CP 602

CMT - AN INNOVATIVE SYSTEM FOR PROJECT RISK MANAGEMENT

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ABSTRACT

A risk management system called Criticality Management Tools (CMT) /1/ is introduced. This system (procedures and software tools) supports a preventive and proactive approach, which enables early identification of hazards and risk affecting the project objectives. The hazards may originate from a broad range of disciplines, such as economy, politics, technology, environment, etc. An information management module contains the resources needed to perform risk monitoring and controls experience data collected from surveys and pilot projects. These data will be continuously updated with experience gained through the use of CMT in ordinary projects.

1. Introduction

Defence industries occasionally experience projects which are characterised by large cost overruns, substantial delays and major quality or performance deficiencies. With the last years defence-budget cutbacks in the various NATO countries, the need for a cost-effective management of projects has become immense. Common to most of these projects are their substantial complexity, thus making project management a difficult task. It seems that there are inherent and sometimes inevitable risks and uncertainties associated with complex projects. The ability to manage and control risk thus becomes an integral part in obtaining project success.

Negative deviations from the project objectives are often claimed to be the result of unforeseeable and uncontrollable risk causes (called hazards) such as technological problems, contract disputes, marked changes, political interference, human or organizational problems and/or mismanagement. However, in this paper it is claimed that most hazards are in fact predictable and controllable, and that project failures are largely the result of lack of early attention by project managers due to the information and work overload occurring in complex projects.

On these grounds a project risk management system called CMT (Criticality Management Tools) is being developed. The CMT project is a cooperative R&D project between a large supplier; Aerospatiale Missiles (ASM), a large buyer; The Norwegian Defense (NDA), and a major risk assessment and quality assurance organization; Det Norske Veritas (DNV). The CMT project was initiated in late 1993, and the

Paper presented at the AGARD FVP Symposium on "Strategic Management of the Cost Problem of Future Weapon Systems", held in Drammen, Norway, 22-25 September, 1997, and published in CP-602.

development phase is planned to run for a 4 year period with a total investment of 25 MNOK.

The main objective of the CMT project is to develop a systematic approach to identify, assess and control risks in projects, programs, and portfolios. The CMT system (software tools and procedures) supports a preventive and proactive approach, which enables early identification of hazards and includes risk scenarios from a broad range of areas. This will lead to a cost-effective risk handling, as most hazards (and certainly the project objectives) are difficult and expensive to change once the project has been defined, the contract signed and the project activities started. Although CMT is primarily a tool to control risks with a downside potential, it is also well suited for handling opportunities, i.e., "upside risks". Being an aid for cost-effective decision making in this regard, the application of the CMT system may lead to project savings of at least 2-5%.

Main components of a risk are its hazards and their associated consequences which are defined as a deviation from the project objectives. In principle, all types of hazards and consequences can be handled by CMT. Hazards may originate from domains like politics, economy, technology, communications, project management, human relations, and others. These hazards may in turn have consequences to the project objectives, such as cost, schedule, product quality, safety, goodwill, environment, etc.

To facilitate the CMT process a computer tool called EasyRisk is being developed. This program may be operated in two modes - standard and advanced mode. The standard mode is a "CMT-light" version and is very easy to use, while the advanced mode offers the flexibility of complex scenario modeling using influence diagrams and Monte Carlo simulation technique.

So far, the CMT system has been implemented in 6 pilot projects. These projects have provided important feedback to the development team, including experience data which are used to build an experience database consisting of generic hazards and risk scenarios. The pilot projects also serve as useful validation of the CMT procedures themselves. Thus far it seems fair to say that putting focus on risks has had a positive effect on the projects. The extra awareness of critical risks may precisely be the main prerequisite to avoid them.

2. Risk Management Philosophy

A project is always an undertaking involving risks. Whereas management of such risks have been left to the project manager in the past, it is now becoming more and more usual that larger and complex projects encompass a separate risk management function /2/. The main objective of such a project risk management (PRM) function is to identify and structure information to (i) ensure that all the risks are managed, and (ii) ensure that all the actors are aware of the interfaces towards their own work that involves risk. The risk management function may thus be viewed as a quality assurance function of information flow in projects, to ensure proactive management of such information, and finally improve success-rates of projects. The following scenario-based logic can be used to explain some central concepts:

A project is executed in order to achieve certain *project objectives* which are defined in terms of schedule,

budget, performance of system development, etc. A deviation from these objectives is defined as a consequence. A risk scenario starts with

project hazards which may lead to

consequences measured as outcome severity and probability of occurrence. This measure is called risk and is used to categorize the effect of each hazard into

risk classes in order to decide whether to

ignore, monitor or mitigate the risk(s)

The above (chain of) events and conditions are the 'building blocks' of project risk scenarios.

2.1 Why Risk Management?

While negative deviations from the project objectives in the past were often attributed to uncontrollable factors outside the project and thus to some extend neglected, the tendency nowadays is rather to put focus on these risk causes. Early identification and awareness of the risks affecting the project will in general enable the project to respond and act in a way that leads to cost-effective risk handling. This will in turn also lead to better fulfillment of the project objectives (budget, schedule, quality, etc.)

2.2 Dealing with Uncertainties

It is a well known fact that humans have a strong tendency to engage in tasks which are familiar and to underestimate and avoid uncertain issues. Why then put focus on uncertainties? First, merely ignoring the uncertainties will not make them go away. On the contrary, you thereby increase the likelihood that they will effect your project in a negative way. Second, the uncertainty can sometimes provide useful information that can be crucial for decision making. To exemplify this in a straightforward manner, assume that you were to decide between two alternatives, where the estimated cost of alternative A is $1000 and alternative B is $1100. If the two alternatives can be considered to be equally good in terms of the delivered item, you would, with no further information, most likely select the alternative with the lowest cost, i.e. alternative A. However, let us review this decision taking the uncertainties into account. If the more expensive alternative was a COTS project, while the other included some development, the uncertainties associated with the cost estimates would be very different. For the sake of argument let us assume that the uncertainties in the costs were described by probability functions, as shown in Figure 1. The more expensive COTS alternative can be seen as a low-risk project as the cost estimate is rather certain. For the development alternative, on the other hand, the standard deviation in the cost estimate is significantly larger. In effect, the development project is quite likely to give real project costs above the ones of the COTS project. With this additional information at hand, the decision maker is more likely to choose the COTS alternative, despite its larger estimated cost.

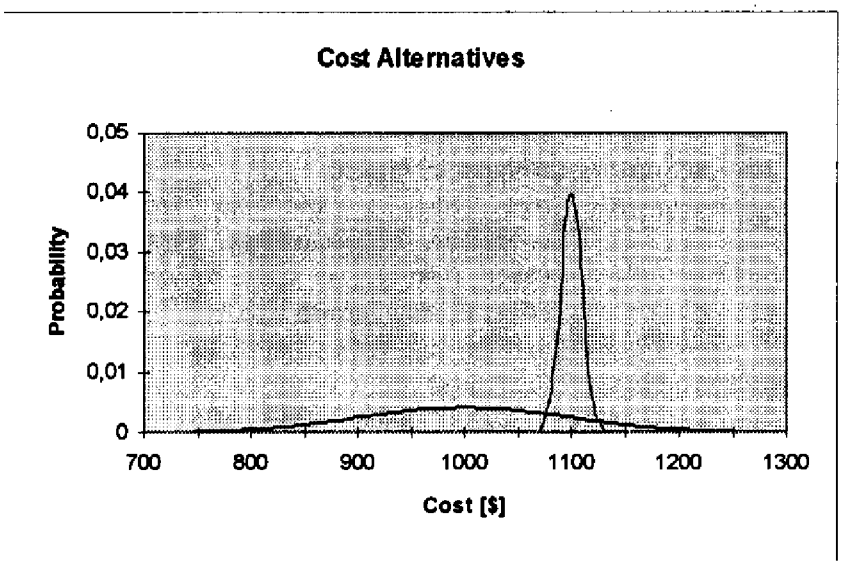

Figure 1: Cost-estimates including uncertainties for two project alternatives.

2.3 The Risk management Process

The following general principles should guide the development of any modern risk management (RM) process /3/:

- RM should be a systematic process, consisting of a method and a sequence of steps directly supported by a software program.
- RM should be flexible, because the thoroughness invested in information management (especially data collection) should be adjusted to the project at hand.
- RM should be intuitive, i.e. the user interface and way of operation should be simple and easy to understand, and reflect the situation of the end users.
- RM should contain guidance to the user on what to do, when and how.
- RM should support the decision making, by letting the consequences of different decision alternatives become clearer.

The CMT RM process has been designed to meet these objectives.

3. Criticality Management Tools - CMT

In CMT focus is put on the risk and their causes, i.e. hazards. By identifying and controlling the risk causes, one supports a preventive and proactive approach, which enables early identification of hazards and project risks. This in turn will lead to cost-effective risk handling, reducing the need for expensive "after-the-fact" mitigations.

3.1 The CMT process

The CMT risk management process consists of the following main steps:

- Initiation: Project objectives are identified. In this step risk acceptance criteria are also defined and a Risk Management Plan is prepared. The preparation of this plan implies that the generic CMT approach is tailored to

the needs and conditions of the project at hand.

- Hazard Analysis: Relevant hazards (risk causes) are identified, using check-lists, generic scenarios, generic projects, experience from other relevant projects, brainstorming sessions, etc. In principle, all types of hazards and consequences can be handled by CMT. The hazards may originate from domains like politics, economy, technology, etc. These hazards may in turn have consequences to the project objectives, such as cost, schedule, product quality, safety, goodwill, etc.

- Risk Assessment: Data is collected or estimated for the hazard probabilities and consequences, and for other relevant variables in the risk scenario. (A consequence means a deviation from the project objective.) The hazards are then classified according to the risk they represent on the various project objectives. Typically, three risk classes are used. Negligible risks (against which no particular action is required), Significant risks (which are acceptable on the condition that they are constantly monitored and re-assessed), and Critical risks (which are unacceptable risks, against which actions must be deployed).

- Action Analysis: Potential actions are identified, and their risk-reducing effects are evaluated. The actions are then ranked according to their cost-benefit value.

- Action Deployment: A given action is selected and initiated (deployed).

- Post-Implementation Evaluation: The relevant risks are re-evaluated after the action(s) have been implemented and the effects have materialised.

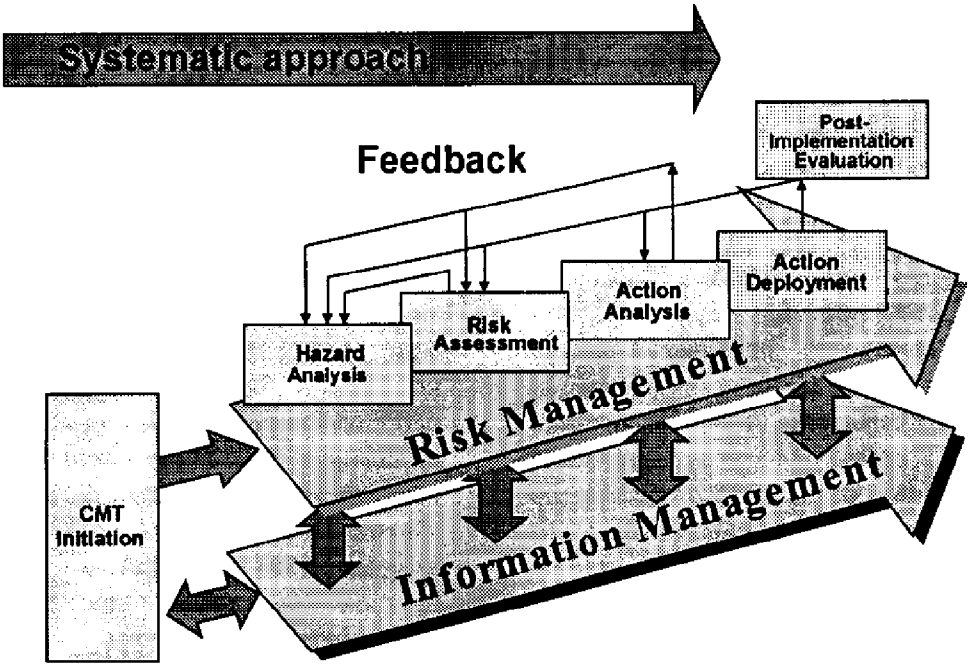

Figure 2: The CMT process overview

This process is iterative, thus capturing the dynamics of the risk management process: Periodically or whenever needed, one must redo the necessary steps in the process. The risk analysis steps are illustrated in Figure 2.

The CMT process can be performed in two different modes - standard and advanced. The standard mode is a "CMT-light" version, which is easy to use and provides the analyst with immediate, but simplified results. The advanced mode offers the flexibility of complex scenario modeling using influence diagrams and a Monte Carlo simulation technique.

In CMT, project risk is either defined as the expected deviation from project objectives, or related to the uncertainty associated with the objectives outcome. The first definition is used in the standard mode, while the advanced mode takes the full uncertainty as well as the interdependency between risk causes (hazards) into account. The standard mode disregards uncertainty, as it - for each hazard - only considers the typical value of the of the severity of the deviation (consequence) and the typical or mean probability of occurrence for that deviation.

The standard mode analysis will typically be the starting point for a more advanced analysis. Due to its simplicity it allows non-experts with little background in statistics to participate in the risk analysis. This is crucial for a successful implementation of the CMT process in the organization, allowing the end-users to build up their competence in a gradual manner.

3.2 Computational Tool - EasyRisk

A computer tool called EasyRisk is being developed to facilitate the CMT process and its documentation. It supports the two modes of CMT - standard and advanced.

In both modes of operation the hazards (selected from a built in list, or new) have to be evaluated with respect to probability of occurrence and severity of final consequence. This can be done on a user selectable (3, 6 or any-point) scale, or with advanced probability functions. When hazards have been identified and assessed, they are classified according to the risk they represent to the various project objectives. Typically, three risk classes are used: Negligible risks (against which no particular action is required), Significant risks (which are acceptable on the condition that they are constantly monitored and re-assessed), and Critical risks (which are unacceptable risks, against which actions must be deployed).

3.3 Calculational Techniques

In the standard mode of CMT each hazard is treated independently and evaluated without regard for uncertainty. This simplification, although sometimes appropriate, usually conceals useful information. In the advanced mode of CMT on the other hand, one uses scenario modeling to reflect the interdependencies between the various hazards and events. The variables in the scenario can also be assigned the appropriate probability function to reflect the associated uncertainty in its mean value. This approach provides the decision-maker with more comprehensive risk data, allowing e.g. the following:

- A multiobjective formulation: Several objectives can be taken into account, using the theory of utility theory./4,5/ This allows the decision-maker to perform trade-off analyses between diverse and possibly conflicting objectives: It may not be beneficial to hit bulls-eye on one objective if that means you have to deviate strongly on another objective.. The multiobjective formulation is designed in a way allowing CMT to also cover portfolio management. For this purpose the various projects themselves represent the different "objectives", and the portfolio management then allows for trade-offs between different projects and total risk calculations on the portfolio level.

- Sensitivity analyses: The scenario is analyzed in order to locate its most sensitive and most important elements. This information is in turn used to identify what type of actions will be most cost-effective, and where in the project-scenario they should be implemented.

- Upside-downside risk considerations: In the advanced mode the simulation provides probability functions describing all the possible outcomes of the objectives, thus covering both the upside and downside potential.

3.4 Information and Experience Management

The importance of information and experience management in complex projects cannot be overestimated. Most project failures are largely the result of lack of early attention by project managers due to the information and work overload occurring in complex projects. To facilitate and structured the handling of such information, and thus simplify this process, the CMT system is equipped with two important tools:

- The Risk Manual: A folder supporting the documentation in the various steps of the CMT process. This folder follows the project through its life-cycle, documenting the risk status at any time. Using Easyrisk, these documents can be printed out directly and put in the Risk Manual. This way the risk management information is utilized, structured and documented.

- Project Risk Experience Database: A database of different projects with typical hazards, objectives, actions and their assessments. Various "lesson-learnt" evaluations are also included in these database. EasyRisk is delivered with a database consisting of generic projects, generic scenarios, generic hazards, and generic actions. Typically each user organization will adapt this database to their own organization, reflecting the typical hazards and risks occurring in their projects.

4. Experience from use of CMT in pilot projects

The CMT system has so far been implemented in 6 pilot projects, where the cost of implementation has been split between the CMT development project and the actual project. Demanding that the projects themselves covered some of the costs was done deliberately to secure their genuine participation in the pilots.

The pilot projects serve several purposes:

- Provide feedback to the CMT development team regarding functionality and user friendliness of EasyRisk.

- Validation of the CMT procedures themselves

- Provide data for the CMT Project Risk Experience Database

- Prepare for a full implementation of the CMT system in the organization.

A true value of the project saving by the use of CMT in the pilot projects is hard to predict, but estimates may indicate savings of at least 2-5%. When CMT is firmly established in these projects and the full strength of the computer tool EasyRisk is exploited, this number is likely to increase.

The reactions so far from the members of the pilot projects have also been positive. When CMT was initiated in these projects, focus was first put on reducing (downside) risks. The interest and engagement from the project members was surprisingly high, indicating that they were not unfamiliar with the concept of hazards and risks. But so far there had been no systematic way to treat or document these "potential problems". CMT now provided a systematic system for them.

As CMT became familiar to the project participants they also began to consider "upside risks", i.e. opportunities. During CMT sessions the members now outdid each other in brainstorming possible opportunities for the project. No longer did they worry about exceeding the budget; they wanted the project to finish below budget!

The pilot projects have provided useful feedback to the development team, allowing them to refine both the process, procedures and the computing tool EasyRisk. But maybe most importantly they have told us that there is both a need, demand and desire for Risk Management.

5. Summary

A risk management system called CMT is introduced. The CMT system consists of both procedures and software tools. CMT provides a systematic approach to identify, assess and control risks in projects, programs, and portfolios. The focus is put on the risk causes - the hazards - as CMT supports a proactive and preventive approach. The hazards may originate from a broad range of disciplines, such as economy, politics, technology, environment, unrealistic requirements, etc.

To support the CMT process a software tool called EasyRisk is being developed. The computer program guides the user through the various steps of the process and facilitates the information and experience management. On a day-to-day basis the program is used to keep the Risk Manual updated. The Risk Manual documents the risks that may affect the project, and follows the project through its life-cycle, documenting the risk status over time. In addition EasyRisk maintains the experience database.

The experience from implementing CMT in various pilot projects has been encouraging. Putting focus on risks has had a positive effect on these projects. The extra awareness of critical risks may precisely be the main prerequisite to avoid them.

6. References

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