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Management of Novel Projects under Conditions of High Uncertainty

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Most R&D projects are confronted with high levels of uncertainty. The management of these projects requires a different approach than the traditional network techniques (PERT, CPM, etc.) would prescribe. The project management literature recognises this and offers a series of methods to master uncertainty, in order to extend the domain of application of these network techniques. But when projects are confronted with a high level of uncertainty we argue that these traditional risk management methods become counterproductive and actually create a false confidence that all risks have been addressed. On the basis of a series of in-depth case studies we have classified uncertainty in three categories (variation, known unknowns and unknown unknowns, or unk-unk's). In this paper we will show on the basis of a few examples and our cases how one makes a trade off between the different responses based on the cost of each of the methods. We will also show when one needs to move from traditional project risk management methods to learning and/or selectionism. We argue that the choice of response will have a strong influence on the mindset and the style of the project manager, the infrastructure used for the management of uncertain projects and the way the relationships with the stakeholders in the project is managed.

1. Introduction: Project Management and Risk

A project can be defined as a sequence of activities to accomplish a temporary endeavor to create a unique product or service (Meredith and Mantel 2003, 8). Projects represent an organizational tool to respond to risks: they are made up of temporary structures and flexible methods. Each project is unique in some aspect, and is thus managed slightly differently from other projects, or ongoing

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processes. In short, projects are temporary structures and management methods that allow companies to be flexible and to respond to risks.

We recently observe two trends in project management. First, the use of projects by organizations is expanding. This reflects an increase in uncertainty and velocity in many industries (e.g., Kloppenborg and Opfer 2002, Pinto 2002, Kerzner 2003) and the need to invest in R&D and innovation.

Second, project risk management has become an established, formalized and widely used project management method in particular in the field of R&D Management. Risk is commonly defined as "the implications of the existence of significant uncertainty about the level of project performance achievable" (Chapman and Ward, 1997: 7) and is seen as having the two components of probability of occurrence and the consequences/impacts of occurrence. While the details differ, all established project risk management methods recommend actions to *identify* risks beforehand, to classify and *prioritize* them according to probability and impact, to *manage* them with a collection of preventive, mitigating and contingent actions that are triggered by risk occurrence, and to embed these actions into a system of documentation and *knowledge transfer* to other projects.

But on the basis of a range of case studies (Loch, De Meyer and Pich, 2006) we have observed that the established risk management methods enable us to handle mainly the foreseeable risks and what we will call residual risk, i.e. the small occurrences that one cannot plan for.

But handling foreseeable and residual risk does not cover all relevant project challenges in R&D Management. Already in 1987, Morris and Hugh (1987, p. 8-11) concluded that established project management methods are not enough to lead major projects to success, and that many fail. In a large study of 60 large engineering projects, Miller and Lessard (2000) found that only 45% met most objectives, while 19% came in below target (but without crises), 16% had to be restructured, and 20% were abandoned. More generally, over 70% of projects in large organizations fail to meet their stated objectives (Project Management Institute Factbook 2002).

The first reaction, of course, might be that the reason lies in poor management; indeed, these failures to meet stated objectives are often interpreted by the organization as failures of the project management team, negatively affecting rewards or even careers. While poor management cannot be excluded, this interpretation fails to grasp an essential reason for the failure of many projects, which lies in novelty, in unforeseeable uncertainty, or unknown unknowns ("unk unks" in engineering language).

Morris and Hugh (1987, p. 216) concluded that technical uncertainty was a major contributor to project problems. Miller and Lessard (2000) extended this observation: multi-year projects with multiple stakeholders fundamentally pose unforeseeable uncertainty and are systematically affected by unplannable events. And this is necessarily so because only such projects offer sustainable economic rents. Simple projects are easily copied and their rents quickly competed away. Increasing industry dynamics and sophistication force us to push the envelope in seeking new markets and new technologies. Unk unks are a fact of life in today's challenging R&D projects.

But the fundamental logic of existing project risk management methods does not address unk unks. Traditional project risk management is an *instructionalist* approach—contingency plans are drawn up as instructions for the project management team to follow, and contingencies and flexibility are pre-planned and then only "triggered". This approach works fine as long as all risks are identified and their impact on the project can be predicted. But it actually prevents organizations from understanding and appreciating the true challenges of project management when faced with novelty and unk unks:

- Risk lists give the project management team the unwarranted belief that all risks have been identified and addressed;

- Detailed project plans—possibly with contingencies—come to be seen as the objective itself, rather than the means to achieve an objective;

- Project management personnel are chosen for their experience in project planning, control and firefighting, but not for a mindset for learning and flexibility;

- Stakeholder relationships and contracts require an objective to be reached utilizing a specific path—what is learned is ignored as those best positioned to summarize this learning are no longer in the organization.

- Stakeholders interpret inevitable changes in the project situation as evidence of dishonesty or incompetence and react defensively, rather than working through the changes in a way that keeps the collaboration as stable as possible.

Traditional project risk management can, therefore, limit an organization's flexibility and capability of dealing with unexpected surprises and cause damage.

2. The Limits of Established Risk Management Methods

Project management risk research and practice incorporates a strong mindset around planning and execution: a set of 'instructions' to implement a network of interdependent activities to achieve an objective: risks are defined as deviations from the plan. This mindset is suitable for projects where we know the range of things that can happen, even if we may not be able to predict with certainty which ones of the identified events will happen, or we may not have good probability estimates. This corresponds to *known terrain*, where it is known in principle what events and outcomes of actions to expect, and with *moderate complexity*, where the nature of the "solution space" is roughly known and we can choose a best course of action.

However, established project management risk methods break down in environments of either unforeseen uncertainty or complexity. In such cases it is naïve to assume that we can design the appropriate systems, processes, and relationships needed to meet specific objectives. If a project with complexity and unforeseen uncertainty is managed using classical project risk management, the team does not have the flexibility required to respond to surprises, and the team members' careers may suffer because they are evaluated against targets that have become irrelevant during the project.

Consider, for example, the Circored project, an innovative process development project undertaken by the US-based company Cleveland Cliffs and the German company Lurgi Metallurgie GmbH (Loch et al. 2006). The project constructed and started a first-of-a-kind facility for converting iron ore into hot briquetted iron using a revolutionary new technology, Circored. The technology consisted of efficiently reducing the iron ore in a pressurized and heated (650 degrees) circulating ("fluid bed") hydrogen atmosphere and offered a cost advantage of about 10%, a huge advantage in this cost-driven industry. Cleveland Cliffs had experience in mining engineering and wanted to operate the facility, using it to enter a new market segment, and Lurgi had developed the technology and verified it in a lab-scale prototype.

Construction started in 1997, based on diligent risk planning: business scenarios had been estimated, and detailed risk lists, including estimated impacts and preventive and contingent actions, had been produced. In February 1999, the first phase of the start up, at lower pressure and temperature, went very well. But then one problem followed the other in a seemingly endless succession. The team had to work itself through the facility; each time they had solved one problem, the next popped up just downstream in the chemical process. And worse, the problems predicted in the risk lists hardly occurred, while most problems were unexpected ones. Each iteration took days to cool down the facility and remove the explosive hydrogen, perform the engineering change, and heat the facility up again. Over more than a year, the project manager repeatedly had to step in front of the board and say, "we thought it would work, but there was an unexpected problem again, but this time we'll fix it!"

After over a year, the project team had lost credibility, and the leadership was exchanged in the Spring of 2000. The new leadership introduced more sophisticated methods, but also benefited from the fact that the most significant unexpected problems had been fixed, or at least been identified. The facility was successfully ramped up in March 2001, a major technical success that eluded competitors who failed to make competing technologies work.

In spite of the ultimate technical success, several competent people had their careers damaged by the events. The project manager and the board were surprised when the problem solving activities turned out different from what had been predicted, and surprise turned into frustration and disappointment. What was missing? What can we learn from this project that is applicable for project risk management more generally?

In order to understand the roots of the failure in the Circored project, we need to *understand and classify the roots of project risks*, not only by the contextual source (as is done in risk lists), but also by the foreseeability of the underlying influence factor and by their complexity. This is summarized in Figure 1. A project is shaped by many influence factors, such as technical variables, market trends and tastes, competitor moves, logistical constraints, interests and actions by project stakeholders, etc. In Figure 1, we classify all of those influence factors by their uncertainty and their complexity:

- *Uncertainty type Variation:* Their impact is small, so we only need to worry about some variation around our targets.
- *Uncertainty type Foreseeable Influences:* We know what the influences are, but we do not know whether they will occur or not and we do not know the precise impact (probability of occurrence and impact). This is the notion of risk used in established project risk management.
- *Uncertainty type Unforeseeable Influences:* We do not know what the influences are. They are not within our horizon, they are outside of our knowledge, and therefore, we cannot plan for them. The decision theory and economics disciplines call this "unawareness" or "incomplete state space", and technology management scholars (cf. Schrader *et al.* 1993) call it "ambiguity".
- The vertical axis of Figure 2 represents *complexity, or the number of interactions among influence variables*. For most projects these interactions are a consequence of the number of tasks to be performed or the number of stakeholders that relate to the project.

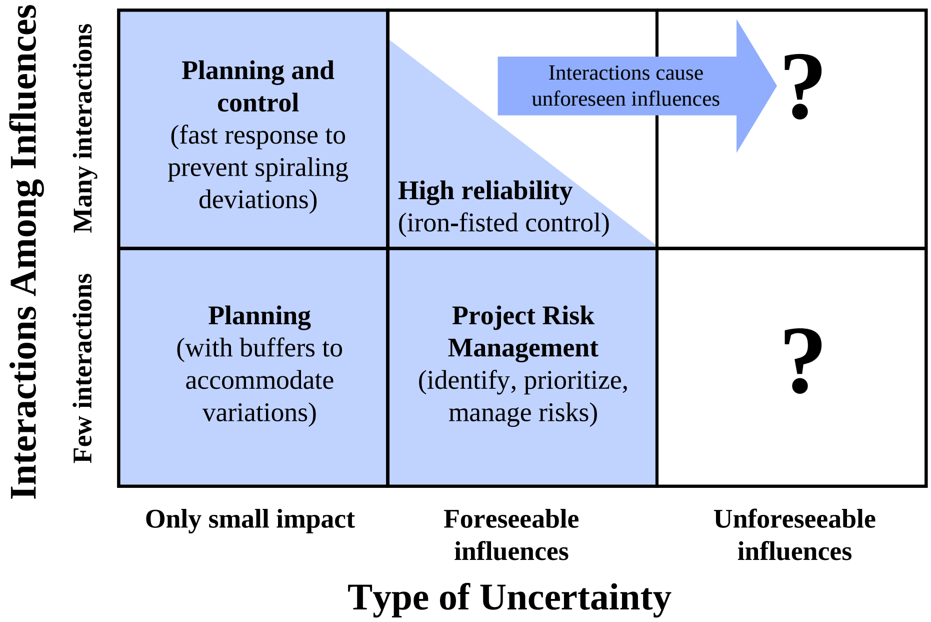

Figure 1: The limits of established project risk management methods

In figure 1 we indicate that we know how to manage projects that are subject to variation only – we apply critical path and network planning methods (which can handle many interacting variables), and add buffer management to account for variation around our schedule and budget. We also know how to handle foreseeable risks Project risk management does, however, not address the question of what to do in the face of unforeseeable influences, nor of foreseeable influences that heavily interact.

There is one useful and interesting attempt to address unforeseeable events stemming from interactions among many influences in a complex system. In their book *Managing the Unexpected*, Carl Weick and Kathleen Sutcliffe (2001) discuss what organizations do who must guarantee a reliable functioning of a very complex system, such as a nuclear power plant or an aircraft carrier. Reliable operation must be guaranteed (at almost all cost) because so much is at stake.

Weick and Sutcliffe recommend that the organization develop what they call "mindfulness". Mindfulness includes a number of "soft skills", such as preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise. In our approach, mindfulness means the ability to know precisely what the target state of each component of the system is, to detect even small deviations from the target state, and to quickly react to them, containing them so they do not spread to other components of the system, causing a major problem there. In other words, mindfulness represents *iron-fisted control*: we prevent deviations if possible, and if one occurs, we contain it immediately.

Mindfulness does not "fill" the upper middle box in Figure 2 because it does not solve the problem of the project management team facing unknown influences and/or interactions because the project is not an ongoing steady-state system that can be kept at its target state..

3. Diagnosing Complexity and Uncertainty

Confronted with a project, how does the project team determine the type of uncertainty and complexity present? It is a critical insight that project teams often have a feeling for the fact that they do not know all the possible turns of events, that there are "unk unks" lurking out there, or that the project is so complex that not all effects of their actions can be predicted. We have developed a tool to determine qualitatively the uncertainty profile of a project.

This is demonstrated in Figure 2. The project on the left represents the development and construction of a cruise ship that has many tasks running in parallel (e.g., 2,000 people from 500 subcontractors working on the site, building the restaurant, the casino, the hotel, the swimming pool, etc.), enough to require diligent coordination among many subcontractors who work on the site at the same time, and buffer management to control schedule variations. However, the design is fairly well known, so there are really no significant gaps in knowledge, and therefore no unk unks. Also, the components of the ship do not strongly interact and can be built quite separately.

The project in the middle refers to a multi-year, several hundred million dollar earth-moving project for the construction of a residential community in Southern California (Loch, De Meyer and Pich, 2006). The Ladera Ranch team moves millions of cubic yards of dirt to provide independent builders with house pads, streets, water runoff, landscaping, and utilities. Their major objective is to plan the cuts and fills in a way that moves dirt the shortest distances possible. Geological studies exist about moisture levels and soil types. Moist earth requires more excavation and takes longer to settle before you can build on it, so the project team might opt to dry the dirt rather than delay selling lots. Some types of soils may require different slopes for stability, influencing the available amount of flat area for houses and streets. While this can all be planned in principle, building a contingency plan for each scenario ("If soil is moist and type x at location y, do Plan A. If it is dry and soil type z, do Plan B." And so on), in practice this rapidly becomes unfeasible because of the interdependent nature of cuts and fills across locations. The number of scenarios proliferates with the number of locations considered, making the moisture level and exact soil type, in effect, unpredictable. Thus, the Ladera Ranch team is forced to deal with foreseeable uncertainty, digging and then scrambling to handle what they find. In contrast, truly unforeseen events are rare—like the discovery of prehistoric Indian ruins or a rare animal or plant species, for example—which would completely alter their operation.

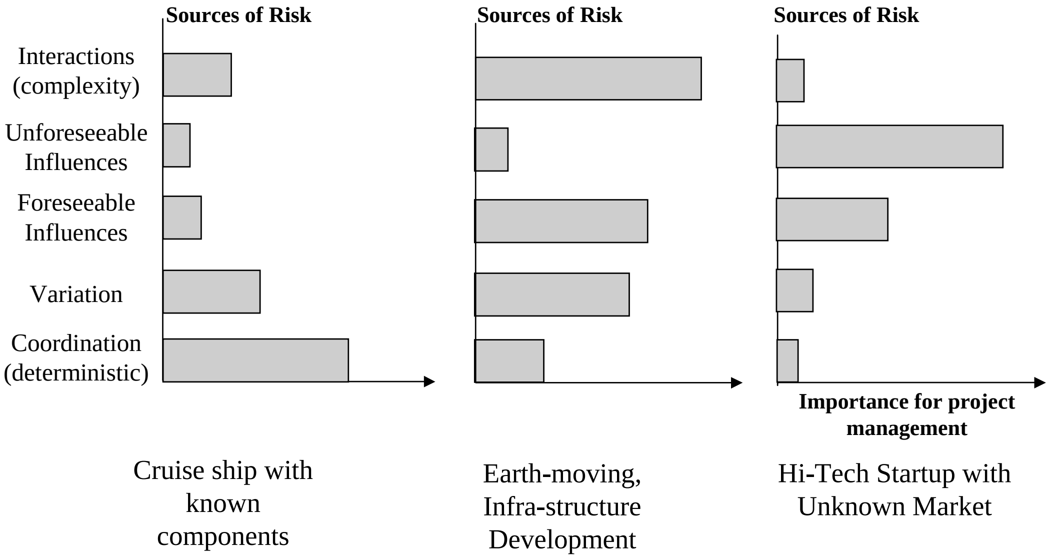

Figure 2: Uncertainty Profiles: Diagnostic Tool

The project in the right hand panel of Figure 3-1 refers to Ihrpreis.de, a 1999 German Internet startup that applied the Priceline reverse-auction business model (which cannot be patented in Europe). Despite numerous changes in the selling process to accommodate the specific preferences of the German consumer, the company could see by mid-2000 that the consumer auction boom was faltering. Knowing that it could not survive on customer-driven pricing alone, it developed software services for industrial customers and an Internet-based ticket search engine for travel agents. By summer 2001, this search engine, which dynamically optimizes offers from multiple airline reservation systems, had become the most promising of the company's offerings. In response to the re-definition, one of its investors commented, "How can they change the business model this much? It is like we gave them money to develop a sausage factory, and now they tell us they have moved into building fighter planes." In the end, the company succumbed to the travel business contraction after the burst of the Internet bubble; it gave half of the invested money back to the investors in 2002.

Figure 2 can be used as a diagnosis tool at the outset of the project – project teams are able to think through what they know about their project, to identify schedule variation, to identify significant risks in using project risk management, but also to ask themselves where the limits and gaps in their knowledge are. If there are gaps in knowledge, the team must anticipate unk unks.

Of course, being able to identify them shifts them from unk unks to identified risks, which can be addressed by project risk management. However, in novel projects there will be areas of knowledge gaps that can be identified as such without being able to identify the risks themselves. Also, the uncertainty profile changes over the course of the project: at critical transitions, major uncertainties are resolved or emerge, and after some point, the team should know precisely what is ahead. This is what the diagnostic tool can help the team to recognize and track over time.

4. How to cope with uncertainty

Through our case studies and analytical analysis (Pich, Loch and De Meyer, 2002) we came to the conclusion that there are fundamentally three approaches to managing risk in project: (i) instructionism, i.e. planning and then execution of the plan; (ii) learning and (iii) selectionism. Current risk management methods for project management coincide to a large extent with what we call instructionism and we will not spend time on it in this presentation. We will go into some more detail about learning projects and selectionism.

4.1. Learning Projects

Learning involves a flexible adjustment of the project approach to the changing environment as it occurs, making adjustments based on information obtained during the development process, as opposed to at planned trigger points.

The essence of this approach to project management is that each new activity will provide new insights and information, which can be used to review and revise the project plan, the resources required and the stakeholders to be dealt with. While each of the changes may be minor, the project itself may look quite different at the end from the original plan and intention.

This type of learning 'as we go' should not be confounded with projects as instances of learning about the organization (because you do something out of the normal activities of your organization) or post project audits that are used to improve future projects

To understand learning 'as you go', imagine a simplistic example from mountaineering. Consider two mountaineering expeditions, one up a known mountain for which we have a map and a weather forecast, and another up an unknown mountain with unknown weather conditions. The project manager asks: How do we plan the trip? How do we choose personnel? How do we monitor whether we are on track? How do we coordinate the participants? And how do we measure whether we have been successful?

The essence of the comparison is between executing an existing plan versus developing the plan as one goes along and learns about the terrain. Mastering the unknown mountain requires more sophisticated mountaineering, more experienced and flexible people who can observe the terrain and the weather during the expedition and who can make decisions in response to what they learn. More information needs to be gathered and coordination among all stakeholders must be more flexible.

This requires a very different philosophy than for more familiar terrain. Imagine that the team decides that the originally targeted mountain is too difficult in the given weather conditions, and proposes to scale an adjacent lower peak. They radio back to the sponsor whose furious response is: "I need people who fulfill the agreed upon targets! I don't need people who always find excuses!" This is a recipe for ending good people's lives (or, in a management context, careers).

4.2. Multiple Parallel Projects: Selectionism

Selectionism refers to generating variety (via independent parallel trials) and then choosing the solution with the most favorable outcome.

There is a large literature in the field of combinatorial optimization that shows that the more complex a problem, the more parallel trials should be run. Thus, the more complex the problem, the more worthwhile it is to pay the cost of selectionism (e.g., Fox 1993). Higher ambiguity may also make selectionism attractive: if the team does not know the project terrain, it may choose to try several different solutions in parallel, hoping that one of them is appropriate for the environment that has emerged when the project is finished. Venture capitalists view their investments this way (e.g., Sahlman 2000).

Imagine a military plane has crashed in the jungle of Laos with a nuclear bomb aboard. The bomb must be retrieved as quickly as possible, but the terrain is so complex that intelligence is not able to provide good tracking; and moreover, there are guerillas in the vicinity, so the search parties will have to dynamically shift depending on were they encounter resistance. The leadership decides to send seven search parties in parallel. Each can attain a huge reward (both monetary and in the form of a medal of honor) if they successfully retrieve the bomb.

The project combines an overarching goal with the individual ambition of each search party. Thus, the challenge is balancing individual rewards (to get the teams to try hard and take personal risks) with a group objective. What matters is that the bomb is retrieved at the end, not by whom. If the groups overemphasize the personal targets, they will not collaborate, not support each other, not share information (perhaps even hide information), and thus put the overall mission in jeopardy.

4.3. Integrating Selectionism and Learning

Both selectionism and learning have been discussed in other contexts. But no guidelines have been proposed for comparing, combining or choosing between selectionism and learning in project management.

In an ideal world we may want to do a bit of everything: plan, be flexible enough to learn as one goes, and to have several alternative approaches in parallel. But of course, the answer depends on *costs* – both parallel projects as well as flexible learning cost money. If learning is very expensive (e.g., requiring a costly test market that also risks leaking the product specifications to the competition ahead of time), it should be avoided. On the other hand, if parallel trials are expensive (e.g., a prototype of a new plane costing tens of millions of dollars), only one project route should be used (for example, the first flying prototype of the Boeing 777 was later sold as a commercial product, see Sabbagh 1996). This much we know – it is summarized in Figure 3. But what approach do we choose if the costs are not so different? And what if the costs are not known and cannot help us to decide?

Cost of Learning and Iteration

Cost of Parallel Selctionist Trials	low	high
high	**Learning** • One effort with major adjustments over time • E.g., Flexible start-up companies can change project definition	**Right the first time** • Try to plan comprehensively • Leave "design buffers" to adapt • E.g., Boeing 777 (the first prototype was sold commercially)
low	**Selectionism and learning** • "ecology" of small experiments that evolve • E.g., internet auctions and automated markets	**Selectionism** • E.g., "product churning" in Japanese consumer electronics in the early 1990s • MTV program trials on air

Figure 3: Cost Considerations in Comparing Learning and Selectionism

It turns out that the *combination of complexity and ambiguity itself has implications* for whether learning or selectionism is better. It is established knowledge (formally proven and demonstrated many times in computational problems in science) that the more complex a problem is, the more parallel trials are needed to get to a solution in reasonable time. However, this may be reversed when complexity and ambiguity combine: *fewer* trials are warranted. The reason is that ambiguity reduces the information that the parallel trials produce. If complexity is low, missing ambiguous project variables does not invalidate the decisions that the team takes on the variables it sees. However, high complexity causes interdependence among all project variables. Thus, neglecting ambiguous project variables may make irrelevant as well the decisions the team makes on the known variables.

An important implication of this is that learning is preferred more and more relative to selectionism when ambiguity combines with *increasing* complexity. Our conceptual model suggests that in projects with important ambiguity, it may be *inevitable to first attempt some learning*, reaching at least somewhat stable ground, before engaging in selectionism.

5. Putting this into practice

It is fundamental to accept that all key aspects of project management are impacted by selectionism and learning. We will focus in particular on three areas, (1) establishing the project mindset, (2) putting in place the infrastructure, and (3) managing the relationships with stakeholders.

5.1.Establishing the Project Mindset

Classical project management is about doing your homework up front and then delivering with iron-fisted discipline (as one executive said to us, "we need people who deliver on their promises!"). However, discipline (while always important) is not enough in the face of unk unks. Unk unks require a mindset of not asking where we are in the plan but asking what you really know.

The mindset is not a procedures and process question, nor should it rest on the shoulders of heroic individuals. The mindset must be "automated" in a *culture*, or *habits*, of never taking things for granted and always look left and right for things we have overlooked. This is shared with Weick & Sutcliffe's (2001) concept of mindfulness. They show high reliability organizations, such as the crew of the aircraft carrier, have internalized as a deeply-ingrained habit to be constantly on the lookout for small things out of the norm, which could later spiral into large failures.

In order to have a chance to get to the right mindset, it is necessary to bring in the personnel with the right experience, especially the project manager. Selectionist and learning approaches require a different management style than the instructionist approach.

In the instructionist approach, the project manager tends to be a master planner, an efficient administrator, and a person who can spot deviations from the plan, solve the underlying problems and expedite it within the existing framework of the organization.

In the learning approach, the project manager needs to be able to motivate the team to spot upside risks, to very quickly turn around experiments and learn from these experiments (e.g., Thomke 2002), and he/she needs to be able to foster the learning in the team (and thus overcome the NIH syndrome). Such project managers have a lot in common with intrapreneurs. They often have to play some role of information gatekeeper, or at least ensure that this role is performed.

In the selectionist approach the project manager will need to be an arbitrator between the different projects. One of the major challenges will also be the motivation of the teams that are not chosen. Guaranteeing the going concern for the organization will be very important: how do you avoid that an organization falls apart once a particular project is chosen. Therefore he/she needs to be perceived to be a team player and a good marketer of the team. He/she has also to be a great people developer, who can ensure that members from teams that are not selected will feel that they still have a role to play in the organization.

5.2. Putting the Infrastructure in Place

The infrastructure of a project concerns the processes and systems for planning, monitoring and progress measurement, coordination and relationship management, performance evaluation and information management. The two center columns of Figure 4 provide a summary of the project infrastructure for a planned project versus a learning and Selectionist project.

Planning systems emphasize milestones of learning, versus delivered results. Monitoring must track what has been learned, rather than progress along the planned tasks. Coordination must be richer and more flexible, as opposed to a work structure with deliverables. It must include the possibility of rearranging the responsibilities as the character of the project changes. This flexibility must be supported by richer and less structured information systems. Finally, the project team should not be evaluated on target fulfillment -- as the outcome is not under the control of the team, this would cause withdrawal of the best people from learning projects. Rather, upward incentives and process measures should be used.

	Planned Projects	Learning Projects	Parallel, Selectionist Projects
Planning Systems	• Plan tasks and targets • Work structure and defined responsibilities • Use buffers and simulation to manage risk	• Overall vision, intermediate targets • Tasks to learn • Rapid turnaround of experiments to learn	• Collective vision, differentiated roles across projects • Intermediate diagnosis criteria of the potential of an individual project
Monitoring Systems	• Target achievement • Progress tracking (e.g., % complete, or deliverables)	• Track "experimentation" • What has been learned? • What problem to solve next?	• Project stopping criteria (updated relative potential) • Information transferable to peer projects, to be shared
Coordination Systems	• Fulfillment of deliverables • Coordination via work structure in hierarchy • MBE (management by exception) • Little decision power necessary	• Dynamic and less formal • Long-term trust-based relationships handle changes • Decision power to change approach or targets • Higher problem solving necessary	• Relative progress of the projects • Sharing of learnings • Stopping decisions
Informaton Systems	• Planned information: progress, deliverables, actual outcomes of events	• Richer, unstructured information exchange and mutual adjustment	• Overarching over peer projects
Evaluation and Incentives	• Target fulfillment • Measurement of output	• Upward incentives on output • "Process quality" incentives	• *Shared* incentives on output • "Process quality" incentives

Figure 4: Infrastructure for a Planned, Learning and Selectionist Projects

Project complexity makes it particularly pressing to coordinate and share information quickly. For example, complex engineering projects typically start by cutting the complex problem into pieces. A sub-team solves the design of its respective piece, and then the sub-teams integrate learning about unforeseen system interactions as they emerge. Unfortunately, this type of learning leads to cascading changes and oscillations: if I change, I force you to change, you in turn force a third sub-team to change, which at the end makes it necessary for me to change again. Such oscillations have been reported in the engineering literature (e.g., Allen 1966, Loch et al. 2002).

To avoid such oscillations of system changes, it is important to share information quickly, with as little delay as possible, even if this looks like information overload at first glance. Moreover, engineers should be willing to release preliminary information (even when they are not quite sure yet), which reduces the amount of work done with obsolete information, and to satisfy, or be willing to make small compromises at the component level to make the overall problem solving more stable.

The second and fourth columns of Figure 5 offer a few indications of the differences between planning and selectionist approaches. The overarching idea is that one needs to keep a global view of the different projects, and while tracking what is being learned in the individual projects. The overarching tracking allows to share insights and to stop individual projects when they no longer contribute to the whole. Systems and incentives that keep the whole of the organization committed, even when the projects to which some of the individuals are allocated have to be stopped.

5.3. Managing Relationships and Project Governance

Relationship management with internal and external stakeholders is a key dimension of project management. Indeed, the project team almost never has all the necessary resources under their control; it needs to be able to mobilize resources that belong to others, and to influence other parties, over whom they do not have formal power. Stakeholder management is also about controlling and possibly neutralizing the negative influence of adversaries outside the project .

The higher the number and interdependence of the parties involved, the harder is the management of the relationships. Obviously, in an age of increasing outsourcing and dispersed expertise, this is often correlated with the complexity of the project tasks – the more dispersed the task and the expertise, the more parties will be involved.

Structuring Project Contracts

Large projects are rarely performed with one organization's internal resources alone: the resource commitment is too great, the risk becomes too high, and the range of specialized expertise areas goes beyond what exists in one company. Therefore, managing major projects typically involves working with partners. Collaboration with external parties poses a trade-off – the above advantages have to be weighed against multiple interests, which are never perfectly aligned and cause possible interactions among multiple influences, in other words, complexity and the risks that go with it.

Contracts are the most widely used way to handle external partners. The literature distinguishes three major contract forms, fixed price, cost reimbursable, and mixed incentive contracts (e.g., Kerzner 2003). They differ in their appropriateness in allocating risks. Lump sum turn key (LSTK) fixed price contracts allocate all risk to the contractor; they seem to have increased in importance over the years, as they clearly allocate responsibility to one major contractor who assumes most risk and can control the project's execution, minimizing interfaces and working with more overlap.

Project Governance

Even if the contract is written flexibly and with good intentions on all sides, it is unrealistic to hope that classical client-contractor contracts can completely solve the challenge of unforeseen influences, such as a complete failure of the technology or unexpected market conditions. Those simply fall outside the traditional supply contract toolbox (Miller and Lessard 2000). Contracts must be complemented by other tools of "project governance", e.g. equity stakes , the fostering of ongoing relationships and trust (that is, reputation and repeated interactions), powerful tools for mid-course re-definitions and renegotiations of benefits, a mindset and an understanding (ie. experience) of the arising need of changing the project's structureand well determined strategies for project exit. ges or minimize involvement.

Managing Stakeholders

Relationship management must be mindful not only of the parties to the project contract, but also of stakeholders, or parties that have an interest in and an ability to influence the project even though they are not official parties to the contract. For example, BP suffered a major setback with the dismantling of the Brent Spar oil storage platform in the mid 1990s, when Greenpeace forced them to dismantle it on the shore rather than sinking it in the deep sea. The solution chosen in the end was more expensive as well as inferior in terms of risk for employee security and no better than sinking in terms of environmental impact. But an external stakeholder, the relationship with whom was not properly managed, forced them into a bad solution.

6. Conclusion

The core argument that we developed here is that the established risk management methods can help you in managing the variation and the foreseeable uncertainty, but that they run out of steam in the face of unforeseeable uncertainty or unk unk's, which are so often a typical characteristic . In order to cope with these one needs to develop a combination of learning and selectionism. The choice will have an important impact on the key aspects of project management e.g the mindset, the project infrastructure and the management of stakeholder relations.

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