Unit 6 Project Monitoring and Controlling

Structure:

6.1 Introduction

In the previous unit you have studied about project scheduling. In this unit let's discuss about project monitoring and controlling. Usually the project manager monitors the overall project whereas a phase project manager monitors each phase. If there are any risks then the phase project manager reports to the overall project manager. In this unit you are going to study in detail about how a project is monitored and controlled by project and phase managers.

Objectives:

After studying this unit, you should be able to:

- explain the process of project status reporting
- discuss project metrics
- describe earned value analysis
- discuss project communication plan and techniques
- explain the steps to process improvement

6.2 Project Status Reporting

During project monitoring and controlling phase project managers and overall project manager jointly should:

- Identify risks, potential project problems, as early as possible
- Identify when goals may not be met
- Identify when constraints may be violated

- Ensure that contingency plans occur before unrecoverable problems occur
- Provide and receive project status for the phases and total project.

When there is a significant chance that the goals of the project will not be met, this risk should be reported to upper management. Also, when the constraints of the project may be violated, specifically, costs being overrun and schedules significantly slipped, these risks will be reported.

When there are disagreements between the phase project manager and overall project manager, then resolution will be escalated to the change control board. Lack of resolution there could escalate to upper management. Of these identified important risks, some will be actual problems and contingency plans in the schedule would be initiated. Figure 6.1 shows different categories of risks.

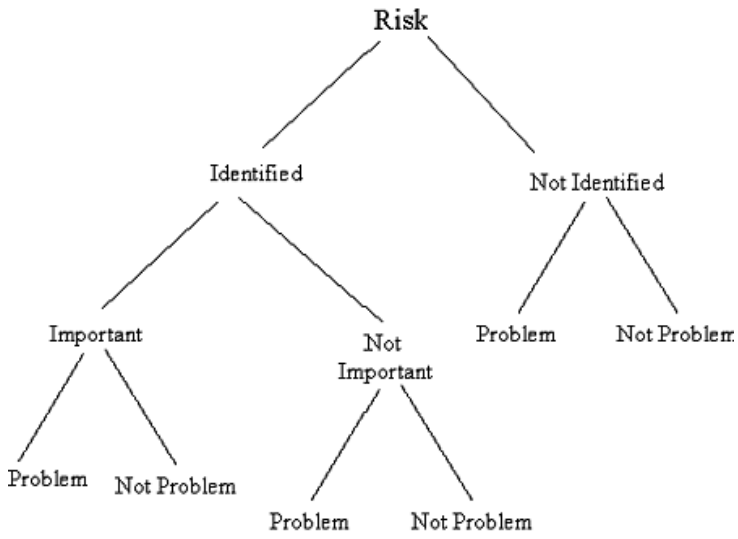

Fig. 6.1: Categories of risks

Of the identified risks, some will be considered not important. These later may not become problems, as expected, or may indeed become problems. The other category of problems, unidentified problems, has a higher likelihood of being overlooked. Of these, some will become problems and others will not.

Thus, as shown in Figure 6.1 there are three paths that result in problems:

1) Those risks that are identified as important and you do nothing about them
2) Those risks that are identified as unimportant and later change into a high risk
3) Those you do not identify and later become problems.

Risks in category 1 should never become a problem because the project managers would build them into the schedules. Risks in category 2, although probably not built into the schedule, should be recorded and remembered and periodically revisited by project managers to determine if they are now turning into problems. Unidentified risks (category 3) require constant monitoring by project managers to identify and resolve.

In this unit, we discuss complex projects where a lot is likely to be unknown, and thus it is likely at points in the project that the project will be ahead of technology and ahead of standards, resulting in risks involving these areas. There are also likely to be many generic project risks; Table 6.1 from reference identifies the top ten project risks, ranked from most important down to least important, as compiled from studies in three different countries, the USA, Hong Kong and Finland. The results were very much the same in each country.

Table 6.1: Generic Software Project Risks

Project Risk	Importance
Lack of top management commitment to the project	9
Failure to gain user commitment	8
Misunderstanding the requirements	8
Lack of adequate user involvement	7.5
Failure to manage end user expectations	7
Changing scope/objectives	7
Lack of required knowledge/skills in the project personnel	7
Lack of frozen requirements	6.5
Introduction of new technology	6
Insufficient/inappropriate staffing	6
Conflict between user departments	5.5

In order to provide stability to the project, project agreements must be recorded, and any changes to agreements must be evaluated for their

effects upon other agreements. These agreements should thus be recorded in controlled documentation and when an agreement is changed then all other agreements that are based upon that agreement must be reevaluated. In order to control controlled documents in the project, it is proposed that there be a **change control board** to review changes. The change control board would include the overall project manager, phase project managers, representatives of workers, users, the data processing group and business policy management, and perhaps a change control administration manager to update schedules and provide unbiased advice on business, technical and administrative decisions. Problems of interest to upper management, such as budget issues, would be escalated up to them for resolution.

As the project progresses, the responsibilities of the phase managers might be consolidated and the change control board might grow smaller, eventually just handling maintenance changes rather than monitoring the project. When a phase is completed, resulting automated systems should go into maintenance mode. Changes to an automated system agreed upon by the change control board would be sent to a business group for design and to a maintenance group for implementation in the automated system. The maintenance group is often part or the entire group that did the development of the automated system. Once a phase is implemented, a help desk should take telephone calls from users of an automated system. The help desk would give advice on the use of the system and report on errors and suggested enhancements to the maintenance group who would go through the change board for review. As the automated system matures, a user group might take over the change control board in reviewing changes.

Controlled Documents

Controlled documents may include the following:

- Organizational objectives, priorities of objectives, strategies and goals
- Project objectives, priorities of objectives, strategies, goals and constraints
- Business requirements
- Workflow requirements
- System requirements
- Organizational business policies
- Interface plans

- Functional specifications
- Internal design documents (programming specifications)
- Vendor customization specifications
- Programs and program code
- Databases and data dictionary
- Test plans
- Performance and scalability requirements (a “Performance and Adaptability Plan”)
- User documentation, including descriptions of user interfaces.

Once an automated system has been implemented, then the automated system must be maintained. After an automated system has been completed and goes into “maintenance mode”, documents that extend beyond the project should be maintained and kept up-to-date with an asterisk next to them.

As we have already indicated, the documentation that describes an automated system is functional specifications and internal design specifications. These documents should also be controlled. Doing so and enforcing that any changes to the automated system also be recorded in the functional and internal design specifications, provides control over the automated system. Technical items from which an automated system can be built – program code and databases – are also controlled. Program code and databases for previous versions of the automated system are also kept in case a severe problem occurs that requires a changed automated system to be backed out, returning to a previous version.

Other documents than those listed above are less often controlled during the project, including project plans, risks and contingency plans because they are likely to change and be updated quite often, but should only be changed with careful consideration and consultations.

Controlled documents can be used:

- to control changes that may seriously harm a project
- to distinguish an error in the project from a change in the project

An **error** is an inconsistency between how an agreement, workflow or automated system is implemented and how it is documented – this is either an error in the implementation or in the documentation. A **change** is a modification in the way an agreement, workflow or automated system is implemented when the implementation matches the documentation of it – for a change, the agreement, workflow or automated system and the documentation should be changed.

Change Control Board

Questions the change board might ask are the following:

- Is the change necessary? When?
- What groups are impacted by the change? How will dependencies and schedules be impacted?
- Is there are more effective and preferred change to the one that is proposed? Can changes be consolidated?
- How and when can the change be best made with the least negative impact?
- Will the change also change the overall project?
- After approved: What is the priority of the changes with respect to other approved changes?

If the change would change the overall project or change other phases in the project, then the overall design will have to be re-visited to determine the change's effect on other phases of the project.

Monitoring Changes to Workflows

Reengineering workflows is not a "one shot" deal but should involve ongoing process management and improvement. Once workflows have been implemented, they should be monitored for actual improvement in business operations and for compliance with business policies. Reengineering is imbedded both within human processes implemented in the organization and within user interfaces. Both should be considered for further (even radical) change once the project is complete. As in the project reengineering process, the employee should be heavily involved, as reengineering is a social process in addition to a business and technical process.

Monitoring System Performance

A potential problem when automated systems are involved is the potential of the systems not being able to handle increased volumes of data in the future. To take care of this, performance monitoring should be a part of all automated systems that are likely to grow in size, identifying potential future bottlenecks in the system, including lack of disk space, lack of processing power, approaching transaction limits, long before they become a problem, so corrective action can be taken.

This process is very complex because automated systems will grow in size due to systems being installed incrementally (e.g., they may be installed at a pilot location first) and due to future increases in number of customers over time. It is also complex because new technology may become available that handles greater capacity but that will incur additional costs to the organization to implement.

Communicating about the status of your project is one of the most important components of project management. It will help you realistically allocate your time and resources, to strengthen control over the project, and free you up to manage. Reviewing the current status allows you and your team members to track the progress of the project against the project plan and determining what you need to do if something is going wrong.

A project status report is a concise summary of the current condition of the Project. It is like a snapshot of the project at a point in time. The change log of a Project is what tracks the changes from the baseline to the present condition. This is much like your monthly bank statement tracks the changes from your previous month's balance (baseline) to your current balance (current condition). Status reports need not occur by the calendar only, but may also occur as the result of achievement of an important milestone, or completion of a major phase of work.

Just about every organization will have its own special form, style, or format for a status report. But generally, they all contain much the same information, at a minimum. A sample status report will be as shown in Table 6.2.

Table 6.2: A sample project status report

Project Name: **ABC** Data Warehouse Status **Date:** ……..…..

Project status	Planned Start Date	Actual Start Date	Planned Complete Date	Actual Complete Date	Percent complete	Status or Comments
Business Analysis						
Review current capabilities						
Develop requirements						
Refine requirements						
Develop Deliverable						
Source Data Analysis						
Develop Data Model						
Develop Data Transformations						
Data Conversion Analysis						
Legacy system review						
Develop conversion requirements						
Data conversion cost-benefit						
Technology Analysis						
Software acquisition						
Develop infrastructure						
Transformation test						
Develop prototype						

Here are some of the key features:

Objective Statement

– What the project is trying to do (stated concisely)

Milestones

– Key accomplishments (not too many) planned in the project schedule

Cost Summary

– Cost or effort summations for the period, and the project to date

Accomplishments

– Major items completed for this period

At the minimum, every project status report should convey the status of the project with respect to the elements of the triple Constraint: i.e. Scope, Schedule, Cost and Quality

Self Assessment Questions

1. When there is a significant chance that the goals of the project will not be met, this risk should not be reported to upper management. (True / False)
2. When there are disagreements between the phase project manager and overall project manager, then resolution will be escalated to the _____.
3. A/An _____ is an inconsistency between how an agreement, workflow or automated system is implemented and how it is documented. (Pick right option)
   a. Error
   b. Change
   c. Risk
   d. None of the above

6.3 Project Metrics

Software Metric is a measure of some property of a piece of software or its specifications. Since quantitative methods have proved so powerful in other sciences, computer science practitioners and theoreticians have worked hard to bring similar approaches to software development. Tom DeMarco stated, “You can’t control what you can't measure”.

Common software metrics include:

- Order of growth (See Analysis of algorithms in terms of Asymptotic analysis and Big O notation)
- Source lines of code
- Cyclomatic complexity
- Function point analysis
- Bugs per line of code

- Code coverage
- Number of lines of customer requirements
- Number of classes and interfaces
- Robert Cecil Martin’s software package metrics
- Cohesion
- Coupling

Limitations

It is very difficult to satisfactorily define or measure "how much" software there is in a program, especially when making such a prediction prior to the detail design. The practical utility of *software* metrics has thus been limited to narrow domains where the measurement process can be stabilized.

Management methodologies such as the Capability Maturity Model or ISO 9000 have therefore focused more on process metrics which assist in monitoring and controlling the *processes* that produce the software.

Examples of process metrics affecting software include:

- Number of times the program failed to rebuild overnight
- Number of defects introduced per developer hour
- Number of changes to requirements
- Hours of programmer time available and spent per week
- Number of patch releases required after first product ship

6.4 Earned Value Analysis (EVA)

Earned Value Analysis (EVA) is an industry standard method of measuring a project's progress at any given point in time, forecasting its completion date and final cost, and analyzing variances in the schedule and budget as the project proceeds. It compares the planned amount of work with what has actually been completed, to determine if the cost, schedule, and work accomplished are progressing in accordance with the plan. As work is completed, it is considered "earned”.

EVA is a snapshot in time, which can be used as a management tool as an early warning system to detect deficient or endangered progress. It ensures a clear definition of work prior to beginning that work. It provides an objective measure of accomplishments, and an early and accurate picture of the contract status. It can be as simple as tracking an elemental cost estimate breakdown as a design progresses from concept through to 100%

construction documents, or it can be calculated and tracked using a series of mathematical formulae (see below). In either case, it provides a basis for course correction. It answers two key questions:

1) At the end of the project, is it likely that the cost will be less than, equal to or greater than the original estimate?
2) Will the project likely be completed on time?

Calculating Earned Value

Earned Value Management measures progress against a baseline. It involves calculating three key values for each activity in the WBS: (Work Breakdown Structure)

1) The Planned Value (PV), (formerly known as the *budgeted cost of work scheduled* or *BCWS*) – that portion of the approved cost estimate planned to be spent on the given activity during a given period.
2) The Actual Cost (AC), (formerly known as the *actual cost of work performed* or *ACWP*) – the total of the costs incurred in accomplishing work on the activity in a given period. This Actual Cost must correspond to whatever was budgeted for the Planned Value and the Earned Value (e.g. all labor, material, equipment, and indirect costs).
3) The Earned Value (EV), (formerly known as the *budget cost of work performed* or *BCWP*) – the value of the work actually completed.

These three values are combined to determine *at that point in time* whether or not work is being accomplished as planned. The most commonly used measures are the cost variance and the schedule variance:

Cost Variance (CV) = EV - AC
Schedule Variance (SV) = EV - PV

These two values can be converted to efficiency indicators to reflect the cost and schedule performance of the project. The most commonly used cost-efficiency indicator is the Cost Performance Index (CPI). It is calculated as,
CPI = EV / AC

The sum of all individual EV budgets divided by the sum of all individual ACs is known as the cumulative CPI, and is generally used to forecast the cost to complete a project.

The Schedule Performance Index (SPI) is calculated as:
SPI = EV / PV

It is often used with the CPI to forecast overall project completion estimates. A negative Schedule Variance (SV) calculated at a given point in time means the project is behind schedule, while a negative Cost Variance (CV) means the project is over budget.

Tools and Techniques

There are several software packages available which will prepare an earned value analysis. Examples include:

- Schedulemaker
- Planisware OPX2
- RiskTrak
- Winsight
- Primavera

Self Assessment Questions

4. Tom DeMarco stated, “You can’t control what you can't measure”. (True / False)
5. _____ is a measure of some property of a piece of software or its specifications.
6. _____ is a software package used for preparing earned value analysis. (Pick right option)
   a. MS Project
   b. Primavera
   c. Lotus Notes
   d. None of the above

6.5 Project Communication Plan & Techniques

In a large project, all communication takes place in context of an overall communications strategy and plan. Status meetings and status reporting are required, just as for a medium size project. In addition, there are many other types of proactive communication that need to be considered. This creative and proactive communication is laid out in a Communication Plan, which is created as follows.

1) Determine the project stakeholders. In some cases these are groups of stakeholders with similar communications needs, for instance, a Project Steering Committee. In other cases, there may be a single person, for instance the Sponsor.

2) Determine the communication needs for each stakeholder, and what you are trying to accomplish. Usually this breaks down into three general areas:
   - **Mandatory:** This information is pushed out to the recipients. Examples include project status reports, legal requirements, financial reporting, status meetings, regulatory information, etc.
   - **Informational:** This is information people want to know, or that they may need for their jobs. This information is made available for people to read, but requires them to take the initiative, or pull the communication. Examples include project awareness building sessions, project deliverables placed in a document repository, project announcements on a website, etc.
   - **Marketing:** These are designed to build buy-in and enthusiasm for the project and its deliverables. This type of communication is also pushed to the readers. Examples include project newsletters, traveling road shows to various locations and departments, testimonials, contests, project acronyms and slogans, countdown clocks until live date, etc.
3) For each stakeholder/objective, brainstorm how to fulfill the communication need. Determine what information they need to know, how often they need an update, and what the best manner is to deliver the information. Be creative in looking for ways to communicate to the project stakeholders.
4) Determine the effort required to create and distribute each of the identified communication options outlined in step 3. Also determine what the potential benefit of the communication is.
5) Prioritize the communication options that were established above. Discard those that require high effort for marginal benefit. Also discard those that provide marginal benefit, even though they may take little effort from the project team. Implement the communication options that provide high value and require low effort from the project team.
   Also evaluate those options that have high value and require a high level of effort from the project team. Some of these might make sense, others may not.
6) Regardless of the prioritization, implement any communication options that are mandatory for the project or for the environment. This could

include Project Status Reports, government required reports, legal reports, etc.

7) Add the resulting communication activities to the work plan. This will include assigning frequencies, due dates, effort hours and a responsible person(s) for each communication option implemented.

   Project communication can take many shapes and forms. For large projects especially, the project team should be creative in determining how, what, to whom, where and how frequently the communication takes place. If the project is controversial, requires culture change or is highly political, the positive aspects of marketing communication become more and more critical.

Communication techniques for software development include:

- Use Cases (UML)
- Sequence and Activity Diagrams (UML)
- Gantt chats
- PERT networks etc.,

6.6 Steps for Process Improvement

Process Improvement is a series of actions taken to identify, analyze and improve existing processes within an organization to meet new goals and objectives. These actions often follow a specific methodology or strategy to create successful results.

IEEE recommended the following steps for process improvement

1) IDENTIFY BUSINESS PROCESSES
2) Document Process Definition
3) Document Process Purpose
4) Identify Process "Steward"
5) Establish Process Boundaries
6) Create Process Flow chart
7) IDENTIFY PROCESS OUTCOMES
8) Document Outputs
9) Identify Recipients and "Stakeholders" of Outputs
10) DETERMINE EXPECTATIONS
11) Identify Current Formal/Informal Agreements
12) IDENTIFY YOUR NEEDS

13) Identify Needs From Others to Make Process Work
14) Identify Those Providing Inputs
15) List Current Formal/Informal Agreements
16) IDENTIFY OPPORTUNITIES FOR IMPROVEMENT

Six sigma

Six Sigma is a set of practices originally developed by Motorola to systematically improve processes by eliminating defects. A defect is defined as nonconformity of a product or service to its specifications.

While the particulars of the methodology were originally formulated by Bill Smith at Motorola in 1986, Six Sigma was heavily inspired by six preceding decades of quality improvement methodologies such as quality control, TQM, and Zero Defects. Like its predecessors, Six Sigma asserts the following:

- Continuous efforts to reduce variation in process outputs is key to business success
- Manufacturing and business processes can be measured, analyzed, improved and controlled
- Succeeding at achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management

The term "Six Sigma" refers to the ability of highly capable processes to produce output within specification. In particular, processes that operate with six sigma quality produce at defect levels below 3.4 defects per (one) million opportunities (DPMO). Six Sigma's implicit goal is to improve all processes to that level of quality or better.

Six Sigma is a registered service mark and trademark of Motorola, Inc. Motorola has reported over US$17 billion in savings from Six Sigma as of 2006.

In addition to Motorola, companies that also adopted Six Sigma methodologies early-on and continue to practice it today include Bank of America, Caterpillar, Honeywell International (previously known as Allied Signal), Raytheon, Merrill Lynch and General Electric (introduced by Jack Welch).

There have been a few retail companies that have attempted to adapt this methodology to their business with mixed success. Perhaps the most notable was former CEO Bob Nardelli's attempt to adapt his systems from his former employer, General Electric, to the retail industry. There is one inherent problem with attempting to apply Six Sigma to retail. Retail=people, Six Sigma=defects. So, you have to look at your lacking areas as defects by your employees. Home Depot attempted to solve this by thinning out their workforce and implementing training programs for the remaining employees in order to reduce defects. On paper, this may work well but once the human factor was applied it led to massive frustration from the employees and the customers due to the lack of salespeople on the floor at any one time. Although the employees were better trained, they were now required to help 22.8 customers per hour rather than the previous 13.4. Other retailers are learning from these mistakes of the first big box retailers to attempt this and are tweaking the methodology to better suit their company goals. Recently some practitioners have used the TRIZ methodology for problem solving and product design as part of a Six Sigma approach.

Self Assessment Questions

7. Status meetings and status reporting are required for a medium size project. (True / False)
8. _____ is a set of practices originally developed by Motorola to systematically improve processes by eliminating defects.
9. Six Sigma is a registered service mark and trademark of _____. (Pick right option)
   a. Microsoft
   b. Sun Microsystems
   c. Motorola
   d. None of the above

6.7 Summary

Let’s summarize important points:

- Project status reporting is a concise summary of the current condition of the Project. It is like a snapshot of the project at a point in time. This will boost up the project progress well in time.
- Software metrics is a measure of some property of a piece of software or its specifications.

- Earned Value Analysis is a project progress indicator.
- Six Sigma is a philosophy of doing business with a focus on eliminating defects through fundamental process knowledge. Six Sigma methods integrate principles of business, statistics and engineering to achieve tangible results.

6.8 Terminal Questions

1. What are software changes? How documents controlled can be listed out?
2. What is status reporting? Explain in brief.
3. Explain the steps for (IEEE) process improvement.
4. What are the various project communication plans and techniques?

6.9 Answers

Self Assessment Questions

1. False
2. Change control board
3. a) Error
4. True
5. Software Metric
6. b) Primavera
7. True
8. Six Sigma
9. c) Motorola

Terminal Questions

1. In order to provide stability to the project, project agreements must be recorded, and any changes to agreements must be evaluated for their effects upon other agreements. These agreements should be recorded in controlled documentation and when an agreement is changed then all other agreements that are based upon that agreement must be reevaluated. (Refer Section 6.2)
2. When there is a significant chance that the goals of the project will not be met, this risk should be reported to upper management. Also, when the constraints of the project may be violated, specifically, costs being overrun and schedules significantly slipped, these risks will be reported. (Refer Section 6.2)

3. Process Improvement is a series of actions taken to identify, analyze and improve existing processes within an organization to meet new goals and objectives. (Refer Section 6.6)
4. In a large project, all communication takes place in context of an overall communications strategy and plan. Status meetings and status reporting are required, just as for a medium size project. In addition, there are many other types of proactive communication that need to be considered. (Refer Section 6.5)