How can organizational capacity help to clarify project performance?

A system dynamics model on the development of project performance

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Abstract

During a long time, studies on project management were focused on duality between temporary organization (the project) and permanent organization to explain the lack of learning form the project. If the literature review emphasizes learning process and knowledge production during life cycle of project, they both disappear once the project finishes because of a lack of knowledge management capitalization. However we think that the real causes of the success or failure of the projects find their roots elsewhere that in knowledge's capitalization. From our point of view, the performance of the project could be explained starting from the concept of the organizational capacity of the project team. The organizational capacity is a collective skill. It authorizes to combine and go into action relevant resources, as team's project attitude (motivation) and team's project aptitude (innovation), organizational competences focused on good relationship at work, coordination, tasks' integration, etc…. In this way we have developed a dynamic model of project's performance based on organizational capacity. From this model and one of the main question results from this model is : Could organizational capacity improve the project path and behind the success or failure of the project?

Keywords: Learning, Organizational capacity, knowledge, organizing, performance, project management

Our aims

In recent years, the emphasis has been on the capitalization and management of knowledge and the managerial role of the project manager in terms of explaining the success or failure of projects. This research paper puts forward an alternative view of project performance based on the concept of the organizational capacity of the project teams envisaged as an accelerator of the project's possible success.

Initially, we will present the main arguments at the root of our reflections. Despite the abundance of literature on project performance, organizations have not yet developed methods of learning from projects, and the individual and collective learning which distinguishes between temporary and permanent structures remains fairly inefficient. Secondly, we will be clarifying the concept of organizational capacity via a review of the literature and a project maturity model. This will then enable us to construct a systematic model and to present the results, before issuing certain conclusive comments.

I – Learning from projects: observations of persisting difficulties on the ground

Drawing lessons from past experience in order to formulate recommendations useful for improving current or future projects remains largely a hidden exercise among contemporary organizations, despite being a recognised necessity (Pinto, 1999; Davies and Brady, 2000; Kerzner, 2000). In 2005, following the trail forged by others (Sterman 2000; Morris 2002; Williams 2004; Lyneis 2001, 2001; Lyneis and Ford, 2007), Bulbul continued with his research on the persistence of project failures and on the deficiency of learning from them. In general terms, the literature offers multiple explanations on the obstacles to learning from projects or to the lack of distribution of the knowledge accumulated: Ekstedt et al. (1999) point to the difficulties of disseminating knowledge within temporary structures, Brady, Marshall, Prencipe and Tell (2002) talk of the departmentalization of the knowledge due to the discontinuity of the task-oriented project activities; Cooper, Lyneis, and Bryant (2002) demonstrate that the theory which consists of thinking that projects prevent learning is off the mark; Cooke-Davies (2002) underlines the lack of appropriate post-project analysis. To sum up, the obstacles to learning remain entrenched.

More specifically, project management studies have long since focused on the duality between temporary and permanent structures in order to explain the obstacles to learning from projects. This literature proposes that all of the processes of learning and of knowledge production that accumulate during a project's lifespan are not conserved after its end and are dissipated, in the absence of any capitalisation of the knowledge. For instance, Koskinen, Pihlanto and Vanharanta (2003) see, in temporary structures, the difficulties with sharing the implicit knowledge due to a lack of time to develop and share a common language and culture. This disruption in the continuity of the knowledge accumulation process then leads to a breakdown in the distribution of the knowledge, practices and feedback resulting from the actual experience. In other words, the fragmentation of the knowledge would be connected to the lack of close links between the temporary and permanent structures. Whether at individual or collective level, the knowledge gained as a result of projects is based on our own accumulation of technical knowledge or on our actual experience within the project's context. This knowledge (tacit or explicit) is the subject of retention, i.e. it is not distributed, as there is no process controlled by the permanent structure (Disterer, 2002) and designed to manage this

knowledge. Combined together, these elements create a discontinuity in the learning from organizations, a fact which could help to explain the low level of learning from projects.
Previously, Morecroft (1994) had emphasized that fixed structures do not facilitate analysis of the different aspects of a project's dynamic behaviour during the development phases when organizational changes occur, or when the characteristics of the product are modified over time. In other words, static models are of limited value when it comes to helping managers to learn from projects. There are two reasons for this: the first is that projects are highly complex dynamic systems which static models are incapable of grasping; the second is that the effects of time, delays and causal relations are not linear.

However, the benefits of learning from projects are manifold and widely recognised by the literature and practitioners. In this regard, we can observe the significant improvement in the tacit and explicit knowledge of project teams based on learning from experience (Turner, Keegan, and Crawford 2000), the improvement in the processes of pre-project evaluation and assessing the associated risks (Williams, 2005), progress with decision-making (Azzone and Maccarrone, 2001), the optimization of the subsequent phases of the project based on the lessons learned in the previous phases and the consequent possibility of reducing new product development costs and delays (Kumar and Terpstra, 2004).

But drawing lessons from experience, improving knowledge and distributing it to the other project contributors as well as to the organization as a whole is not straightforward. This observation can be explained by two main factors:

- The first comes down to the very nature of the procedures put in place to garner useful lessons. These procedures may be deployed throughout the project's lifespan or as from the end-of-project review – which is generally the case in our experience. In this latter case, they are generally relatively poor in terms of content due to the paucity of time devoted to this activity, the lack of orientation of this specific process and the absence of motivation among the individuals to pass on their knowledge so that it can be codified and then distributed.

- The second reason relates to the lack of precision in the analysis of the real causes of the success or perceived failure of projects. Often perceived as a "witch-hunt", the project "post-mortem" analysis is not of a nature that allows valuable knowledge to be obtained for use on other projects: it is commonly limited to the level of specific learning, which is therefore localized, difficult to apply as a whole and far removed from generic learning. These "post-mortem" analyses remain centred on specific issues and there is an intrinsic inability, in the way these analyses are conducted, to free them from the local context for the benefit of the general context, and to therefore extract what may be useful. Two elements serve to support this idea: the first concerns the procedure used, while the second relates to the recognition of the complexity of projects, a factor which further increases the obstacles to learning from them.

    - The typical procedure used to conduct post-mortem analyses is based on a succession of linear stages in which all of the processes are rationalized, stripping them of the context, action and social dynamic which emerge during the course of the project. Based on a logic of fragmentary decomposition, the result of the analysis does not attain a sufficient degree of knowledge, due to having failed to appreciate the causal interactions generated by the interdependence of the different elements. However, in order to circumvent

this lack of generalization Cooper, Lyneis and Bryant (2002) demonstrated the great usefulness of systematic approaches to learning through project modelling, which managers could use to test new ideas, assess the effects of their decisions and memorise best practices. To our knowledge, however, learning based on project modelling in France remains extremely limited, not to say nonexistent, judging by the management training programmes or in-house training courses.

- The eruption of complexity in project (Baccarini, 1996), whether structural, temporal, technical or directional (Remington & Pollack, 2007), has further increased the difficulty of learning from projects, due to the absence of appropriate models of thought for dealing with their complexity. This is because, within this complex setting, reductive initiatives based on disjunctive approaches to thinking are ineffectual. Only open holistic approaches are likely to capture and then model the representation that is made of the project based on the problematic situations encountered. It is a question of conceptualizing and representing agile, scalable systems ("Soft System thinking"). By recognizing the project as a complex social process within which the human activity system tends to widen the representation made of the project, knowledge of the project's general behaviour is enhanced.

Today, learning from projects is an action fundamental to a company's achievement of its strategic goals. As organizations become increasingly project-structured, they primarily base their growth and development on their ability to market ever-more innovative products more rapidly, based on the projects which they develop. Consequently, they have a great deal to gain from developing their capacity to learn from projects and to deploy structured and dynamic learning processes in order to improve their organizational capacity. This is the reason why the dichotomy between learning from projects and learning at organization level has no more grounds to exist, as it is through the exploitation of all the available knowledge and all the experience of individuals that the organization will become more efficient in its operation and results. Projects are therefore the keystone of modern organizational learning (Bredillet, 2004). Other authors such as Ayas and Zeniuk (2001), and also Sense (2003), see the project as a vehicle for learning and for the development of communities of practices. Arthur, DeFillippi, and Jones (2002), meanwhile, propose a classification of project success based on performance and learning, while Brady and Davies (2004) go as far as to state that the knowledge generated by learning from the project results in the modification of the organization's strategic choices.

However, one question emerges from this presentation. If one considers the modern project as a complex social process, how can knowledge be created within projects in order to improve the organizational capacities of teams? In the light of the theories of complexity, this then puts a different slant on the question of learning from projects by raising the issue of knowledge production from a different perspective.
This is because a systematic approach is needed in order to show how, from a set of causal chains, to lead to a system at where the combination of the different elements comprising it form a greater whole than the sum of their parts (Eden, Ackermann, and Williams, 2005; Eden et al. ,2000; Williams, Ackermann and Tait, 1995). More precisely, it is on the basis of the representation made by those involved in a given problematic situation that new knowledge is produced via the implementation of a discursive process in the exploration of the world's reality. It is therefore by comparing their different perspectives on the same social

reality that the contributors can give meaning to and enrich the mental models of individuals, thereby improving the representation and knowledge which they have of a given situation. In other words, recourse to systematic thought in order to comprehend complex systems enables managers to develop mental models, which in turn help in the construction of formal models (Morecroft, 2004). Similarly, Sterman (2000) emphasises that managers have a propensity not to perceive the implications of the long-term effects of retroactive loops, which he attributes to fundamentally insufficient consideration. It is with this in mind that we have developed a system dynamics model aimed at ensuring projects live through time.

From our point of view, the improvement of the knowledge and learning from projects and their performance could be explained on the basis of the concept of the organizational capacities of the project teams. Scarborough et al. (2004) find that a number of organizational factors can affect learning from projects, such as the autonomy of the project teams or the degree of socialisation. Team members have greater motivation to learn when they can obtain direct benefits from this learning. According to the same author, the members of the project team are capable of such learning because they form a quasi-organization capable of sharing within their context and of absorbing previously acquired knowledge. This can then be classed as a genuine community of interest that drives the project towards success.
But for the learning to extend to organizational level, it is necessary to implement organizational learning systems within which the members of the organization interact with the content of the learning, as specified by Lipshitz, Popper, and Friedman (2002). For Sense (2003), five structural attributes are required in order to support the project teams' learning: learning about human relations; understanding the different cognitive styles; knowing the management of the project team; learning about the environment within which the collective action fits and possessing the authority to take it. Bresnen et al. (2003) underline the importance of social processes in the transfer of knowledge within project teams: the barriers to learning are all social (structural and behavioural). Lipshitz, Popper and Friedman's (2002) demonstrate that the project culture can promote more productive learning, for which they highlight five elements: transparency, i.e. a willingness to express one's viewpoints and the actions undertaken in order to receive feedback; integrity, i.e. a willingness to actively seek an inward view of one's own actions; questioning, i.e. a willingness to focus on the relevant information as regards social standards; investigation, i.e. a willingness to keep looking until full and complete comprehension is achieved; responsibility, i.e. a willingness to assume responsibility for learning and the implementation of the lessons.

To sum up, in order to learn from projects in terms of organizational capacities and to go beyond the current insufficiencies of post-mortem analyses focused on the implementation of methodological guides and on the standardization of procedures, to capture the knowledge right throughout the project, it may be useful to link the organizational culture and the organizational structure. These two essential components are associated in terms of the way organizations learn. By improving organizational capacities, we enrich the importance of feedback on experience, create a collective dynamic within the project and therefore social dynamics, which facilitates the study of project behaviour and helps spread knowledge: in other words, learning together during the project.
We have constructed our reflections on the basis of this context. But what does the concept of organizational capacity actually mean?

II – What are the bases of the concept of organizational capacity?

During the 1980s, interest was centred on the business portfolio formalizing the links between the market, the company's behaviour and its performance. It was essentially an economic

perspective, with the project falling victim to the rule whereby the emphasis was especially placed on the controlled management of its performance (cost, deadline, quality). But where did that leave the portfolio of the skills and organization which are the genuine drivers for success, as well as failure? In the late 20th century, there developed a school of thought emphasizing organizational resources and skills, known as the Resource-Based View. According to it, a company's performance derives benefit from human potential (knowledge, skills), but also from organizational potential (formal and informal network of relations and communications). Consequently, results could be explained by the presence of intangible resources which could be shared between those working for the organization and which were also difficult for the competition to imitate. The project is also covered by this immaterial dimension, as is nicely illustrated by the iceberg metaphor. The tip of the iceberg, i.e. the visible part, represents the quantifiable results of the project, while the submerged section, which is larger, represents the human, organizational and even irrational elements, the non-manifest aspects which often have to be worked with. It is this "submerged" part that serves as the "booster" of the project's performance. It is surprising that the training courses continue to favour planning, controlled management and budgets, rather than project management encompassing all aspects of its resources (skills required, formal and informal organizational network, power relations, etc.). All of the manager's attention is focused on the consequences, on deviations from the schedule, on what remains to be consumed, etc. As a result, he concentrates on the results and not the origins of the problem. In cases of clear malfunctions, the emphasis is on identifying the guilty party, one or more scapegoats. In application of the victimization process presented by René Girard, it is believed that a solution will be found by replacing the managers of failing projects. In reality, however, they are just formulating an anti-symptom remedy for the tip of the iceberg. The manager is simply endeavouring to pull the project, but success depends on the team which is pushing it.

Organizational capacity transcends knowledge and skills

Admittedly, a certain number of works have sought to include the management of knowledge within projects as an essential factor in performance. Several authors have dealt with the thorny issue of the capitalisation of knowledge by drawing benefit from project feedback. Accounts of projects exchanged within communities of practices and formalized in the form of news or short stories could be regarded as an essential component in this process. This school of thought includes the likes of Buner and Boje, but the concept of knowledge is too restrictive, as it does not show how the managers who possess this knowledge can deploy it appropriately within a specific environment. This is why it is more worthwhile to talk about the concept of competence, which is the implementation of the knowledge within a given context. The knowledge is put to the test, deployed in order to solve a problem, to answer questions. Competence is then proven as it emerges in a given context. Moreover, in order to succeed, the project needs to rely on organizational knowledge and not on specific purely procedural codified knowledge learnt via training, i.e. a project charter. This organizational knowledge makes it possible to collectively derive optimum benefit from the operational rules of the project process, and permits the alignment of the project with the company's strategic aims. According to Gilles E. St-Amant and Laurent Renard, professors at the University of Quebec in Montreal, this knowledge facilitates the organized action required to carry out the project. However, we would add that the organizational knowledge is not the sum total of the individual knowledge. The former can be more optimized than the latter, but also less effective. In order to fulfil the project's aims, we need to move to a new dimension, that of organizational capacity.

What is organizational capacity?

Organizational capacity is a collective ability permitting the combination and implementation of a set of resources tailored to the project in a situation of integration and in accordance with an initial intention. These resources cover: intra and inter-organizational collaborative knowledge, organizational networks for the exchange of resources, technology, information, financial resources, schemes, etc. The situation of integration is the place where the collaborative action is carried out (project meetings, for instance). Organizational capacity is a strategic asset of the company in the sense that it creates the conditions for converting the strategic aims into action targets and that it permits the triggering of a dynamic into which the project team fits (the team drives the project by means of one or more intentional actions). No organizational capacity exists in its own. It is an emerging transdisciplinary and often cross-functional property that is the product of a structure that has reached an evolved stage of development from the managerial perspective. There is therefore a relationship between this emergence and the maturity of the organization and the project.

Dynamic organizational capacity incorporating time

Furthermore, organizational capacity is not static; it is not fixed in time. It is dynamic, as it develops throughout the life of an organization or a project, but can also be altered with time. Organizational capacity changes state on contact with project situations[1], by interacting with them. There are therefore two dimensions: obsolescence time, where the capacity decreases (e.g., the reactivity of a team is diminished, or even the ability to distinguish between what is essential and what is accessory in a project declines), and the encountering of project situations which enrich it, transform it and may even metamorphose it (e.g.: the ability to negotiate, to find an acceptable compromise between contradictory demands within a project team). Acquired over the course of time, these new organizational capacities are the subject of collective learning within the project itself.

In our view, the dynamic dimension of a project is limited by capitalizing solely on knowledge, as this excludes evolving situations within the project and the other resources such as organisation. We will endeavour to model this organizational capacity by associating it with the project and its performance.

In order to cast light on the system dynamics model which we have developed, we have presented the above concepts in a table that highlights their sequence and interconnection (table 1):

[1] Project situation here should be understood to mean the events which occur within a team (high staff turnover, tension, conflict, loss of commitment to the project, etc.)

	Definition	Characteristic	Preceded by
Knowledge	Intellectual knowledge or experience acquired via a transfer of learning or assimilated on the ground, or even existing in man	It is independent of what man may do with it, i.e. knowledge comes before its implementation, its usage	
Specific individual competence	Set of know-how & expertise, i.e. the use of knowledge. This know-how is linked to man's natural dispositions (logic and rationality, sense of relations with others, his own intelligence, etc.)	Shows how man has appropriated the knowledge and how he deploys it in a given situation. Competence also involves discipline, as it is linked to the treatment of a specific question (deviation from budget, for example)	Knowledge
Organizational competence	Competence permitting the optimization of the method of work organization, the coordination and integration of tasks and activities and working relations, and being able to take advantage of the informal side of the project and from power games	The Organizational competence which exists at group level is not simply the sum total of the individual skills. It transcends them.	Individual competence
Organizational capacity	Combination of tangible and intangible resources such as intra and inter-organizational skills, the information and communication deployed within the organizational network	Organizational capacity is brought into play in a situation of integration where the collective and intentional action that gives meaning to the project takes place. It is linked to the project's maturity.	Organizational competence
Dynamic organizational capacity	Deployment of the organizational capacity over time in contact with successive situations, which leads to changes of state (development)	Organizational capacity leads to obsolescence, but can also be transformed or even metamorphosed, under the pressure of events	Organizational capacity

Table 1

Our hypothesis is that dynamic organizational capacity is linked to each stage of the project's development. In order to clarify these stages, we present three stages of maturity (Figure 1):

The project maturity model

We have digressed from the CMMi (Capacity Maturity Model) model[2] by simplifying it and giving it additional dimensions. Our reasoning is more based around stages of development each corresponding to a sudden transformation of the project. Our approach is structured around three stages of disruption, of discontinuous change. We thus present three scales: the stages marking the disruptions, the behaviour of the project team in terms of cohesion, and the meaning given to the project, together with the energy or resources deployed in each of these three stages.

- The anarchic, confused situation characterises disorder (first dimension). Everyone within the project team acts without coordination and this type of project is based on

[2] The CMMi was formalized by SEI (Software Engineering Institute), which reasons in five progressive and continuous stages

strong individualities within it (second dimension). A great deal of human energy is wasted because of an organisational crumbling (third stage).

- The organized situation marks a stage where the project's methods and techniques are known and applied. However, there is still not yet homogeneity or coherence within the project. Pressure groups exist and diverge on the meaning of the collective action. The project manager tries to pull the team through and to give the project meaning. Numerous resources are expended in order to make the project coherent.
- The managed situation is based on intentional collective action: everyone acts in the same direction, the project team pushes. The project manager plays the role of catalyst. The energy of progression is centred on creativity and innovation and gives the project value.

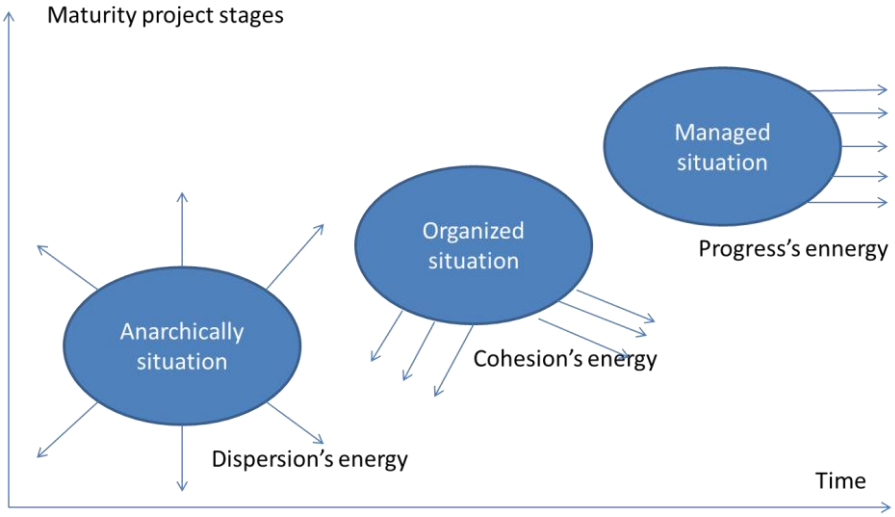

Figure 1: the project's stages of development

Brief review of the literature on organizational capacities

It was in 1972 that the organizational capacities approach was introduced by Richardson G.B., who was endeavouring to discern the notions of skill, experience and knowledge that firms possess.

The theories on organizational capacities then progressed courtesy of several works by other American authors.

According to Grant R.: "A capacity is the capacity for a team of resources to perform some task or activity. While resources are the source of a firm's capacities, capacities are the main source of its competitive advantage". For Amit R. & Schoemaker P.J.: "Capacities, […] refer to a firm's capacity to deploy Resources, usually in combination, using organizational processes, to effect a desired end. They are information-based, tangible or intangible processes that are firm-specific and are developed over time… thought of as 'intermediate goods' generated by firm's Resources…"

For Collis D.J. "This paper will define organizational capacities as the socially complex routines that determine the efficiency with which firms physically transform inputs into outputs".

For Winter S.G. "An organizational capacity is a high-level of routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decisions options for producing significant outputs of a particular type".

French-speaking Canadian researchers have also made their contribution, with St-Amant Gilles E. and Renard L. defining organizational capacity as "the deployment, combination and coordination of resources, skills and knowledge through different value flows in order to implement strategic aims… A value flow is a series of processes of an organization…".
It is clear then that there are as many definitions as there are authors. The concept is not yet totally stabilized.

III - Our system dynamics model: the choices made

There are two ways of modelling a complex situation: bottom-up modelling and top-down modelling. In the first case, the observation data is taken as starting point. The relevant variables are identified (first interpretation), followed by the relations between them (second interpretation). Subsequently, simulation permits the definition of the overall behaviour of the system, which is compared with that which has been observed. Clearly, the model is validated if the results observed are not too far removed from the states and flows calculated. However, we all know that "in vivo" modelling and simulation introduces an underdetermination which stems from the disregarding of all the empirical data and taking into account a subset which is thought to be representative (third interpretation), together with a part of the structure of connections between the variables.
"In vitro" modelling enables the construction of a generic top-down model without concerning oneself with the level of details of the properties and relations observed on the basis of the system observed. It is a question of formalizing, by means of a logico-mathematical structure (dynamic diagram), the main causal relations between the variables. The abstract model should highlight a certain number of general properties and even counter-intuitive ones, which can help us to explain the changes of state, the development of the project and also its performance levels.

Research methodology used:

Our exploratory and qualitative research naturally leads us towards open and plural approaches likely to support our reflections in the construction of our model, the identification of the factors (socio-cognitive, perceptions, etc.), the search for causal relations between the key variables and finally, the construction of a cognitive map, and therefore in the causal model that the map permits. It is on this basis that the systematic model will be constructed. It is therefore a multi-methodological approach that we are using here, by deploying the cognitive maps of Eden et al (1989), together with system dynamics (Forrester, 1961). These two combined approaches are widely recognized by the literature as operational approaches for flexible systems (Senge, 1990; Eden C, Williams T, Ackermann F and Howick S, 2000; Howick, 2003; Mingers, 2003), but rely on the coherence of the combined approaches. For this, we use the theoretical framework of Mingers (2003), which is based on the following two identified aspects: the three dimensions of the problematic situation (social, personal and material) and the different phases of the intervention. The coherence of the methods used is regarded as satisfactory in terms of the criteria from this framework.

From an operational viewpoint, we have constructed our model on the basis of a two-stage initiative, the main themes of which we set out here:

- Stage 1: development of a qualitative model based on the mental models of the individuals interviewed, followed by construction of a causal map.

- Stage 2: transformation of the causal map into a quantitative simulation model. Calibration and validation of the model using the key variables. Lastly, we test our research hypotheses before their presentation to the persons interviewed.

In the following paragraphs, we present the operationalization (implementation) of our research study

The foundations of the model. This includes five sub-systems:
1) the target organization (i.e. its definition)
2) the project's human resources
3) the capacity for innovation and learning
4) the organizational capacity
5) the project's performance.

Sub-system	Principal variables which form it
The target organization	Type of mission; field of control; degree of coupling between sub-projects and between tasks; type of task (sequential, coupled, etc.); rate of fractionation into sub-projects
The human resources	Experienced and inexperienced contributors; contributors recruited and leaving the project; contributors trained; coaching and turnover rates; levels of skill and motivation; total workforce
The capacity for innovation and learning	Multiplication of knowledge through instruction (rules); rate of effectiveness of the communication, turnover of contributors; pooling of skills (extent of working relations permitting the distribution of skills, if they are sufficient)
The organizational capacity	Multiplication of learning; degree of impact of the motivation; rate of effectiveness of the communication; multiplication of innovation; multiplication of skills; work autonomy
The project performance	Progress and deviation of the project (deadline); actual productivity and quality

Table 2

Below, we have depicted the connection variables which interlink these subsystems.

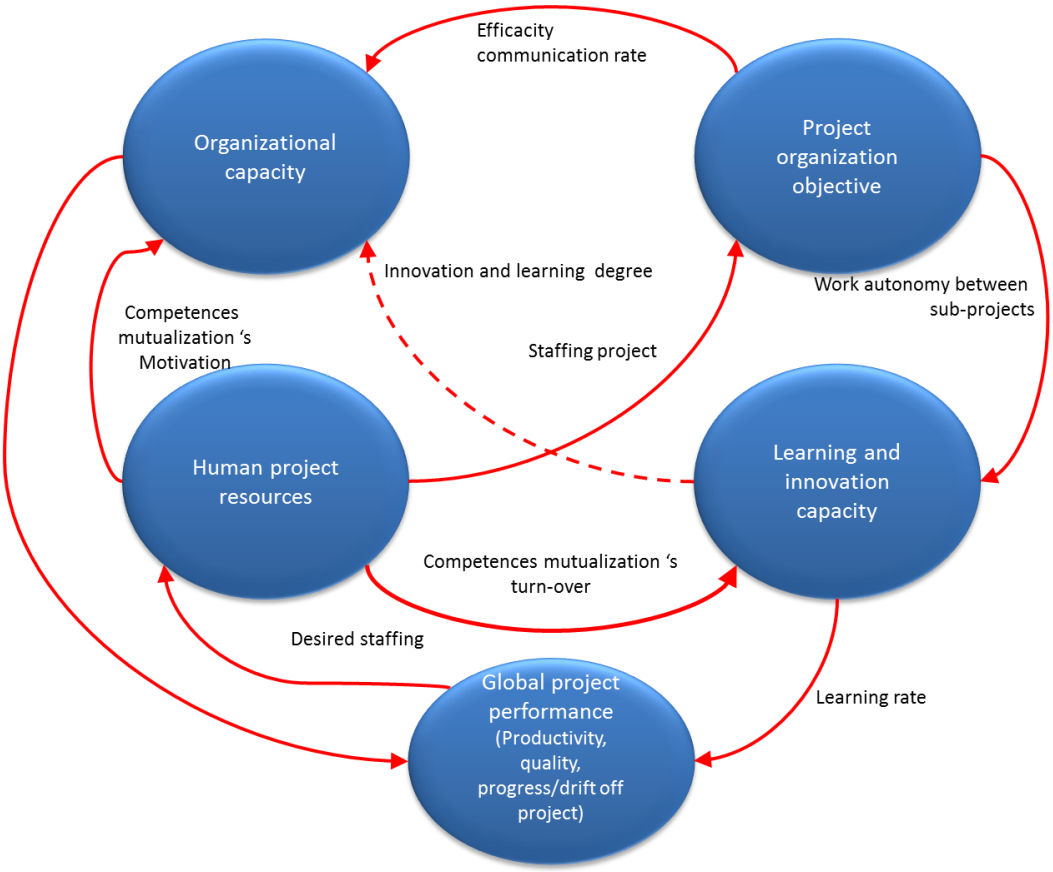

Figure 2: diagram representing sub-systems

The causal diagram

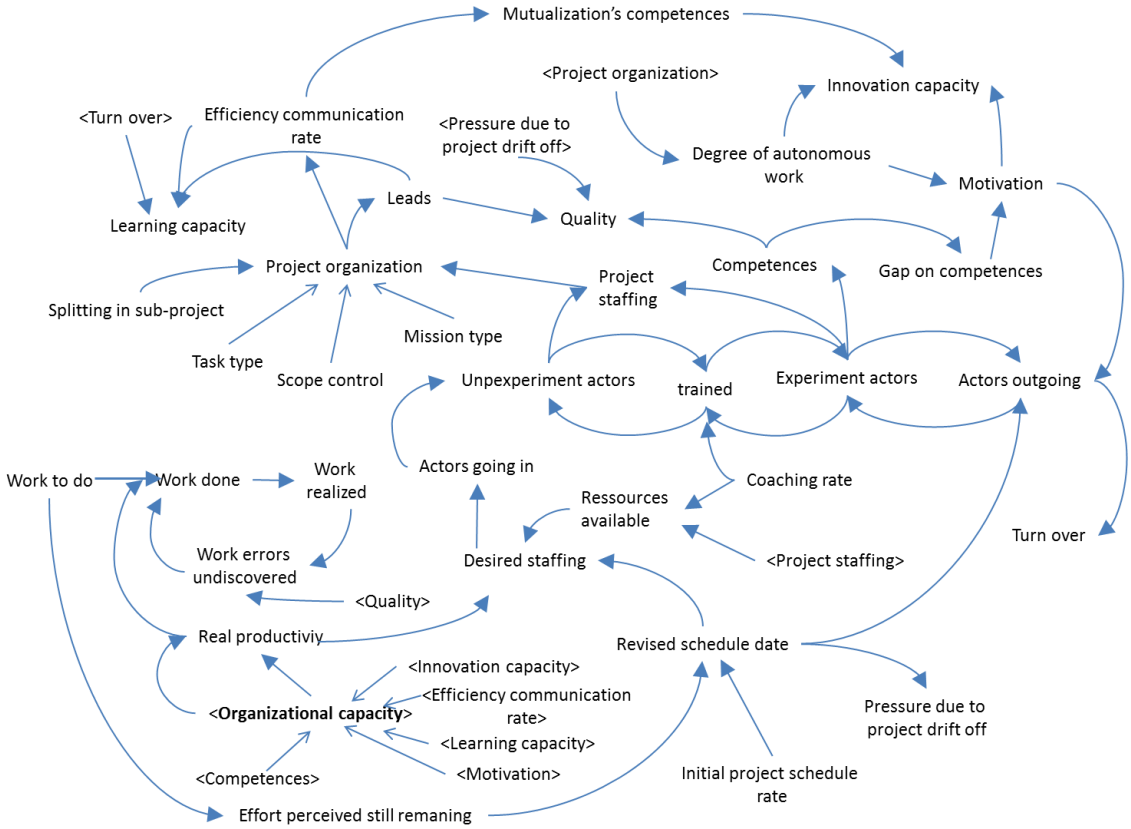

Figure 3: the causal diagram

The variables surrounded by the symbol <…> are repeated at least twice in the diagram below. This serves not to overload the causal diagram and to make it more legible.

IV - The results of the simulation

The number of project failures is considerable. According to a study conducted in 2001 by the Standish Group, only 16% of all projects end in success. This figure, however, should be viewed with caution, as the survey's investigative techniques were not revealed. A project is regarded as a "failure" when the results do not correspond to the initial objectives; for example, budget and time overruns, or even nonconformity with the initial demand from users and from the general management.

Most notable among the chief causes are a lack of skills and knowledge, deteriorated communication between contributors, and failing management (nonexistent leadership). However, we believe that the real reason is centred on the sub-capacity to develop assets or resources within a project (collective learning, pooling and distribution of skills, exploitation of the organizational network and sharing of experience, etc.). To return to the image used earlier in this paper, while the project manager "pulls", the project's success depends on the team which "pushes" the project.

This leads us to pose several questions:
Do the initial assets (the human resources, the initial intangible capital such as the degree of competence, the operational method of organization, the level of motivation, etc.) protect projects from subsequently encountering failure?
Are the duration of existence, decline and failure dependent on the initial level of the assets?
Do organizational capacities explain the existence of path dependency (trajectory) subsequently resulting in failures?
How can we use organizational capacities to generate a self-maintained performance throughout the project?

Based on this questioning, we propose two scenarios (a first organized situation and a second managed one):

1) Resources poorly allocated from the start of the project (limited project staffing, an average level of competence, an organization arranged as a silo (vertical) or functional formation, limited communication within the project, etc.)
2) A reinforcement of the assets or resources at the launch of the project (more staff, extended skills, etc.) and a strong reconfiguration of the project's organisation permitting transversality between sub-projects, the coupling of widened or transverse tasks and assignments, a looser field of control or supervision, etc. However, the major down side is the complexification of the project's structure due to more numerous relations and interactions.

We have selected several graphical results per scenario:

For performance: the actual productivity, the actual level of quality, the revised scheduling date which indicates the project's progress or delay

For the project's resources or assets: the number of experienced and inexperienced contributors, the organizational capacity

Initially, we scheduled a project date of 80 days at the latest. The simulation displays the results each week. As we have specified above, the simulation can be carried out in automatic mode (the computer "decides" alone) or in manual mode (with man in control). The model was developed using the Stella version 9.1.4 software from isee systems.

Results from scenario 1

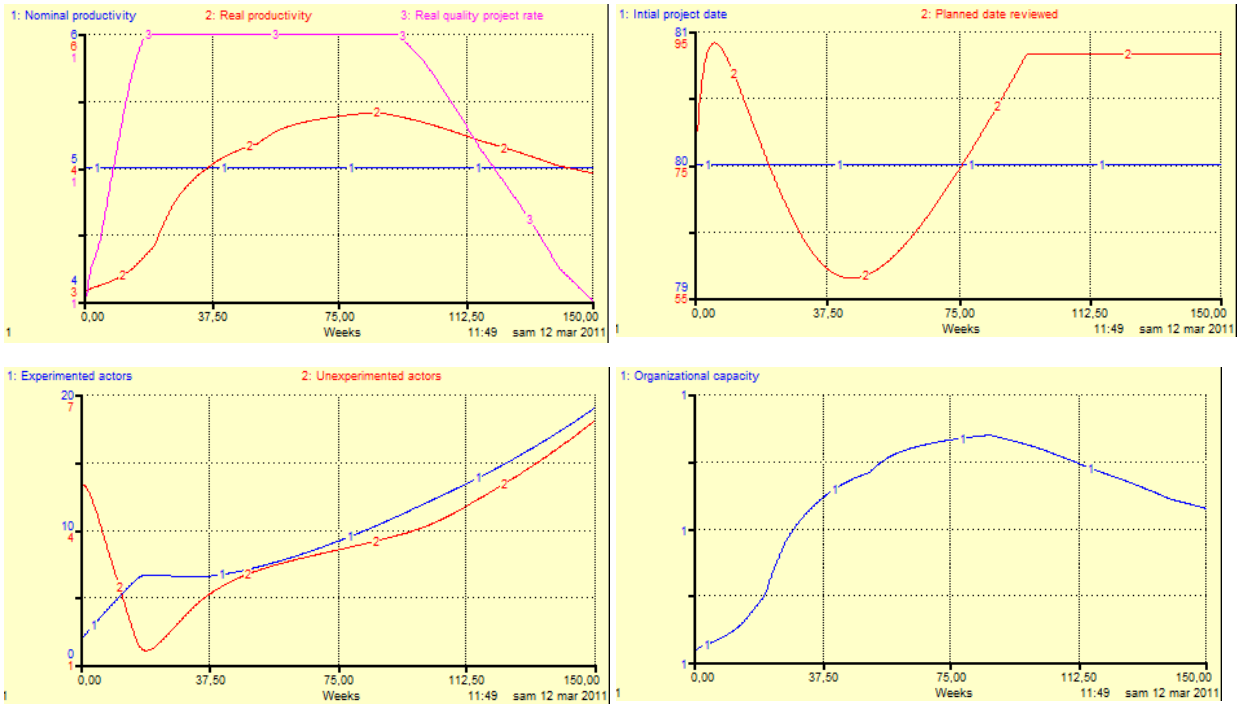

Figure 4: scenario 1

Results from scenario 2

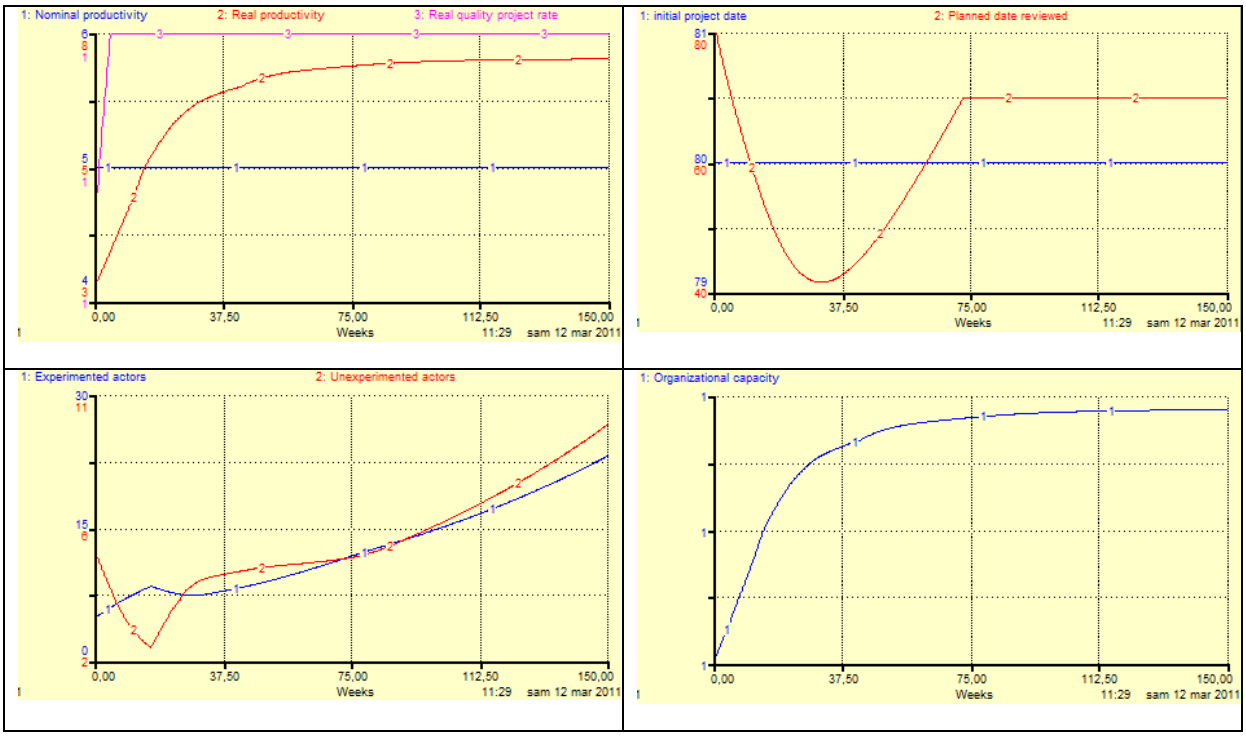

Figure 5: Scenario 2

Discussion

We propose to analyze the results from table 3 below.
Let us recall that Scenario 1 is characterized by minimal resources allocated at the start of the project, with a functional or vertical project organization. The second scenario is defined, from its launch, by somewhat more significant assets (10 staff instead of 7) and a skills index of 0.50 instead of 0.29, but crucially a radical reconfiguration of the project from the point of view of its organization. In essence, the roles are more transverse, the tasks more versatile with reciprocal coupling, the project fractionated in order to take account of the optimum size of the teams[3], and the managerial supervision (field of control of the work) more flexible in order to give the contributors greater responsibility and autonomy in their work.
What do we see?

1) Scenario 1 does not achieve its objective since it finishes in week 92 instead of week 80, a deviation of +15%), which is not catastrophic in itself except in a research project where the rapid filing of a patent is crucial vis-à-vis the competition and also delays the subsequent project relating to the placing of the innovation in production.
2) Curiously, the level of staff at the end of the project (92 weeks for Project 1 and 70 weeks for Project 2) is almost identical for both scenarios. Similarly, the skills index is very similar (0.75 and 0.76). So what is the origin of the performance deviation (number of weeks used)?
3) It can be observed that the productivity is much greater in Scenario 2. By hypothesis, we have developed the concept of organizational capacity which affects productivity in the project (number of tasks per week and per person). It is clear that this is higher in the progression of the second simulation. And yet we know from the theory which we previously explained that organizational capacity is the consequence of several direct and indirect factors representing the organizational resources (capacity for learning, effectiveness of communication, motivation of the contributors, disposition for innovation, skills, degree of work autonomy, etc.).
4) Table 3 highlights the deviation between these factors acting upon each of these two scenarios and it can be observed that it is indeed the components of organizational capacity that make the difference. However, attention should be paid to the project complexity index, which is a great deal higher in Scenario 2 than in the first. This complexity is dependent on the degree of coupling between the tasks and sub-projects. It can inhibit the project's performance through numerous organizational interactions. It is the capacity for learning of the staff[4] which enables it to be dealt with efficiently.

	Scenario 1		**Scenario 2**	
Period in weeks	**37.5** [5]	**92 end of project**	**37.5**	**70 end of project**
Productivity (no. of tasks per week per person)	4.02	4.58	6.42	6.87
Organizational capacity (0.5 to 1.5)	0.81	0.92	1.28	1.37
No. of experienced contributors	7 (2, beginning[6])	11 (2, beginning)	8 (5, beginning)	11 (5, beginning)

[3] It is known that the size of project teams affects the fluidity of the communication (law of diminishing returns in communication: 20 contributors already generate more than 300 reciprocal communication channels!). However, the more the teams are broken up, the more the interfaces between them need to be managed, thus increasing the project's complexity.
[4] See the causal diagram (Figure 3). It is dependent on knowledge by instruction (procedures) but more importantly, it is linked to the effectiveness of the communication which distributes experience within the project, and to the constraint of the turnover which limits it.
[5] 37.5 weeks: practically midway in relation to the project's initial schedule (80 weeks)

No. of inexperienced contributors	3 (5, beginning)	4 (5, beginning)	4 (5, beginning)	5 (5, beginning)
Skills index (0 to 1)	0.66	0.76	0.69	0.75
Capacity for learning (0.5 to 1.4)	0.87	0.86	1.10	1.13
Capacity for innovation (0 to 1)	0.32	0.45	0.57	0.72
Degree of work autonomy	0.56	0.63	0.73	0.83
Communication index (0 to 1)	0.82	0.81	0.99	1
Tasks to be repeated (per week)	25	25	5,3	5,3
Motivation (0 to 1)	0.65	0.73	0.84	0.97
Degree of complexity of work (1 to 2)	1.42	1.42	1.59	1.60

Table 3

Conclusive comments:

What is it that we have sought to demonstrate? In essence, our approach indicates that path dependency exists in projects, taking its roots from the instigation of the project with the constitution of assets or a sufficiently well-performing portfolio of resources. This latter defines an initial imprint on which the success of the project subsequently depends.
Rather than the capitalisation of knowledge and skills that the traditional literature often highlights, it is the organizational capacity and its constituents which should be favoured in the initial design of the project. The attention of the project manager should be focused on this due to the difficulty of grasping an abstract concept.

We have solicited reactions to our model and its hypotheses from several project managers. The sample of projects covers the electronics industry (manufacture of circuit boards) and the agri-foodstuffs sector (field seeds and cereal products). Despite the divergence between these activity sectors, our project managers recognised the importance of the hidden factors represented by the submerged part of the "project" iceberg.

On the basis of this initial work and armed with encouraging returns on the ground, we are currently conducting research on behalf of a specialist project management firm. More specifically, this request made to us directly poses the question of the improvement of the organizational capacities of a project team in a project displaying deviation. From this in vivo modelling work, we intend to refine our model in order to then derive from it recommendations useful to project leaders for the improvement of the control of projects and their performance. Subsequently, our aim is to demonstrate the full usefulness of the system dynamics and modelling made possible, which endeavour to enhance decision-making and therefore action, as well as the knowledge that results from it. Based on our areas of research, we believe it would be useful to change the way that projects are considered and represented by incorporating changes of state and the effects of their organization.

[6] Staff allocated as from the instigation of the project

References

Amit R., Schoemaker P.J., Strategic Assets and Organizational Rent, Strategic Management Journal, 14, PP 33-46, 1993.

Arthur, M. B., R. J. DeFillippi, and C. Jones. 2001. Project-based learning as the interplay of career and company non-fi nancial capital. Management Learning 32:99–117.

Ayas, K., and N. Zeniuk. 2001. Project-based learning: Building communities of reflective practitioners. Management Learning 32:61–76.

Azzone, G., and P. Maccarrone. 2001. The design of the investment post-audit process in large organisations: Evidence from a survey. European Journal of Innovation Management 4:73– 87.

Baccarini, D. (1996). The concept of project complexity: A review. International Journal of Project Management, 14(4), 201–204.

Boje, D., The storytelling organization: a study of story performance in office-supply firm, Administrative Science Quaterly, Vol 36, pp 106-126, 1991).

Brady, T., and A. Davies. 2004. Building project capacities: From exploratory to exploitative learning. Organization Studies 25:1601–22.

Brady, T., N. Marshall, A. Prencipe, and F. Tell. 2002. Making sense of learning landscapes in project-based organisations. Proceedings of OKLC 2002: The Third European Conference on Organizational Knowledge, Learning and Capacities, Session 13-3, Athens, Greece. Athens, Greece: Athens Laboratory of Business Administration.

Bredillet, C. N. 2004. Projects are producing the knowledge which are producing the projects. Proceedings of the IPMA World Congress.

Bresnen, M., L. Edelman, S. Newell, H. Scarbrough, and J. Swan. 2003. Social practices and the management of knowledge in project environments. International Journal of Project References 137 Management 21:157–66.

Buner, J.S, Acts of meaning, Cambridge, MA, Harvard University Press, 1990.

Collins D.J., Research Note: How valuable are Organizational capacities, Strategic Management Journal 15, pp 143-152, 1994

Cooke-Davies, T. 2002. The "real" success factors on projects. International Journal of Project Management 20:185–90.

Cooper, K. G., J. M. Lyneis, and B. J. Bryant. 2002. Learning to learn, from past to future. International Journal of Project Management 20:213–19.

Cooper, K. G., J. M. Lyneis, and B. J. Bryant. 2002. Learning to learn, from past to future. International Journal of Project Management 20:213–19.

Davies, A., and T. Brady. 2000. Organisational capacities and learning in complex product systems: Towards repeatable solutions. Research Policy 29:931–53.

Disterer, G. 2002. Management of project knowledge and experiences. Journal of Knowledge Management 6:512–20.

Eden, C., F. Ackermann, and T. Williams. 2005. The amoebic growth of project costs. Project Management Journal 36:15–27.

Eden, C., T. Williams, F. Ackermann, and S. Howick. 2000. On the nature of disruption and delay (D&D) in major projects. Journal of the Operational Research Society 51:291–300.

Ekstedt, E., R. A. Lundinm, A. Soderholm, and H. Wirdenius. 1999. Neo-industrial organising: Renewal by action and knowledge formation in a project-intensive economy. London: Routledge.

Girard, R., Le bouc émissaire, livre de poche, 1986.

Grant R., The resource based theory of competitive advantage: implications for strategy formulation, California Management Review, 33, 1991.
Kerzner, H. 2000. Applied project management: Best practices on implementation. New York: Wiley.
Koskinen, K. U., P. Pihlanto, and H. Vanharanta. 2003. Tacit knowledge acquisition and sharing in a project work context. International Journal of Project Management 21:281–90.
Kumar, S., and D. Terpstra. 2004. The post mortem of a complex product development – Lessons learned. Technovation 24:805–18.
Le Boterf, G., De la compétence. Essai sur un attracteur étrange, Les éditions d'organisation, 1995
Lipshitz, R., M. Popper, and V. Friedman. 2002. A multifacet model of organizational learning. Journal of Applied Behavioral Science 38:78–98.
Lyneis, J. M., K. G. Cooper, and S. A. Els. 2001. Strategic management of complex projects: A case study using system dynamics. System Dynamics Review 17:237–60.
Lyneis J., Ford, D. (2007). System dynamics applied to project management: A survey, assessment, and directions for future research. System Dynamics Review 23 (2–3), 157–189.
Morecroft, J. 2004. Mental models and learning in system dynamics practice. In Systems modelling: Theory and practice, ed. M. Pidd. Chichester, UK: Wiley 101–26.
Morris, P. W. G. 2002. Managing project management knowledge for organizational effectiveness. Proceedings of the PMI Research Conference 2002, 77–87. Newtown Square, PA: Project Management Institute.
Pinto, J. K. 1999. Managing information systems projects: Regaining control of a runaway train. In Managing business by projects, ed. K. A. Artto, K. Kähkönen, and K. Koskinen, 30–43 Helsinki: Project Management Association Finland and NORDNET, Helsinki, Finland.
Richardson G.B, The organization of industry, Economic Journal, pp 883-896, 1972.
Scarbrough, H., M. Bresnen, L. F. Edelman, S. Laurent, S. Newell, and J. Swan. 2004. The process of project-based learning: An exploratory study. Management Learning 35:491–506.
Sense, A. J. 2003a. Learning generators: Project teams re-conceptualized. Project Management Journal 34:4–11.
St-Amant G., Renard L., Management des capacités organisationnelles, GCO, journée de réflexion, Université du Québec à Montréal, 2007.
St-Amant Gilles E. et Renard L., Aspects théoriques d'un cadre de développement des capacités organisationnelles, ASAC (Association des Sciences Administratives du Québec), 2004.
Sterman, J. D. 2000. Business dynamics: Systems thinking and modeling for a complex world. Boston: McGraw-Hill Higher Education.
Turner, J. R., A. Keegan, and L. Crawford. 2000. Learning by experience in the project-based organisation. Proceedings of the PMI Research Conference 2004, CD-ROM. Newtown Square, PA: Project Management Institute.
Williams, T. 2004. Learning the hard lessons from projects easily. International Journal of Project: Post-Project Reviews to Gain Effective Lessons Management 22:273–79.
Williams, T. 2005. Assessing and building on project management theory in the light of badly overrun projects. IEEE Transactions in Engineering Management 52:497–508.
Williams, T., C. Eden, F. Ackermann, and A. Tait. 1995. The effects of design changes and delays on project costs. Journal of the Operational Research Society 46:809–18.
Winter S.G., Understanding dynamic capacities what are they?, Working Paper of the Reginald H. Jones Center, The Wharton School University of Pennsylvania, 2002.