25

TOOLS AND METHODS FOR RISK MANAGEMENT IN MULTI-SITE ENGINEERING PROJECTS

Mingwei Zhou[1], Laszlo Nemes[1],
Carl Reidsema[2], Ammar Ahmed[2], and Berman Kayis[2]
[1]CSIRO Manufacturing & Infrastructure Technology, Australia
[2]School of Mechanical and Manufacturing Eng., University of New South Wales, Australia
e-mail: Mingwei.Zhou@csiro.au

Abstract: In today's highly global business environment, engineering and manufacturing projects often involve two or more geographically dispersed units or departments, research centers or companies. This paper attempts to identify the requirements for risk management in a multi-site engineering project environment, and presents a review of the state-of-the-art tools and methods that can be used to manage risks in multi-site engineering projects. This leads to the development of a risk management roadmap, which will underpin the design and implementation of an intelligent risk mapping system.

Key words: Risk Management, Enterprise Engineering, Tools and Methods

1. INTRODUCTION

In today's highly global business environment, engineering and manufacturing projects often involve two or more geographically dispersed units or departments, research centres or companies. To enable the collaboration between these multi-site units across space and time, three essential elements are required:

1) ICT platform to support information sharing and collaboration;
2) Appropriate organizational structures and engineering processes to support collaborative work involving different functional groups; and

3) Identification, evaluation and treatment of the risks associated with multi-site engineering projects.

Research on Virtual Enterprises (VE) for global manufacturing [1,2,3] has extensively addressed the first two issues. This paper will focus on the third essential element, i.e. the risk management.

Recent research on project risk management has been mainly conducted in the software, finance, and service sectors. Fewer projects have extensively addressed the requirements of risk management for engineering projects, especially for those multi-site geographically distributed projects.

The IRMAS (Intelligent Risk Mapping and Assessment System) Project, an Australian research project described in this paper, aims to develop a risk mapping and assessment system for multi-site engineering projects, and therefore enhance the local manufacturers' capability of collaborating and competing in the global market.

This paper will firstly discuss the requirements for risk management in a Multi-Site Engineering Project (MSEP) environment. The Purdue Enterprise Reference Architecture (PERA) has been used to model the project lifecycle. This provides a guideline to establish the criteria for the review of the risk management tools and methods. This leads to the development of a roadmap for risk management, and enables the design and implementation of an intelligent risk mapping system.

2. RISK MANAGEMENT IN MSEP

2.1 MSEP as a Virtual Enterprise

With the advent of globalization of economies, enterprises are facing more and more rapid business changes. To seize and maintain its competitive advantage, an agile engineering and manufacturing enterprise must be able to react quickly to the changes in their business. As a consequence, a new business paradigm of "Virtual Enterprise" has been evolved to address this need.

A multi-site engineering project (MSEP) is a typical example of such a Virtual Enterprise, where two or more geographically dispersed business units or departments, research centers or different companies need to work together and exploit the fast-changing worldwide product engineering or manufacturing opportunities.

The MSEP is a competency-based temporary organization that uses the distributed intellectual strengths of its members, suppliers and customers.

The scope of its management is global, looking for the integration of the skills and contributions of those belonging to the value network. It explores the synergy necessary to satisfy the diversity demanded by customers, and to innovate, not just in product, but also in management practices.

However, because all MSEP members in each site need not only to work locally "business as usual" according to their own best practices, they also need to work globally by following the protocols and the plans agreed on in the MSEP. There may be gaps and conflicts in guiding project members' "local" and "global" behaviors. Therefore a set of effective risk management tools and methods is essential for the success of the MSEP.

2.2 Enterprise Integration and Risk Management

In order to manage the dynamic global manufacturing business of a MSEP more effectively, a clear understanding of the concept of virtual enterprise is needed. Therefore, enterprise models, which describe what an enterprise is conceptually composed of and how it works, as well as the Enterprise Integration methodologies become essential.

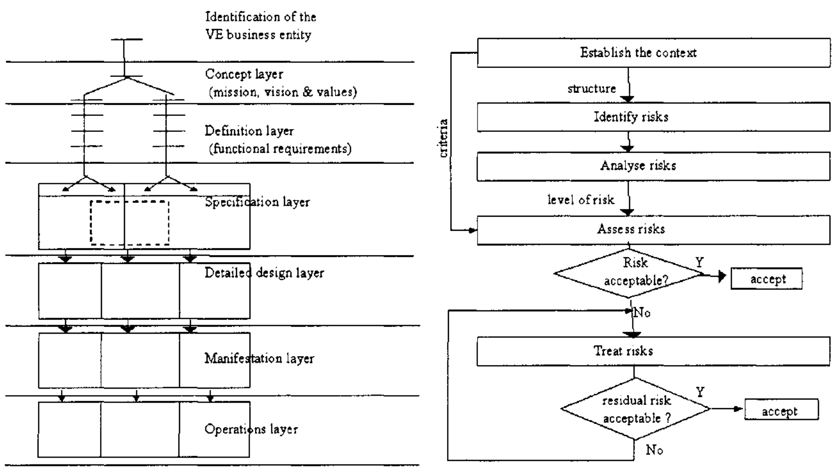

Figure 1. The PERA Methodology (left) and the Framework for Risk Management (right)

Zhou and Neff [4] proposed a virtual enterprise design methodology that utilize both the Enterprise Integration and Risk Manufacturing methodologies. It used the Purdue Enterprise Reference Architecture (PERA) [5] to depict the phases of the lifecycle of a virtual enterprise, and used the Australian/New Zealand Standard on Risk Management [6] as a framework to identify and analyze the risks involved in the building-up and the organization of a virtual enterprise.

As the MSEP is a typical virtual enterprise, this methodology can also serve as framework to help identify the requirements for risk management in MSEP environment.

2.3 Requirements for Risk Management in MSEP

The different phases of the PERA methodology can be used to guide our definition of the requirements for risk management in a MSEP. The first three phases are Identification, Concept, and Definition. The rest of phases represent an implementation view of a MSEP.

The Identification phase deals with the description of the external environment, and the criteria for creating or participating in a MSEP. At this phase, the risk management tools and methods should help the stakeholders to make strategic decisions such as why the MSEP is a feasible approach for the identified business opportunity.

The Concept phase aims to identify the motivation for creating a MSEP. At this phase, the risk management tools and methods should help the stakeholders and the potential project managers to identify and analyze the risks involved in the setting up and operation of the MSEP. Here the emphases will be the cross-site and cross-company boundary interactions within the MSEP.

The Definition phase is mainly focused on the explicit requirements concerning the planning and operation of the MSEP. It indicates a functional view of the lifecycle of a MSEP. The risk management tools and methods should be able to accommodate the specific function of the engineering projects. Here the emphases will be the ability to manage the risks involved in a specific engineering project, for example, an innovative product development project or a routine product improvement project.

The rest of the phases (Specification, Detailed Design, Manifestation, and Operation) are the Implementation phases of the MSEP, in which the MSEP is created, operated and finally dissolved after project completion. The risk management tools and methods for these phases are mainly focused on the implementation of risk management plans, monitoring, assessing and treating the identified risks as planned.

In the following section, we will present a survey and evaluation of the state-of-the-art tools and methods for risk management according to the phases of the MSEP lifecycle.

3. REVIEW OF TOOLS AND METHODS

3.1 The Identification Phase

Multi-site engineering projects, like other types of virtual enterprises, belong to a new manufacturing paradigm. Although many tools and methods have been developed for facilitating the design and operation of virtual enterprises, there are very few tools and methods on risk management for the identification phase.

The virtual enterprise design methodology [4] integrated with the Risk Management Framework can be considered as one of the early attempts to address this issue using enterprise engineering technologies.

Other methods have been largely aimed to achieve a better understanding of the organizational behavior in the "virtual" or the ICT connected multi-site environment. The establishment of Global Engineering and Manufacturing Networks [3], as well as the creation of Virtual Enterprise Communities [8], is aimed to stabilize the organizational structure of this virtual environment. The another term often comes with "risk management" in this phase is the term "trust", some people decide to establish trust *for* the purpose of minimizing risk, while others may prefer to establish trust *through* managing acceptable level of risk. IPR, liability, business intelligence, and many other legal issues are also active topics [8].

The COTS (commercial on the shelf) tools, such as FirstStep <http://www.interfacing.com/>, an enterprise modeling tool, can be used to do some scenario-based analysis and simulation for risk identification and analysis.

3.2 The Concept Phase

There are many tools and methods available for general project management, although none of them specifically developed for the needs of the multi-site engineering projects. Many of these methods are very generic and easy to understand, such as the PMBOK Guide [7]. Some of them have become national or international standards, such as [6].

Most of existing COTS tools for project risk management are for risk analysis and assessment. These tools include:

- Uncertainty modeling tools, such as RI$K <http://www.aceit.com/Products/risk.htm>, and Crystal Ball <http://www.decisioneering.com/>;

- Sensitivity and scenario analysis tools, such as @Risk <http://www.palisade.com/html/risk.html>;
- The "expert interview" tools, such as RiskTrak <http://www.risktrak.com/> and Trims <http://www.bmpcoe.org/pmws/>; and
- The Add-ons to the project planning tools, such as PertMaster <http://www.pertmaster.com/products/index.htm>.

These tools are useful when the identified risks are well understood and their probability and impact are known. It is unclear how effective these tools are in calculating propagated risks as the network of activities conducted in a multi-site engineering project, usually have a high degree of interdependencies.

The disadvantage of those "expert interview" tools is its highly domain specific nature, and seems to be suitable only to those highly structured processes. Those expert systems will need to be tailored for each specific domain.

3.3 The Definition Phase

For the definition phase, the tools and methods used for risk management are becoming more function oriented and domain specific. There are a number of risk management methods and tools already developed for many well-understood processes and domains, such as insurance, financial services, health service, security services, hazard management, and increasingly, the software development and information service domain.

There are many active research efforts looking at various types of engineering projects, such as product design, engineering development, assembly, and tooling. For example, our research team is currently investigating the risk assessment issues for a concurrent engineering project in a multi-site environment [9].

3.4 The Implementation Phases

There is a lack of the methods or guidelines that a project manager can use to develop a risk management plan, although many established companies have already developed their best practices in risk management into a template document for project risk management. However, there is also a lack of the COTS tools that can help a project manager to implement or execute the risk management plan, and manage the whole risk cycle, from risk identification, assessment, monitoring, to its treatment. There are no

COTS tools available that can capture and reuse the lessons learned from previous projects.

There is also a lack of the tools and methods to help a project manager to identify the gaps and conflicts during the monitoring and controlling of risks when different sites of the engineering project are using different risk management policies or at a different level of maturity.

4. TOWARDS A ROADMAP FOR RISK MANAGEMENT

Based on the review of the tools and methods for risk management in MSEP, we sensed an urgent need for a roadmap that can provide necessary guidelines for project managers to manage risks in multi-site engineering projects.

Such a risk roadmap is expected to provide guidance at an appropriate level of detail during the different phases of the lifecycle of a MSEP. Such a risk roadmap should also serve as the interface for project managers to identify and assess risk factors, as well as monitor the risk triggers and mitigate the risks through invoking corresponding risk management tools.

For the Identification phase, the risk roadmap should provide a "bird's eye view" map of the risk issues involved in the MSEP. This can be achieved by "interviewing" the project managers and major stakeholders to establish a risk profile for the new MSEP.

For the Concept phase, the risk roadmap should provide a "key" map of risk factors with a clear mark of the boundary of responsibilities for site to site, and site to MSEP interactions.

For the Definition phase, the risk roadmap should provide a detailed map that provides proactive advices on risk probability and impacts, helps to identify the critical path for the MSEP, and recommends the best practices for risk avoidance and risk minimization.

For the Implementation phases, the risk roadmap should provide an "on road" map that indicates the current project status, and current project positions in terms of the overall project progress against the project plan.

The development of such a roadmap for risk management will underpin the implementation of an intelligent risk-mapping tool for managing risks in multi-site engineering projects.

5. CONCLUSION

This paper discussed the risk management issues in a multi-site engineering project environment. The requirements for the risk management tools and methods have been discussed according to the lifecycle phases of the PERA model. The state-of-the-art tools and methods are reviewed against the identified requirements. Finally, the concept of a risk management roadmap is presented which will enable the development of an intelligent risk-mapping tool for multi-site engineering projects.

REFERENCES

1. Bernus, P.; Nemes, L.; Williams, T.J. (1996). Architectures for Enterprise Integration, Chapman & Hall
2. Zhou M. et al. (1998). A Framework for Design a Virtual Manufacturing Enterprise and its Implementation as a Workbench, in *Information Infrastructure System for Manufacturing*, edited by Miles J.J. and Kimura F., Kluwer Academic Publishers
3. GLOBEMEN. (2000 - 2003). Global Engineering and Manufacturing in Enterprise Networks. IMS 99004/ IST-1999-60002, http://globemen.vtt.fi
4. Zhou M., Neff P. (2000). Virtual Manufacturing Enterprises Design Using Enterprise Integration and Risk Management Methodologies, ICME 2000, Sydney
5. Williams, T.J. (1994). A Guide for Master Planning and Implementation based on PERA, Purdue University, Report No. 157
6. Australian/New Zealand Standard (1999). Risk Management, AS/NZS 4360
7. Project Management Institute (2000). A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – 2000 Edition. Newtown Square, PA
8. Mo J.P.T., Nemes L. (2001). Global Engineering, Manufacturing and Enterprise Networks, Kluwer Academic Publishers
9. Amornsawadwatana S., Ahmed A., Kayis B., Kaebernick H. (2002). A Risk Assessment Approach for Concurrent Engineering Project in Multi Sites, Third Asia-Pacific Conference on Systems Integrity and Maintenance (ACSIM), Cairns