind spots" within the project. PROTEE was instrumental in facilitating the raising of new questions, which had not emerged previously. This certainly is a valuable strength of the approach but quite different from the initial conception. Because this was a first encounter it was not possible to apply the notion of learning curve.

The PROTEE investigator's impression was that this test slightly transforms the shaping of interactions. The issue of assessing the learning curve of a project at t+1 is less one of rating each indicator but more of identifying the questions which have been added, answered, transformed or even made irrelevant by the work done between t and t+1. PROTEE indicators act then as a heuristic to generate questions which in turn foster the descriptibility of projects. Its results are the "redescribed project" and the set of questions both the evaluator and the innovator have agreed upon as THE relevant questions to ask about the project. It is then clear that the synthesis ends – as was done in CIMP (see Section 0 for the TA's views) – upon a prioritisation of questions and the identification of those the next phase should aim at exploring/answering.

At the succeeding encounter, a project which has answered all questions or where the nature of any of the questions identified has not changed will not be suitable for continuation as a PROTEE project. The alternatives are (a) to continue the project with conventional project management methodologies - i.e. it has become a 'mature beast' - or to discontinue it because it has been identified as a 'white elephant'. If a project is considered to be in neither of these two situations, then the quality of the activity should be further explored by looking at the transformation of questions. More live monitoring of projects is required the better to qualify how these transformations can be assessed to differentiate "white elephants" (unable to take into account, or reconcile the views and interests of the different stakeholders because it is too stabilised) from "hopeful monsters" (i.e. able to integrate all contradicting views into a "better defined as before" outcome).

4.3- LESSONS DERIVED BY TECHNICATOME PARTICIPANTS

The participants from TA derived a number of main lessons from the PROTEE presentation, its role for fostering dialogue, and the potential impact on CIMP. This leaves aside the on-going discussions within TA about what is still required for a wider application of the approach to TA research projects.

ABOUT THE PRESENTATION OF PROTEE AND OF CIMP THROUGH A PROTEE DESCRIPTION

The differentiation between different types of innovation projects, the location of PROTEE as only addressing "radical innovations" and the decision as to when it is time to revert to conventional procedures were central to what the audience understood. The use of numerous examples when addressing each issue "dedramatised" the situation, making the project manager as well as others aware that their case was not only not unique, but indeed rather common. It could thus be addressed or thought of in the same way as the other numerous problems any project faces.

Finally there were doubts about the capability of an outsider to give an "accurate" view on a complex project in half an hour, especially since the application of the approach on Commutor was considered rich but difficult to access[14]. On the contrary it appeared as an "easy" and "fluid" approach facilitating dialogue between those knowing the project well and company players external to the project who knew little about it.

PROTEE AS A TOOL FOR FOSTERING DIALOGUE

One of the most striking results was not the discussion with the PROTEE investigator but the exchanges between the participants from TA[15]. A question however remains: would this dialogue have taken place without the mediation of a third party, organising the debate. This raises the following question: even if a company were to adopt a PROTEE approach for monitoring its "radical innovations", how could the process be initiated? Would it be enough to develop a ready made instrument (including training of evaluators) or would it require an intermediary period to give credibility to the transformed process?

DID THE PROJECT MANAGER "LEARN" FROM THE INTERACTION?

This was the hard question for the PROTEE innovators, since it appeared that the industrial partners active in PROTEE (and especially, Krupp) considered that they would have been little to learn from the application of PROTEE. But their experience was a "thought" experiment undertaken retrospectively. Would it be the same in a live case? The answer given

[14] Note by the PROTEE investigator: it is difficult to compare Commutor where the methodology was applied retrospectively at 4 different points to CIMP, an on-going case, where the methodology has been applied only once. This reflects the conclusions we had arrived at from the retrospective case studies and which entailed changes to the work programme. As a potential tool, PROTEE can only learn through its application to live cases. CIMP possibly demonstrates the validity of this hypothesis. But the retrospective cases were needed for to develop PROTEE.

[15] Note by the PROTEE investigator: measured by elapsed time, 3/4th of discussion took place between members of TA and did not involve the PROTEE investigator directly.

by the TA project leader was clearly that PROTEE had offered something positive. He identified a set of issues he himself wishes to pursue within the company and which he wants to take up in the next meeting of the CIMP consortium (see the box below). He has also asked for a PROTEE follow-up by the end of the year, i.e. before they begin the construction of the prototype and the preparation of the demonstration.

Box 1 New questions arising in CIMP following the PROTEE presentation as seen by the TA CIMP manager

- Debates about class 1 showed that "we have not sufficiently clarified our views about the potential users, and especially about those we consider as our lead/first user". "We have to answer the question: in which more global organisation can the project be inserted"?

- Debates about Class 2 showed that "it is not enough to develop a state of the art system at a given time in a project. It should be an on-going reactive effort". "It also showed that we have not considered the "up to date" situation (using the best of existing available technologies) to benchmark our project". The issue within TA is now to decide who should do this.

- Debates about the "criticity of the demonstration" showed too strong a focus on technological feasibility and that issues related to the life cycle of the system were not integrated as criteria for technological choices and that the different possible scenarios of integration of CIMP in the wider container chain had not been identified. This introduces new criteria for the technological choices to be made before the end of the year.

4.4- SOME FURTHER CONSIDERATIONS TO CONCLUDE

The CIMP case was carried out with four main questions in mind: (a) Was it possible to apply PROTEE while only working on existing documentation and a few interviews? What "familiarity" with the area is necessary to become a "relevant" PROTEE investigator? (b) Was it possible to present the PROTEE method to a non-specialist audience and initiate a debate about it? Was it possible to interest the project stakeholders in a PROTEE reading of their project and encourage them to begin a more wide ranging debate about its impact on the project? (c) Would such a debate change the future course of action of the project? (d) Would it help in learning more about the prospects for PROTEE by identifying any future relevant steps which could be taken?

All participants agreed that the PROTEE reading of the project (cf the report on CIMP made before the interaction took place) identified a set of issues which conventional project descriptions do not address. Thus PROTEE can at the least be said to have enriched the ability of a project management to describe the different facets of their project. It also showed that, with only general background knowledge of the area (both in socio-economic and technical terms),[16] it was possible to ask relevant questions which fostered debate and partially renewed probing into the wider implications of the project. In this way, it was possible to generate interest in an audience made up of the project management and other senior managers within the company. It fostered a fairly rich dialogue between the TA representatives and ended with both the will to initiate "non technical" actions in parallel with the technical ones and with the identification of new criteria for the technological choices which have to be made by the end of the present "phase" of the project. Potential changes to the project plan were identified by

[16] Something to be expected from the research directorate of a company or the head of a public transport R&D programme.

the project management, which has asked for another PROTEE encounter at the end of the present phase of the project.

Last but not least, did we, as innovators promoting PROTEE, learn anything? The provisional answer is yes. Views about "marking the learning curve" may have to be changed as a result of the study. It seems that our views of rating the learning indicator by indicator may not have been adequate. We may need another approach based upon PROTEE as a question generator, with the focus on learning from the transformations of questions. But how can this be done? This seems difficult to answer without **a longitudinal analysis of a set of live projects**. This is thus the next step we consider necessary for PROTEE.

Finally, applying PROTEE to PROTEE, the question is: What is our guess whether PROTEE is more a white elephant or more a hopeful monster? Our answer would be dual. While the main reason why PROTEE was developed was to improve the management of publicly funded risky research projects, especially at EU level, there are clear indications of interest in the development of the instrument in at least one company. Thus the PROTEE consortium hopes to be still promoting a "hopeful monster"!

V- CONCLUSION

PROTEE is a procedural approach to the monitoring of radical innovations. It thus addresses decision making at stages where no quantitative tool based on the calculability of risks is yet operational. It is thus centred on a better description of projects which identifies and characterises the nature of risks taken. This better descriptibility of projects is arrived at through a periodic interaction between project promoters and external supporters of the project[17]. The approach is procedural because it does not rely upon best practice but on organising the relationship between somebody who knows much about their project and the world in which it is going to be inserted, and someone who knows little about the project and its future world but is aware of the numerous traps a project may fall into. The periodic meetings of the two sides implement a learning pact where both partners enrich each other, each time better shaping the common objective they pursue.

The core of the development done has been to identify indicators which grasp the usual dangers in which innovation projects may fall while not using so called "best innovation practices" (since one of the core effects of innovations is to make such practices evolve). The choice was to use lessons derived from the work done in "science studies". A systematic reading of work undertaken these last twenty years has enabled to classify these dangers in three main "classes" linked to three common pathologies of innovation projects: the ballistic approach to materialization (which focuses only on technical developments and leaves for later socio-economic aspects), the paranoia of inventors (who discard opponents as non rational instead of taking them as a source of enriching the content of their projects), the self-closure of projects (where trials, tests, demonstrations and experiments remain defined in the small circle of those already involved instead of being dedicated to the mobilization and integration of other partners, groups and future users necessary for the further circulation or diffusion of the proposed innovation).

It contains an implicit definition of "success" in these early stages of a "want to be" radical innovation. This definition is based on the quality of the simultaneous exploration of the technical and socio-economic uncertainties of the innovation. This corresponds to the concluding phase of the periodic interaction between the innovator and the evaluator, and a fourth class of indicators which tries to delineate "hopeful monsters" from "white elephants".

5.1- WHAT HAS BEEN DONE TO TEST PROTEE

We have tried the procedure on several projects either completed or in the process of finalisation by trying to mimic as far as possible the situation of the learning pact envisaged by PROTEE.

- The long detailed study on COMMUTOR demonstrated that PROTEE provides a sort of shorthand for describing a complicated project by offering a common vocabulary stable in time. Through a PROTEE description, projects become more comparable. However, since it was a post-hoc analysis, the conclusion that the project should have been interrupted much earlier, is not very enlightening.

[17] Such as a firm's board of directors, administrators of public research budgets, research foundations and NGOs engaging funds in research activities etc.

-The test on KRUPP's Fast Handling System was of a different nature since the project although stalled was still live. It was a specific case since it helped in better defining some of the descriptive indicators. But its major lessons were about the process. We learnt that innovators could not enter into risky descriptions if the rules of the game have not been stated beforehand, thus the crucial importance of a global organisational setting which provides for the existence of a learning pact. The question remained however open of the possibility both internally within the company and externally (with public funding bodies) of such development.

-The ECT innovation on the automatic handling and transport of containers in Rotterdam is characterised by the extreme intricacy of the technical, organisational and even geopolitical aspects. These converged very rapidly and the compromise arrived at was never questioned again during the life of the project. The main lesson of the retrospective analysis of this long finished project is that a method like PROTEE is useful only when uncertainties about the involvement of "relevant" actors remain.

- The case study on the ETTC platform in Frankfurt (Oder), which was live, tested another crucial feature of PROTEE since the solutions explored by the project were not technical and reached irreversibility through means other than the hardware. The great advantage of PROTEE is clearly to enrich the negotiation by putting technical and non-technical criteria on the same footing, using the same vocabulary throughout. However, we also saw the limits of PROTEE. Once a project has become stabilised enough, it is better to use classical methods of project management.

- These lessons were important enough to push the consortium to reshape the last case study from another retrospective study to an on-going case. The case selected – here labelled CIMP, standing for "Container Inter Modal Project" - .was still at the beginning of its life and thus has forced PROTEE to do what it was designed for, that is, offer a series of ex ante risky descriptions. We have been able to show that it was possible for an outsider in a limited amount of time to re-describe the project with a common vocabulary acceptable simultaneously by the managers of the company, the project manager, and the evaluator. This fostered a renewed dialog between members of the company, no longer based upon usual quantitative criteria for evaluating project, but on the content of the project itself and the nature of risks taken. This provides a definition in act of what a learning pact about. Within this frame, we have demonstrated that the evaluator's description could point at trials unanticipated by the actors and thus play an active role in the redefinition of the project.

5.2- WHAT REMAINS TO BE DONE ON PROTEE

These tests were successful enough for members of the consortium to enter in a "scaling up" process. This was initiated along three complementary directions.

- We have learnt from cases done, that the method can be further developed only by working on on-going innovation projects. This is reinforced by the fact that the CIMP project manager and company decision makers have asked for such periodic encounters. We have thus engaged the same relation on another project managed by the co-ordinator of the PROTEE project, i.e. the KARVOR project (a new short rang ship integrating logistical facilities) which won the French Transport award in 1999. We consider the next phase of PROTEE to be centred on "real" experiments, i.e. given organisations where the "learning pact" approach

is shared internally, enabling risky descriptions to be proposed and discussed, and allowing for a continuous follow up of the same project, with the possibility of witnessing the consequences of the successive risky descriptions. This will require devising a specific research design for learning about the experiment and implementing lessons in a fully usable software tool. Contacts have been taken with a large transport equipment manufacturer about its long term research activities, with a large transport operator about the development of a new system, and with a regional collaborative scheme on transport research.

- The second direction was to start formalising the principles and the know how gained. This has been done by devising a preliminary user electronic manual. We are conscious that is a "research" version mainly dedicated to the present PROTEE experts and researchers for using in their further proposed experiments.

- The third direction was to take hold of academic findings – PhD theses are under way in two of the academic labs participating to the PROTEE project in relation with industry – and to foster a better understanding of the approach in engineering circles – through presentations and courses.

Finally, PROTEE is also a way to facilitate the dialogue among evaluators, administrators and project managers with different constraints to those of the usual set of progress reports and technical annexes. The procedure for writing minutes, organising meetings, comparing outcomes and implementing risky descriptions, is certainly the most important outcome of PROTEE but also the one in most need of experiment. This is probably a new skill and a new know-how, at the junction between the academic world, engineering companies and public administration.

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