Risk e-Business:
Enhancing a Successful Risk Management Process Online

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Abstract

Recently, many TRW project management processes have been moving to the TRW intranet. The move to "e-business" applications is driven by the desire for standardizing processes, and belief that the superior data accessibility afforded by an on-line data base over a conventional file- or paper-based system will reduce costs while providing the possibility of enterprise views of multiple projects.

The new risk management process was a natural for such e-business application, simplifying the data entry and review for all steps of the process, plus enabling automatic email alerts to the risk management board and project leaders as new candidate risks are submitted. The e-business environment can also utilize hyperlinks to project documents and schedules to produce a more complete and easily accessible record of the risk analysis and mitigation process. Risk management lessons learned, recorded as each risk items is successfully retired, are easily collected and transferred to other projects.

While the advantages of using the web as an interface for project risk management are similar to most other e-business applications in providing broad access to project information from any location with Internet access, the risk management process is especially improved by automating communication and expediting risk reviews via the web. This paper describes how our e-business tool, called the Risk Control Center, broadened access to the risk management process, reduced the cost of risk management and enabled the transition to a risk-sensitive culture across all projects.

TRW Risk Management Process Background

TRW's successful risk management process, illustrated in Figure 1, was a key success factor enabling the NASA New Millennium Program's first Earth Observing Satellite (EO-1) to receive the Hyperion hyperspectral imager a week early on an unusually tight twelve-month schedule.[1]

The success of the TRW risk management process in its initial application on the Hyperion project stimulated institutionalizing the process as the new company standard at TRW Space and Electronics. The process was incorporated into the company's Risk Management Guide, and has been successfully applied to numerous projects of all sizes in the three years since Hyperion was delivered.

Project risk management training was established through development of a risk management workshop that has been taught regularly by Mr. Carman through TRW's Professional Development Center. Beyond TRW, the class will also be offered outside TRW through the local University of California at Los Angeles (UCLA) Extension Technical Management Program starting in spring 2002.

One student of the risk management workshop, Mr. Paul Wood, together with a talented programmer, Mr. Patrick Gibo, developed a web-based version of the application of the risk management process on a large classified project. This application met with good acceptance by the team in simplifying the maintenance of the risk documentation through the steps of the process including online risk management board reviews. Through the secure project intranet, all project team members can

Figure 1 TRW Risk Management Process Flow

PROCESS | **OUTPUTS**

Process Improvements

1 Risk Planning
- Define/tailor TRW risk management process to needs of Project
- Incorporate risk process improvements as necessary

Risk Management Plan
- Establish ground rules and risk rating criteria specifically for the Project
- Establishes guidelines & membership of RMB
- Define process and procedures consistent with customer requirements
- System engineering to facilitate process

2 Risk Identification
- Identify and document Project risk items with Inputs from:
- Customer
- Any project team member
- Subcontractors & suppliers

Risk Identification Record
- Description of each potential risk item
- Describe risk potential impact scenario
- Define risk event timeframe(s)
- Identify risk owner for each risk item

IPT Risk Review
- IPT Leaders review risk ID upon submittal to verify risk statements, impact scenario
- If approved, risk moves to Risk Analysis step 3
- If not approved, risk returns to author for revision or to rejected list.
- Risks reviewed each month prior to RMB meeting

3 Risk Analysis
- Determine probability and consequence of each risk using ordinal scales found in the Risk Management Plan

Is cost, schedule and performance risk low?

YES

NO

Risk Analysis Record
- Document current risk level (Low, Low-Medium, Medium, Medium-High, or High) for cost, schedule and performance risk

Risk Watch List
- Low risks monitored for possible changes

4 Risk Handling
- Define mitigation plan to respond to each risk item
- Estimate required resources

Risk Handling Plan
- Document plans to reduce & retire risk
- Estimate cost and schedule for mitigation plan
- Establish metrics for risk monitoring

RMB Risk Review
- Project Manager chairs Risk Management Board that reviews risk ID, Analysis, & Handling Plans
- Watch List risks are reviewed for changes
- All risks are prioritized
- RMB Authorizes funds for Risk Handling of highest approved risks
- Risk Handling plans are incorporated into project master schedule

5 Risk Monitoring
- Track & control progress in performing risk handling plans
- Risk Handling Plan progress is tracked and updated monthly
- Risk Analyses are revised to reflect results of risk mitigation

- Process is continuous: Steps 2 through 5 repeat each month

Risk Status Reports
- Risk status reported as required in all reviews

Prioritized Risk List

Retired Risk List
- Risks are retired by the RMB when they can no longer occur or they could not impact the project
- When a risk is retired, the lessons learned and the actual cost of risk mitigation are recorded.
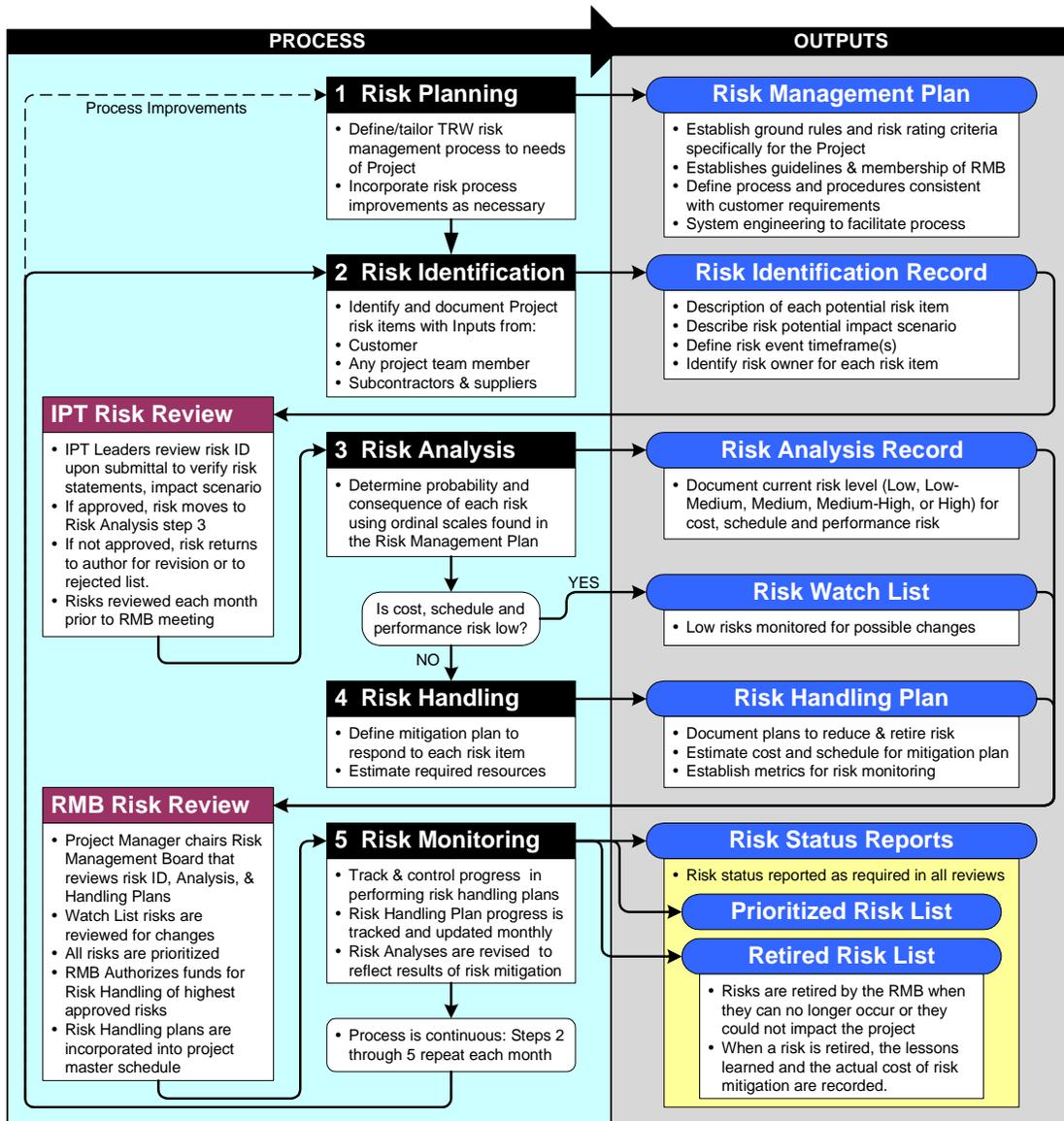
Figure 1 TRW Risk Management Process Flow

access the paperless application of the system. This simplifies the identification of new risks, automates the risk analysis and simplifies the update of the risk handling plans.

This web-based tool was made available to unclassified projects after several enhancements were completed. As the on-line tool was modified for general use, several issues had to be solved. The goal was to provide a single web-based tool useable by multiple projects, rather than have a separate copy of the entire tool for each project. The single site would be accessed through a security checkpoint that would identify the user and provide access to the project he was previously approved to view.

Thus it would appear that each user had an exclusive use of the tool for his project when in fact there is a central "engine" that drives the tool and the screens are customized for each project through sections of the database dedicated to each project.

The Risk Control Center

The new risk e-business site was named "The Risk Control Center." A central website provides a place to find out general information about the Risk Control Center and has links to a practice version of the risk process tool so that people can explore the online process. Contact information is available to establish a home

page for a new project. A sample project home page in the Risk Control Center is shown in Figure 2.

Figure 2 Risk Control Center Project Home Page

The Risk Control Center (RCC) includes a database that provides access for each project user by checking the identification of the user with a list of people previously authorized by each project. The web pages are then tailored with the database content including all risks unique to that project. In this manner, the tool provides flexibility to be used for projects of all sizes, from large programs that require a multi-tiered risk management program to small projects that require a simpler interface.

Planning

Since the risk management process begins with each project creating a Risk Management Plan tailored uniquely for that project, that plan is linked to the Risk Control Center home page for that project. The details of the project WBS, organization assignments and risk process tailoring are all incorporated into the web tool. In addition, any context-based information that references the Risk Management Plan can be hyperlinked to the appropriate sections of the document.

Because all projects share a single e-business tool, the possibility of an enterprise view of project risks arises. This can be useful when the Space and Electronics management wants to have a global, enterprise view of risk across multiple programs. This view can provide insight to common program risks and enable investigate the possibility of corporate action that could reduce recurring risks.

Another enterprise advantage is the risk lessons-learned database that is a natural byproduct of the risk process, since the process requires the risk owner to document the lessons learned from the risk item at the time each risk is retired, along with the rationale for risk retirement and the actual cost of the risk mitigation activity. As these lessons accumulate, the on-line tool can provide access to lessons learned from other projects, possibly helping other projects avoid similar risks.

The following section describes the technical details of the Risk Control Center (RCC) implementation, and describes the features of the RCC at each step of the risk management process.

RCC System Platform Technical Overview

The Risk Control Center (RCC) web-based e-tool application is based primarily on a Microsoft technology platform. It extensively uses ASP (Active Server Pages) with Visual Basic Script, JavaScript and DHTML (Dynamic HyperText Markup Language). The database is based on SQL (Structured Query Language). A few functions also use Macromedia's Cold Fusion.

The system hardware is based on two shared servers hosted by the TRW Space & Electronics e-Enterprise organization, as illustrated in Figure 3.
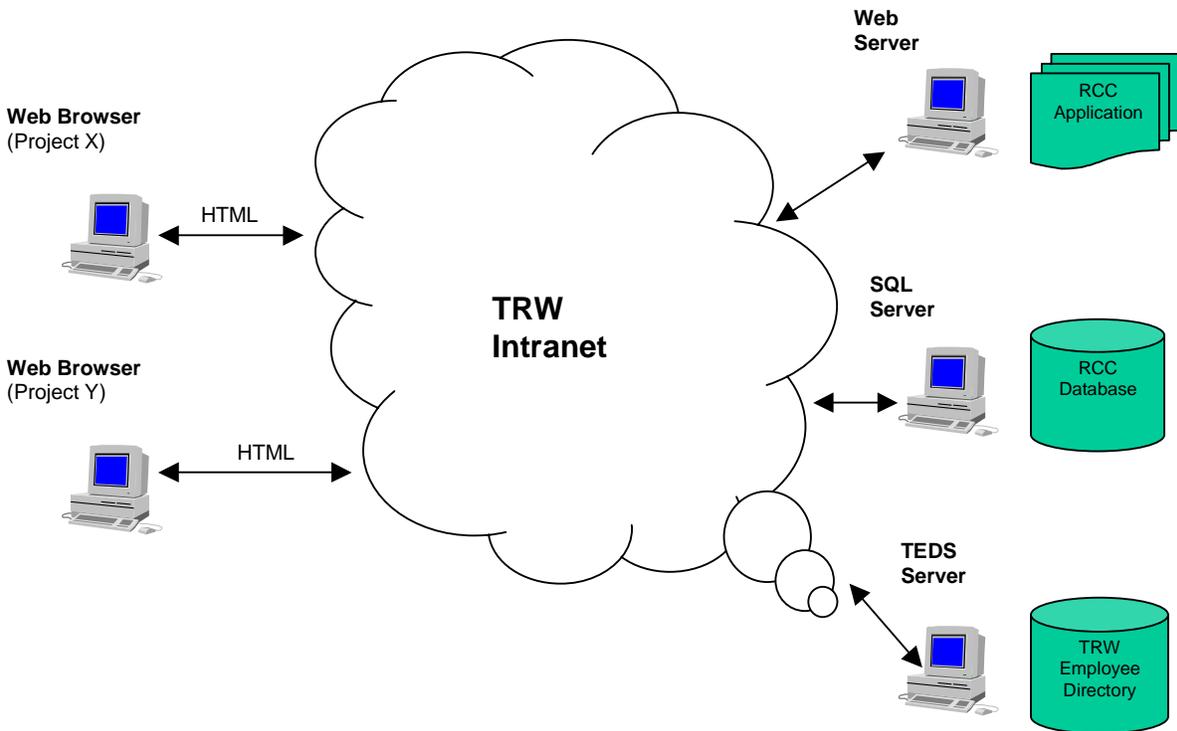
Figure 2. Enterprise-wide TRW Space & Electronics Risk Control Center (RCC) Architecture

The web server is a Dell PowerEdge 4400 with two Pentium III Xeon 667MHz processors, 2GB RAM and RAID 5 disk configuration with 54GB storage. This server is running Windows 2000 Server, Internet Information Server 5.0, Active Server Pages 3.0 and Cold Fusion Enterprise 5.0.

The SQL (database) server is a Dell PowerEdge 6400 with four (4) Pentium III Xeon 700MHz processors, 2GB RAM and RAID 1+5 disk configuration with 72GB storage. This server is running Windows 2000 Server and SQL 2000 Server. The platform configuration and Intranet based enterprise-wide access to this e-tool is depicted in Figure 3.

Risk Control Center Application Description

A new project is established by making tailoring project-specific database entries to establish a Project-unique home page on the RCC. These data include the project name, project RCC administrator, a list of project sub-systems and/or Integrated Project Teams, key project milestones (e.g., PDR, CDR, Delivery, etc.) and dates, and risk analysis categories. The project

is also tailored to match the process flow indicated in the project Risk Management Plan.

When a user accesses the main RCC web site, the system inquires which project the user wants to access. A new user indicates which project he/she would like to access, and indicates his/her association with any project subsystems or Integrated Project Teams. The subsystems indicated will ensure that the user receives notification of any risk identified in those subsystems.

The designated project RCC administrator reviews these requests and grants appropriate access to the user. Thereafter, the RCC application automatically authenticates each user by matching the user's desktop login information and matching it with the TRW Enterprise Directory Service (TEDS) and the RCC access database for that project.

Risk Identification

The second step in the process is risk identification (see box 2 in Figure 1). Risks can be submitted at anytime, from anyplace, by anyone on the project via access to the RCC.

IPT members typically identify risks as they are encountered. Clicking on a "New Risk" tab, the user begins the process of identification of the risk item by filling out risk identification record entries online. Each risk is submitted via the Risk Control Center by completing the Risk Identification Record shown in Figures 4 and 5. The risk identification record includes a description of the potential risk item, which WBS elements and subsystems and/or IPT it could affect, and when it might occur.

Figure 4 Risk Identification Record

The user provides a brief risk title, a risk overview and summarizes the risk as an "if-then" (*if* this happens, *then* that may happen) statement. A risk identification number, submitter's name and submission dates are automatically assigned by the RCC application.

The user selects a desired resolution date that could be a fixed date or could be a project milestone plus or minus a specified number of days. The dates could be hyperlinked to a project schedule line item start or end date such that any change in the project schedule will automatically revise the risk schedule.

The user can also indicate an association between this risk and previously entered risks already in the project database by using a drop-down menu. The user also identifies a risk timeframe to show in which phase(s) of the program it will possibly occur. The responsible project subsystem is selected via a drop-down menu and any other project subsystems possibly affected are identified by check boxes.

The user can then submit the identified risk item for review, save it as a draft, or withdraw it. The RCC system checks to make sure that all required fields are entered before submission, and prompts the user when a field has not been properly completed.

Once it has been submitted by clicking the "Submit" button on the risk identification record, a link to the RCC risk item is then emailed to project leader identified to review and approve risks associated with the indicated primary subsystem or IPT. The reviewer can accept, reject or return the item to the originator with a request for more information. In a small project, the reviewers may be the members of the Risk Management Board.

If the reviewer accepts the risk, he also identifies a risk owner – often the person who submitted the risk. A list of all applicable personnel for each subsystem is made available online from the project RCC database to streamline the process of selecting the appropriate risk owner.

Risk Analysis

Once a risk has been identified, reviewed and accepted as being valid then the risk owner is authorized to complete a detailed risk analysis, including a risk impact scenario. The risk owner enters the RCC and begins to document the risk analysis by entering data in the fields as indicated in Figure 5. These RCC risk analysis fields are not available to the user until after initial approval of the risk item, thus minimizing any effort that may have been expended on a rejected risk item. In addition, once the risk item is accepted, any documentation associated with the risk item can be attached via hyperlinks

using buttons on the RCC web page. These uploaded files are stamped with time and the user name for historical reference.

Figure 5 RCC Risk Scenario and Impact

The risk owner describes the project impact scenario that would most likely take place if this risk happened and nothing had been done to mitigate it. In other words, describe the risk consequence. The impact scenario includes quantitative estimates of potential cost, schedule and technical impact. The user can input the risk impact scenario that includes the optimistic, most likely and pessimistic estimates of the associated risk's cost impact, performance impact and schedule impact. This scenario forms the basis of the estimate of the risk consequence analysis.

The Risk Analysis procedure, step three in the process (see box 3 in Figure 1), evaluates the risk level of each risk. By clicking on the "Risk Analysis" button shown near the bottom of Figure 5, the Risk Analysis Form appears (Figure 6). Five possible risk levels (high, medium-high, medium, low-medium or low) can result from the risk analysis. Since risk is a function of its probability and impact severity (or consequence), each risk item's probability and impact are analyzed using the Risk Analysis Record via the Risk Control Center.

The risk analysis record utilizes predefined ordinal scales to estimate risk consequence and probability. These ordinal scales are included in the Program Risk Management Plan, and the Risk Control Center risk analysis record is hyperlinked to the Risk Management Plan to ensure that the latest scales are used in the analysis.

First, the estimated cost, performance, and schedule impact severity (or consequence) is scored using the impact assessment scales, based on the estimates from the risk identification record. Note that three separate consequence scores from 1 to 5 will be determined: one for cost, one for performance, and one for schedule impact. These vary from Negligible to Severe (1 to 5), and are entered into the Risk Analysis Record.

Secondly, the Risk Probability is estimated from a family of ordinal scales for parameters that contribute to the probability of occurrence, including Technology Readiness Level, Design Difficulty, Manufacturing Difficulty, and others. The analysis will use as many of these scales as are applicable to the particular risk under analysis, each producing a separate probability score from A to E, entered into the risk analysis record with a brief rationale for that score.

With the set of probability and impact severities established, the risk level can be determined using the risk analysis record, which automatically computes the risk level for each combination of consequence and probability using the risk scoring matrix (see Figure 3). The resulting multiple risk levels for all combinations of cost, schedule and performance impact with the each of the probabilities is reduced to three values of risk by selecting the maximum risk level in each category for cost, schedule and performance risk. This trio of risk scores is always used in reporting and tracking the risk item, enabling the project to easily see what the cost risk, schedule risk and performance risk levels are for that risk.

Figure 6 Risk Analysis Form

The RCC application supports the risk analysis and automatically calculates the associated risk rating. The risk rating is calculated for cost, performance and schedule. A combined score is also calculated.

The risk analysis record requires the user to select from a drop-down menu the consequence of occurrence for cost, performance, and schedule, based on the risk scenario. The risk consequence choices provided are 1 (negligible) through 5 (severe).

The user selects the appropriate risk probability from ordinal scales for the applicable sub-categories in each major category (e.g. Hardware, Software, Integration, or Human Resources) for each consequence column. The risk probability choices provided are A (Low) through E (High). The user also enters a narrative rationale for the values being entered.

A "calculate" button is provided for the user to see the risk rating score based on the inputs provided in the risk analysis form. Based on the inputs for each sub-category under each consequence column (C, P & S), the system does a table lookup from a risk-scoring matrix shown in Figure 7, and automatically assigns risk ratings of Low (L), Low-Medium (LM), Medium (M), Medium-High (MH) and High (H). The

Risks that score low in all three consequence categories (cost, schedule and performance) do not require a risk handling plan, and are placed on a "watch list" to be monitored regularly for changes in status. When there are multiple risks that have completed analysis, they can be ranked by the risk levels determined from the analysis, from the highest risk levels at the top of the list to the lowest at the bottom. This risk ranking helps the Risk Management Board (RMB) MB apply resources to the highest-leveraged risks on the program.

Risk Probability	Risk Consequence				
	1 (Low)	2 (Minor)	3 (Moderate)	4 (Significant)	5 (Severe)
E (High)	Low-Medium	Medium	Medium-High	High	High
D (Significant)	Low	Low-Medium	Medium	Medium-High	High
C (Moderate)	Low	Low-Medium	Medium	Medium	Medium-High
B (Minor)	Low	Low	Low-Medium	Low-Medium	Medium
A (Low)	Low	Low	Low	Low	Low-Medium

Figure 7. Risk-Scoring Matrix.

system also calculates the maximum risk rating for Cost, Performance and Schedule. Once the

user submits this analysis, all three risk ratings are carried forward in the ranking of the risk item.

Risk Handling

Once the analysis is completed, the risk handling plan is prepared, which is the fourth step in the process (see box 4 in Figure 1). The Risk Handling Plan describes the planned response to the risk item, and the appropriate response is selected from a pull-down RCC menu (Figure 8).

Risk handling plan strategies include *avoidance* (changing the design or requirements to eliminate the risk), *transfer* (change responsibility for the risk), *control* (implementing a mitigation plan to reduce risk), and *acceptance* (doing nothing to mitigate the risk, but sometimes allocating cost and schedule resources to allow for the impact, should the risk occur). Once a strategy is selected, the proposed steps are documented on the Risk Handling Plan, and a schedule of events is prepared with an associated cost estimate if additional resources are required.

Based on this selection, appropriate fields for the risk-handling plan are displayed for user input. If the risk item scored "L-L-L" (Low cost risk *and* Low schedule risk *and* Low performance risk), the risk handling section is not required and thus not made visible.

After completing these sections the user can submit the risk item to the Risk Management Board (RMB) for review.

Risk Monitoring

Step five of the process (see box 5 in Figure 1) is the Risk Monitoring step that is led by the project manager and the Risk Management Board (RMB). The RMB meets monthly to evaluate new risks, disposition resources requested for implementing handling plans, review status of the handling plans in process, and retire risks when possible. Risks are retired
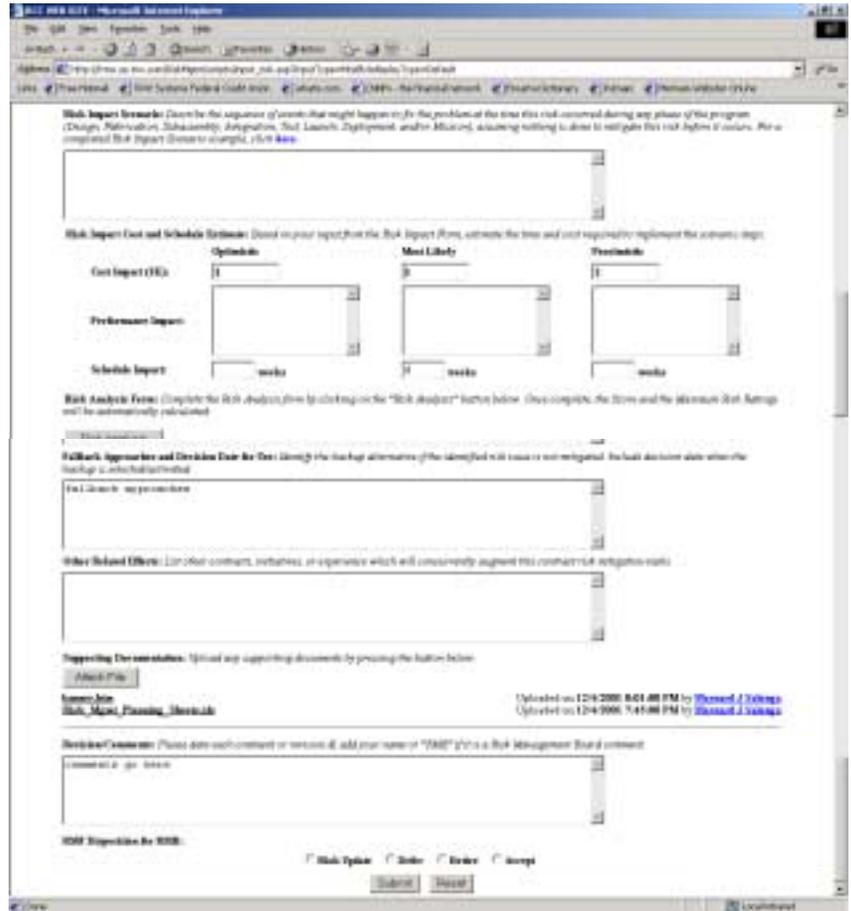

Figure 8 Risk Handling Plan

when either they can no longer occur, or their occurrence has negligible effect on the project. Risk retirement is cause for team celebration and praise for the risk owner, thus promoting a risk-sensitive team culture.

During the RMB review process, The RCC provides a comment field to record Risk Management Board actions as well. The RMB is also responsible for eventually closing the risk item by selecting the retire option. During this phase, the user can also record the actual cost impact of the risk item and the lesson learned.

Following each monthly RMB meeting, Risk Status Reports will be developed from the Risk Control Center database to provide the risk status summaries and details when needed at periodic reviews.

Query and Prioritization

The RCC application also allows various query options to retrieve records. The user clicks on

the "Query" tab to access to recall any or all of the risk items based upon any combination of its review authority, status, required resolution date, submission date, last modified date, responsible sub-systems and scores. The user could also query risk items based on its assigned identification number or request all records to be displayed. Figure 9 dhows the Query page and Figure 10 the resulting display of risks.

Figure 9 Risk Query Page

Figure 10 Risk Query Results

Once the records are displayed, the user can also sort the records either based on its identification number, title, review authority, status, responsible sub-system, date submitted, required resolution date, last modified date, or risk score. Since all three scores (cost, performance and schedule) are maintained, the risks can be prioritized by sorting on each of these parameters, or on a composite score calculated based on a summary of all three scores.

In addition to the query options, pre-configured reports can be generated as well. The user could decide to get a report on all new risks, high scoring risks, low scoring risks or retired risks. Various other reporting options are being planned to be part of the system.

Administrative Options

An administrative option is also available to the user. From this option, the user can view all the users for the specific project of the system. It shows a matrix with user names, status, badge-number, e-mail and the associated system privileges. A user could be either an authorized reviewer of the Risk Management Board (RMB) and/or Integrated Project Team (IPT). If a user is an authorized reviewer of an IPT then it may belong to one or more project sub-systems. A user could also belong to a project sub-system without being an IPT reviewer and thus get updates to risk items related to that sub-system. The system recognizes two types of users, either they are an administrator or a basic user. Administrators have privileges to edit the user access and profiles.

The system also provides various help options, including frequently asked questions, appropriate links to the project risk management plan and other resources related to risk management.

Technical Performance Measures

Technical Performance Measures (TPMs) are often identified as metrics for a particular risk item. Allocated cost reserves and schedule margin will be tracked on a monthly basis. Management reserve provides the resources necessary to fund mitigation activities, while schedule margin provides the time required for these activities, should it be needed.

The continuous risk management process, which cycles back to step 2 (or 1, as needed) each month (see feedback arrows in Figure 1), is periodically supplemented with quantitative risk analyses using Fault Tree Analyses, Failure Modes and Effects Analyses, Probabilistic Risk Analyses and Monte Carlo analyses. Quantitative analyses produce a view of the

total, integrated risk environment that yields completion date and cost at completion with confidence values related to the risks. These results greatly improve the quality of the decisions that are made to guide the program and invest in risk mitigation.

Use of the process on many TRW projects has demonstrated that the process can be equally effective on large and small projects.

Next Steps

Future enhancements of the Risk Control Center e-business tool include the move from the TRW intranet to the Internet with appropriate levels of security. A true Internet-compatible tool would better link all project contributors including suppliers, subcontractors and customers to the risk management process.

Another augmentation will be the addition of enterprise-level reports that can combine risks from multiple projects into a single global report. Such enterprise views can aid in managing risk across the corporation.

Conclusion

The Risk Control Center has demonstrated that utilization of the web browser as an interface to the risk management process can provide important benefits in rapidly communicating risk status and reducing the cost of implementing this approach. In short, risk e-business has not proven to be a risky business.

Authors

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[1] Conrow, Ed; Carman, Stephen and Cramer, Bryant, *Risk Management on Hyperion: Consultant, Industry and NASA Perspective*, Proceedings, Risk Management 2000 Conference, Paper IIIB, December 1, 2000.