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Project risk action management

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This paper examines the requirements for project risk action management techniques which can assist clients and project managers to assess and pre-empt potential sources of risk. These sources may be external or internal to the project and include those which may result from the manager's own actions. The aim is to encourage project managers to be sensitive to these potential sources of risk, to be able to anticipate their occurrence, to appreciate their potential impacts on the project objectives and to reduce their future impact through appropriate risk action management strategies.

The paper examines project management goals and objectives and discusses risks which may arise to threaten the achievement of these objectives. The conventional risk analysis approach is reviewed in the context of the need to identify and assess such risks and their potential effects. The paper reviews the direct relationship, as presented in the conventional approaches to risk analysis, between 'risk drivers' and risked consequences, and demonstrates that this represents a primarily passive approach to project risk management. It argues that, if the manager is able to anticipate risks, he should also be able to take appropriate pre-emptive actions before they occur. Thus, we show how risk action management techniques, within the context of project management, can support project managers in the formulation of project strategies, planning and the achievement of project objectives.

Keywords: Project risk areas, project management goals, risk drivers, risk analysis, risk factors, project risk profile, risk action review, risk action management, risk management responsibilities.

Introduction

High-quality project management requires a great deal of skill on the part of the manager at the technical level of the project he is managing, at the interpersonal level of the human relations he has to handle and at the level of knowledge of good project management practices (e.g. Mintzberg, 1975). In all these areas, the manager must have considerable skill in anticipating problems that may arise in connection with his project and in knowing how to act in order to solve them or, at least, minimize their effects on his project (Baker, 1986; Turner, 1984).

This paper deals with how to enhance or encourage the development of this skill of project managers by focusing on areas of risk in a lifetime of a project. We first discuss the principal goals of a project manager and the objectives he has to meet, thus identifying particular areas where problems may arise for the project. We then proceed to discuss how conventional

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approaches to project risk analysis, which concentrate only on a limited number of risk drivers, fail to review much of the information required to formulate strategies aimed at reducing or removing the negative impact of other risk drivers on the project objectives and how, even more importantly, they fail to help the manager handle the problems that arise due to their impact. We describe how this situation may be improved through *risk action review* as an effective basis for project risk action management.

Project management goals and objectives: Identifying risk areas

The project manager's role is very difficult to fulfil, as it lies at the intersection between two different worlds with often conflicting expectations of the project, different expertise and knowledge about the project or the area it addresses, or different views on the criteria for a successful project. On the one hand, there is the world external to the project consisting of people who have an interest in the project such as the client and the manager's own organization, external subcontractors, regulatory agencies, etc. On the other, there is the internal world of the project, i.e. the personnel who will be actively involved in carrying out the work necessary for the project to be completed.

Effectively, the project manager plays the role of the mediator between the project and its environment. In this role, he has to make sure that the requirements for the project (i.e. what the client wants, what this should be like, by when it should be ready, at what cost, etc.) are clarified unequivocally, and to return the results of the project to this environment in a way that satisfies these requirements fully. The consequences of not achieving these two objectives are tremendous. In the short run, they may lead to the cancellation of the project with often heavy financial penalties attached. In the long run, they are likely to impinge adversely on the reputation of his company and may create future difficulties in gaining new contracts.

However, the cause of failure to achieve these objectives may or may not lie entirely with him. External events completely out of his control (e.g. fire, earthquake, transport strike, etc.) may have started a sequence of events that will necessarily lead to the failure of the project. In these cases, there is little that the manager can do to avoid their consequences for his project. Apart from these occasions, however, there are occurrences where the risks could have been foreseen and counteracted beforehand. Achieving this would depend on his ability to manage the project satisfactorily.

Managing the project implies fulfilling three further goals:

1. Making a plan for the project which can organize the work that needs to be done and ensure that all the required resources are available for the project when needed.
2. Maintaining the relation between the plan and the reality of the project work as it is carried out by effective monitoring, control practice, rescheduling, etc.
3. Facilitating project work throughout the project by making sure that project personnel can work under good working conditions and have all they need to carry out their work.

In the same way that we can characterize successful project management results in terms of managerial goal achievement, we can characterize the *risks* associated with a project in terms of the role they play in spoiling or preventing the achievement of any of the goals outlined above.

Risks that can upset the achievement of project management goals

Some of the risks mentioned in the previous section may be beyond the control of the manager, in the sense that he is not able to act on the project or within its surrounding environment in such a way that it will reduce the probability of the risk occurring. For example, a good and viable plan might have been prepared by the manager, but required resources may not become available at the expected time, or may be withdrawn from his project leading to a less satisfactory plan or a highly strained working situation created by trying to meet the original plan with less resources than anticipated. Or, during the execution of the project, it may transpire that the resources made available to the project are less skilled than were originally expected, or that some required hardware or development tools are not available when needed. Furthermore, problems may arise in handling project personnel at an interpersonal level, e.g. some people having difficulties working together, going sick, having difficulties with the client, etc.

However, the fact that it may be difficult to control the occurrence of a risk does not absolve the manager from the need to *anticipate the risk*, and thus find ways of lessening the impact of its occurrence on the achievement of projects goals. This may involve ensuring that the planning for the project is flexible in the face of the occurrence of the risk and/or that subsequent contingency planning can be made in the event of its occurrence.

Conversely, some risks may arise directly from the project manager's *own actions* when planning and executing the project. For example, the planned task schedule may have bottlenecks on the critical path, with particular tasks placed in such a way that, if they overrun or fail to produce results of the required quality, much of the future planned work on the project may be threatened. Or the manager may, in his planning, fail to allow enough time for the induction and training of the new staff who will need to be recruited, or may even underestimate the amount of his own time that will be needed to manage the project successfully (Berkeley and Saunders, 1988). Risks like these, whose ocurrences are, in part at least, consequences of managerial actions, need to be anticipated at the time the instigating managerial actions are planned or executed (Morgan, 1987).

Furthermore, some risks may result as side-effects rather than direct consequences of a manager's actions. For example, a manager may formulate a plan that appears to be very efficient in terms of human resource utilization but which turns out to produce work patterns that are confusing or unsatisfactory to the members of the project team actually assigned to the tasks according to the plan. This could result in a reduction in morale, motivation and performance (cf. Mumford, 1983).

We could list many problems in each of these areas of concern for the project manager, but we will still fail to address exhaustively all that can go wrong with a project (see, e.g. Keider, 1979, for more illustrations of some specific problem areas). Our purpose, however, is not in constructing exhaustive lists of problems that the project manager may have to face, but in making sure that he can cope with problems as and when they arise during the whole lifetime of the project.

At the beginning of this lifetime, during the feasibility study stage of a project, risk analysis tools or risk analysts are typically employed in an attempt to quantify the risks inherent in the specific projects. The results of this analysis are then used to set up risk margins in the contract (typically, a percentage attached to the price of the contract such as 10 or 15% depending, for example, on the kind of project and experience the company has had in the past with similar projects). These analyses are mainly based on the assessment of some pre-

specificed factors, which are taken as indicators of the riskiness of the project. The next section outlines how these analyses actually focus on *risk drivers*, and the extent to which they may or may not inform project management in practice.

Risk drivers and risk analysis

In recent years, project managers in the construction, computing and aerospace industries (to name just three) have gained a generally poor reputation for coping with risks on projects (Albino, 1988). We have seen many major projects failing to meet deadlines and cost targets. As a result, both clients and contractors have suffered, particularly where the contractor is working overseas.

Not surprisingly, this has resulted in frequent exhortations in the project management literature and training courses on the need to do something to avoid this state of affairs (Hayes *et al.*, 1986). The following pointers to good practice are frequently identified:

- No project risk should be ignored.
- No project risk should be dealt with in a completely arbitrary way.
- Project risks should be identified during the earliest project phases.
- No major project decisions should be made unless those risks having the greatest impact on the project manager's decisions are clearly understood.
- Practical project risk appraisal should be subject to review. An assessment should also be completed of the variable risk factors acting on the project and their likely extent and level of interaction.
- More project management effort should be devoted to risk management as a rigorous and continuing activity throughout the life of the project.

The need to anticipate the possibility of occurrence of risks and to understand their likely impact on the project has led to much research aimed at identifying *risk drivers*, i.e. observable phenomena that are likely to drive up the possibility of some risked consequence which depends, in part at least, on the occurrence of this phenomenon. Risk drivers have been identified in many domains, e.g. those to do with size and complexity of the project, degree of knowledge within the organization about the potential project's environment and application, the technology required to carry out the project, characteristics of the client and the contract strategy implemented on the project (Humphreys, 1990).

However, to be useful in practice, a risk driver must meet the following two key requirements:

1. It must be reliably quantifiable in relation to the risk(s) which it drives in terms of an ordering of levels (even if only 'low', 'medium' and 'high', or 'present' *vs* 'absent') on a *risk factor*. This is a scaled factor whose description indicates what is to be observed (or to be directly inferred from what is observed). This quantification must also identify explicitly how the project risks that are 'driven' by the risk driver *depend* on the observed level of the risk driver, i.e. we must know which levels are likely to drive *up* or drive *down* the likelihood of the risked consequence occurring, compared with that of the baseline assumed in estimating key project parameters indicating degree of goal achievement (e.g. relating to cost, duration quality, morale, etc.).

2. It must be observable in the context of the particular project *before* the risk which it 'drives' actually occurs as a consequence of the driver's existence. If there is uncertainty about the impact of an observed level of a driver on a particular risked consequence, then the degree of dependency of the actual occurrence of this consequence on the existence of the driver must itself be at least approximately quantifiable.

In theory, if a set of risk drivers can be identified for a particular project which (1) meet the above requirements and (2) collectively cover the range of sources of risks relating to the project objectives, then the manager is in a position to anticipate potential risked consequences by observing the actual levels of the risk drivers as the project progresses. In practice, this may not be so straightforward, as risk drivers are initially identified only through *past* experience: there is no guarantee *a priori* that we can always identify a concise set of risk drivers which are exactly appropriate for anticipating the risks that may eventually materialize in a particular project. The remedy of trying to observe *everything*, in case it may be a risk driver, is doomed to failure: the time taken would be enormous, delaying the possibility of formulating managerial strategy until after the risked consequences had actually occurred. The amount of intrusion of the project would be so great that little productive work would ever get done, and the resulting plethora of information would be impossible to interpret in terms of its overall impact on actual risked consequences (Glahn and Borg, 1988). Thus, in practice, the project manager's primary aim should be to evaluate the *key* high-level risk drivers in the project *before* any risks have actually materialized.

Hence, the major initial goals for a *risk analysis* are to define a limited set of key risk drivers which apply to a particular project, according to its type, environment, stage of development, etc., and to assess their relative impact on risked consequences that could result in a failure to satisfy project goals. Only if this can be achieved satisfactorily does it make sense to proceed to assess levels on the identified risk drivers and calculate their likely effects, the latter usually being expressed as a *project risk profile* (Cash *et al.*, 1983; Cats-Baril, 1987). This is a multi-factor index of project risk that can be compared across projects and which reflects the likelihood that risks identified for the project may initially materialize in the range of domains addressed by the factors on which the risk profile is defined. These factors address a wide-ranging and heterogeneous set of domains. For example, Jobling (1988) identifies a typical set of domains comprising promotor, host government, funding, definition of project, project organization, concept and design, local conditions, permanent installed plant, construction, logistics, estimating data (time and cost), inflation, exhange rates, *force majeure*.

Thus, in order to construct a particular project's risk profile, personnel involved in the task are likely to have to explore five specific and qualitatively different worlds. These are the worlds of (1) the client organization, (2) the contractor organization, (3) other external stakeholders (e.g. regulatory agencies, existing partners whose interest may be affected, clients at large), (4) potential suppliers and subcontractors and (5) the potential project team (Ashley, 1987). (Details of what these explorations may need to focus on are given in Humphreys, 1990.) Such explorations provide the information for construction scenarios that look into the future and address the client's situation and the impact of the proposed project on the contractor organization. In turn, these scenarios, together with experiences from relevant past projects, constitute the information base for the project risk analysis in building the project risk profile, expressed either in absolute terms or in comparison with other projects.

Project managers, and the managers who are responsible for the decision of whether or not to take the project on in the first place when left to their own devices, may prioritize different aspects of what is considered within any of these explorations depending on their individual responsibilities, concerns and expertise. This could result in basing their judgements on different sets of indicators of potential risks to be run and benefits to be gained through taking the project, or, more often, in assessing such indicators differently and/or assigning different weight to particular indicators. Group decision-making procedures can resolve some of these differences by providing a forum for consolidating the various concerns and diversity of expertise existing within senior management. These techniques promote explicit consideration by the whole group of (1) the potential sources of risk which are uncovered within each exploration and (2) what the relevant indicators of these risks may be (Phillips *et al.*, 1990). The use of these techniques may also help to clarify the assumptions that different managers make in their individual explorations (Humphreys and Berkeley, 1987; Mason and Mitroff, 1981).

However, contractor organizations who have developed their own project risk assessment models do not usually use group decision-making procedures to fix the structure of the risk model each time a new potential project is assessed. Instead, the standard practice is for a generic structure to be developed for the risk model at policy level within the organization (Chapman, 1979). This is then conveyed to the managers responsible for negotiating, accepting and managing specific projects, together with strict instructions on its use in assessing individual projects. This facilitates comparison across projects and provides for a consistent interpretation of the organization's policies on the importance and acceptability of various types of risk.

Many organizations who regularly use such procedures consider that the construction of a generic risk model, carefully tuned to reflect their policies and operating conditions, gives them a major competitive advantage in deciding how to price and negotiate project contracts. For this reason, the proprietary information in the generic model is usually kept strictly confidential within the organization. Thus, while we are aware of the contents of several of these models, we are unable to reproduce or comment specifically on these here. Instead, we present below a typical procedure for the implementation of such a model in practical risk analysis. This serves to illustrate the activities which are typically required of the project manager when following this approach to risk analysis:

1. Identify the risk drivers particular to the project, relating to, for example:
   - Project organization
   - Contract strategy
   - Location
   - Novelty of design
   - Delayed start
   - Extended durations
   - Cost-estimates
   - Cash flow
   - Industrial relations
   - Language and communication problems
2. Break the project down into elements. For example:
   - Disciplines

- Locations
- Pre-contract packages
- Phases
  - Design
  - Procurement
  - Construction/installation
  - Commissioning
  - Handover
  - Operational start dates

3. Test the sensitivity of the project's programme (broken down into the appropriate elements and sub-elements defined above) to those risk drivers particular to the project. For example:
   - Delayed start of 1, 2, 3, 4, 5 or 6 months
   - Extended durations of 5, 10, 15, 20%, etc. (singly or in combination)
4. From the results, including the effects found on the project interaction, select the 10–20 principal risked consequences.
5. Critically assess the likelihood of those selected consequences being affected by each of the identified risk drivers.
6. Repeat steps 3–5 for other views on the project of interest to senior management (e.g. project resource consumption estimates, cash flow), using the appropriate sensitivity test criteria.
7. Review the risk findings with the organization's senior management.
8. Monitor the results and compare them with the forecasts.
9. Modify the forecasts as appropriate.

A number of variants on this procedure have been proposed (e.g. Cooper and Chapman, 1987) in which the steps and their ordering are not quite the same as those shown above. However, the comments we make in the next section apply in general for all these variants.

Risk action review

In the above, steps 7–9 indicate the need for managerial review and continuing managerial work in monitoring the effects of the principal risk drivers identified in risk analysis. However, they assign, by default, a primarily passive, rather than active, role to the project manager in the face of the identified risks. The dependency linkage between risk drivers (the *independent variables* in the analysis) and the consequential risks being run in the project (the *dependent variables* in the analysis) is examined without considering the potential intermediary effects of managerial actions. Some of these actions might actually succeed in *breaking* some of these dependency links. This would have the desirable effect of reducing the *actual* risks run in the project significantly below the level indicated in the risk analysis.

Thus, the conventional project risk analysis approach described above fails to guide the project manager in the actual management of the project risks evident in the project risk profile it produces. Many risk specialists promulgate the view that such conventional approaches simply focus on analysis rather than effective management (Jan and Christensen, 1988). However, effective risk management on projects requires that the project manager be

able both to *anticipate* the risks to the project and to *design* suitable organizational structures within the project to minimize their negative practical impacts. To achieve this in practice, the project manager needs to examine what sort of 'project risk intelligence' he needs in order to implement the most effective strategies and to highlight those techniques he will need to use to manage the identified levels of risk in the context of his particular project.

To provide project management with such a supportive framework, it is necessary to enhance the support which can be offered through risk analysis with techniques for what we call, collectively, a *risk action review*. The object behind the use of risk action review is to improve the manager's understanding of precisely what consequences are actually being risked and what may be done about it through timely management action. Thus, the technique focuses on those project risk drivers which have direct implications for timely management actions.* What is *timely*, however, will vary with the phase of the project's development. Berkeley *et al.* (1990) give a detailed analysis of how various management actions may be triggered and refined in support of particular goals during different project phases. Here, though, we have space only to indicate the nature and use of a risk action review in the following two phases where the nature of those management actions which may be timely is quite different:

1. During the initial phase when a project is being established, in determining whether or not to negotiate the contract for the project with the client.
2. During the running of the project, in determining the adequacy of the current planning, potential pitfalls, and actions which can be taken to improve the implementation of the plan in practice.

In the following two sections, we consider the role of risk action review in support of risk action management in each of these two phases.

Risk action management in negotiating the contract for a project

Once the decision has been made to give consideration to a potential project, risk analysis may be used in support of the goal of viewing the risks inherent in the project. But this needs to be done both from a managerial and from a technical point of view. The objectives for *risk action management* at this stage are:

1. To use the project risk profile produced by risk analysis to identify the particular management skills and techniques necessary for minimizing the risks inherent in the project.

2. To seek out, review and interpret key information in the project's environment that is necessary to ensure the smooth running and successful outcome of the project. In support of this goal, information from the project's environment which is useful to review and interpretation at this stage concerns, among other things:

- the requirements to be met by the project;
- the functions to be achieved by the project and their interrelations;

* The risk action review can also form a useful basis for a project review by senior management. This is particularly valuable in major projects where the uncertainties in the plans of the various company divisions and contractors often compound to produce that which remains invisible within the perspectives available within the project.

- the coherence of, or contradictions in, the objectives imposed on the project by different parts of its environment;
- the project's inputs, resources consumed, recipients for its outputs, and resources produced;
- pertinent characterisitics of key resources likely to be needed, possibilities for resource substitution, and training needs and possibilities for human resources; and
- regulations guaranteeing security and privacy.

Information from all these domains may be required in order to set realistic price and time-scale targets for the project. These should include adequate provision for the costs incurred in managing and overcoming the risks which may materialize during the running of the project. In risk action management, it is also important that the resource targets for the project set through the use of this information are made explicit at this stage rather than evolve later. Otherwise, managers may often unwittingly give way on these targets in the final stage of contract negotiations, thus increasing the risk of severe planning and management difficulties after the project has started.

3. To ascertain when, how and with whom to conduct negotiations which are likely to facilitate the project's progress and acceptability of its outcome. Early negotiations can help considerably in meeting the manager's goal to obviate or minimize the risks inherent in the potential project. The risk profile can be used at this stage to guide the negotiation process by indicating those specific factors on which the project exhibits a high level of risk. These could be reduced through procedures agreed with the client (e.g. concerning product specifications, review procedures, acceptance testing, financial arrangements, preferred suppliers, etc.).

A risk action review can also provide guidelines to facilitate these negotiations which may cover, for example:

- identifying potential conflicts in the objectives and structures required for the project and finding ways to resolve them;
- negotiating mutually acceptable deadlines and milestones;
- negotiating a shared understanding of contractual terms; and
- clearing ambiguities with the client or other involved parties.

Risk action management when running the project

As we indicated earlier, once management responsibilities have been assigned for the actual planning and running of the project, and the project has started, one of the major influences on project risks (for better or worse) are the actions of the manager himself. These actions may serve to *drive up* or *drive down* the likelihood of the risked negative consequences actually occurring.

It is our experience, supported by the literature (Cats-Baril, 1987), that certain aspects of the project manager's activities are especially important with regard to their effects on project risk. These concern (1) a coherent and consistent work breakdown structure, (2) milestone management and accurate monitoring, (3) successful verification procedures and (4) change control systems. Thus, these constitute *critical risk management factors* for achieving project management objectives.

A coherent *work breakdown structure* on different levels and consistency in the developed structure is essential for the project manager to outline the make-up of the project and ensure

that all details are attended to in an ordered, efficient and timely manner. Risk action management issues which need to be addressed here through a risk action review include:

1. Are there omissions or discrepancies in the requirements specification used as a basis for the work breakdown?
2. How complete is the work breakdown used as a basis for planning?
3. How well has the complexity of individual tasks and the interfaces between them been estimated?
4. How many parallel critical or near-critical paths are there in the task schedule and how great are the interdependencies between parallel paths?
5. How accurate are the estimated completion times for activities likely to be (including time reserved for handling errors)?
6. How good are the resource estimates, e.g. what provision has been made within them for people going sick, how much dependence is there on individual knowledge owners, will there be time-sharing of resources with other projects which could result in conflicts?

Managing milestones provides the project manager with accurate means to track progress and make any necessary adjustments to schedules and budgets (Sweet, 1986). Risk action management issues which need to be addressed here through a risk action review include:

1. How well can the global history of the project be monitored and reviewed, e.g. so that the overall estimates, and effort spent, can be examined as a function of time?
2. Have adequate intermediate checking mechanisms been placed on long time-scale activities?
3. Has provision been made for adequate monitoring of activities which are likely to go wrong?
4. Is the recording of progress likely to remain realistic (rather than be a pretence)?
5. Are the reporting and review procedures likely to be effective in giving an idea of what is likely to occur in the future, e.g. reporting exceptions and predictions as well as confirmations?

While tracking milestones indicates the progress of a project, it still does not assure the quality of the product (Weinberg and Freedman, 1984). This requires *verification* and *quality assurance*, which can take place in various ways at different phases of product development during the running of the project (see Cats-Baril, 1987, for details). In general, issues which need to be addressed here through a risk action review include:

1. Has adequate provision been made for reviews, walkthroughs and/or inspections during the design and development stages in order to avoid pitfalls later on?
2. Have testing and systems audits been planned in order to provide verifications at the earliest appropriate points in the development cycle? (It is far less expensive and much easier to remove defects in the early stages of product development than later on.)
3. Is there a continuation of verification activities through the stages of product development and testing in order to ensure that the product corresponds to what the client actually wants (rather than to what he said he wanted)?
4. What are the possibilities for accessing and correcting the product after the delivery date?

Effective *change control* requires the setting up of criteria for allowable changes and providing for adequate co-ordination, communication and documentation of all changes. Otherwise, severe problems may arise and quickly make the project unmanageable. Risk action management issues which need to be addressed here through a risk action review include:

1. What is the likely impact of a proposed change on the technical team? (In negative terms, it may involve disruption of their work schedules and personal frustration, as in the case where a deliverable of which the team is proud is scrapped. In positive terms, a proposed change may allow members of the team to escape from working on a deliverable in which they, as well as the client, have lost confidence.)
2. If, after trading off potential benefits and disadvantages, a specific change is decided upon, is it likely to be done under tight control so that system quality is not degraded?
3. To what extent may the impact of all changes be reflected in the projected schedule?
4. What is the nature and degree of on-going client involvement in the product development process? (When the client has a real understanding of the characteristics of the product and its application, together with an understanding of the work requirements of the project team, he is more likely to become an ally in the effort to keep changes under control.)

Supporting risk action review and management

In the previous section, we described how a project manager might conduct a risk action review with the aim of using the results in risk action management. In this section, we consider the additional issues which need to be taken into account for a project manager to be able to work effectively on this task with a computer-based project management support system. We will show how such a system must do more than just offer the project manager a risk analysis tool.

From our earlier discussion of critical risk management factors, we can infer that there is a strong requirement for such a support system to *anticipate* the expectations from the environment which need to be taken into account in project risk action management. However, most current risk analysis tools are based on static risk assessment models of the project and of environmental expectations for the project. They fail to take into account organization- or project-specific variations to which the project manager is sensitive and are oblivious of the need to make predictions. The result is often that the tool and the manager have conflicting views on what decisions to take.

Part of the problem is the limited nature of the information available in the databases of stand-alone risk assessment tools. As indicated in the previous section, risk action review is not something which can be done once and for all on the basis of consideration of external risk drivers. Rather, it is a process which needs to operate continously in reviewing the results of the manager's *own* actions, as he develops and reviews his planning for the project, and monitors the results. Hence, truly comprehensive *risk action management support* can only be provided by building the appropriate techniques into an integrated *project management support system.*

In the following discussion of how such support may be provided, we draw upon experience gained (cf. Berkeley *et al.*, 1990) in the design and development of a

comprehensive support system called PIMS (Project Integrated Management System) developed through ESPRIT project 814, which provides support environments for project management methodology definition, project start-up, planning, progress control, reporting and project closing. In *all* these environments, risk management techniques have their part to play, and so it does not make sense to separate out risk management into a separate tool or environment. Instead, we outline below the nature of the risk management support techniques which need to be built into the support offered for the whole range of the manager's activities in *any support environment*. Such activities may range from those which are quite concrete and closed (e.g. monitoring progress, allocating resources) to those which are very abstract and open (e.g. negotiating with affected stakeholders for permission to revise a project plan). It is inappropriate for an interactive risk management technique to operate in a concrete and closed way in a dialogue with a manager working on a task requiring abstract and open thinking, and vice versa (Berkeley *et al.*, 1987).

For effective *monitoring*, the project plan must be regularly updated but treated as fixed between updates. This is because assessments of slippage, the lateness of deliverables, etc., must be made against the provisions of the plan currently in operation for the project. It is inappropriate for risk management at this level to adjust the project plan in such a way that slippage disappears. Thus, supporting monitoring, the support system needs to provide information about what *is*, rather than about what *could be*, as the focus at this level is on the relation between a fixed plan and the immediate reality. However, this information should be presented in a form which enables the manager to understand the risks represented in it (e.g. task *slippage* and *closeness to critical path* rather that just task progress data).

Exploring what 'could be' involves *simulation*, the ability to explore 'what if' situations* within the current project plan, whose structure is treated as fixed. Fixed structure is necessary for a risk support management technique to be able to perform a *sensitivity analysis*, indicating the other points in the plan where changes occur or risks arise (and to what extent they do so) as a result of a specific change considered by the manager. Successive changes of values by the project manager, with the support of feedback and guidance from the associated sensitivity analyses, can provide for effective exploration of possibilities for risk management under consideration.

Knowing which changes to consider depends upon the *diagnosis* of the problem to be investigated within the simulation. The initiation of this diagnosis usually lies with the project manager rather than with a risk management technique, because it is the manager's responsibility to take action to remedy the problems which may arise. Conversely, support for effective risk action management at this level means identifying (1) those particular aspects of the project where monitoring has identified primary (rather than secondary) symptoms of a risk, and (2) those aspects of the problem plan which may be affected as the deviant process which leads to the initial risk symptoms continues.

Effective *co-ordination* of all the activities within the project boundary is a major goal of the project manager in building and maintaining the project plan. Within a balanced dialogue, in response to the manager's commands, a risk management technique operating at this level should be able to *police the coherence of the structure* of the project plan as it is being built. The technique can then advise on gaps and inconsistencies, and warn when a proposed reorganization of one part of the structure may require much subsequent replanning to restore overall coherence.

* Details on the range of 'what if' situations that need to be considered by project managers can be found in Berkeley and Humphreys (1988).

In replanning, the project manager focuses on the need to compare alternative planning aproaches (Thamhain and Wilemon, 1986). This often results in a *restructuring* of the project's organization. Risk management support can be provided at this level by a technique which can *advise on implications for project risks* of particular plans (e.g. on potential bottlenecks in a schedule, where slippage could produce wide-ranging problems, or on potential over-reliance on the capabilities of a specific resource within a particular plan). This facilitates the comparative evaluation of plans, and also indicates where the manager might best direct his efforts in trying to improve a particular plan.

Where restructuring of the project's organization has potential repercussions across the project boundary, affecting other stakeholders in the project environment, the project manager will predominantly be involved in *negotiating* activities. Effective risk management support for these activities is likely to be *active* in mode rather than responsive, i.e. advising on possibilities for reducing project risks, or facilitating their management through negotiation. However, such advice should be offered as provisional in the system's dialogue with the manager, as the system, like the manager, is likely to have only partially structured information within its exploration into the client organization and the wider domain of the contractor organization.

Conclusion

The aim of this paper was to show how the quality and results of project management can be considerably improved through a consideration of project risks within the framework of project risk action management rather than merely project risk analysis. The approach to project risk action management we propose offers the following major advantages throughout the lifetime of a project:

- During the initial planning phase it provides an assessment of the project uncertainties. This assessment is essential before any irrecoverable commitment.
- It identifies the major sources of project risk drivers. The project plan may then be revised, or management may devise effective contingency responses.
- It provides management with an objective basis for comparing alternative management plans to reduce the project risks.
- Throughout the progress of the project, the regular use of project risk action management monitors the actual process of project risk management. This enables management action to be refined early enough so that contingency actions are effective.

Thus, we conclude by stressing that much could be gained if project managers could be educated to manage their projects effectively through an appreciation of the potential effects of the interdependency of risk drivers and their own managerial actions within the projects they manage (Ashley and Jaselkis, 1987). We have indicated how such education can be provided through skilled use of *risk action review* techniques. These techniques can provide support for risk action management across the full range of the project manager's activities, from the most concrete and closed, like monitoring progress of tasks, to the most abstract and open, like negotiation with the client and other stakeholders.

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