UNIT - V

Checkpoints of the process: Major mile stones, Minor Milestones, Periodic status assessments.
Iterative Process Planning: Work breakdown structures, planning guidelines, cost and schedule estimating, Iteration planning process, Pragmatic planning.

9. Checkpoints of the process

Three types of joint management reviews are conducted throughout the process:

1. *Major milestones.* These system wide events are held at the end of each development phase. They provide visibility to system wide issues, synchronize the management and engineering perspectives, and verify that the aims of the phase have been achieved.
2. *Minor milestones.* These iteration-focused events are conducted to review the content of an iteration in detail and to authorize continued work.
3. *Status assessments.* These periodic events provide management with frequent and regular insight into the progress being made.

Each of the four phases-inception, elaboration, construction, and transition consists of one or more iterations and concludes with a major milestone when a planned technical capability is produced in demonstrable form. An iteration represents a cycle of activities for which there is a well-defined intermediate result-a minor milestone-captured with two artifacts: a release specification (the evaluation criteria and plan) and a release description (the results). Major milestones at the end of each phase use formal, stakeholder-approved evaluation criteria and release descriptions; minor milestones use informal, development-team-controlled versions of these artifacts.
Figure 9-1 illustrates a typical sequence of project checkpoints for a relatively large project.

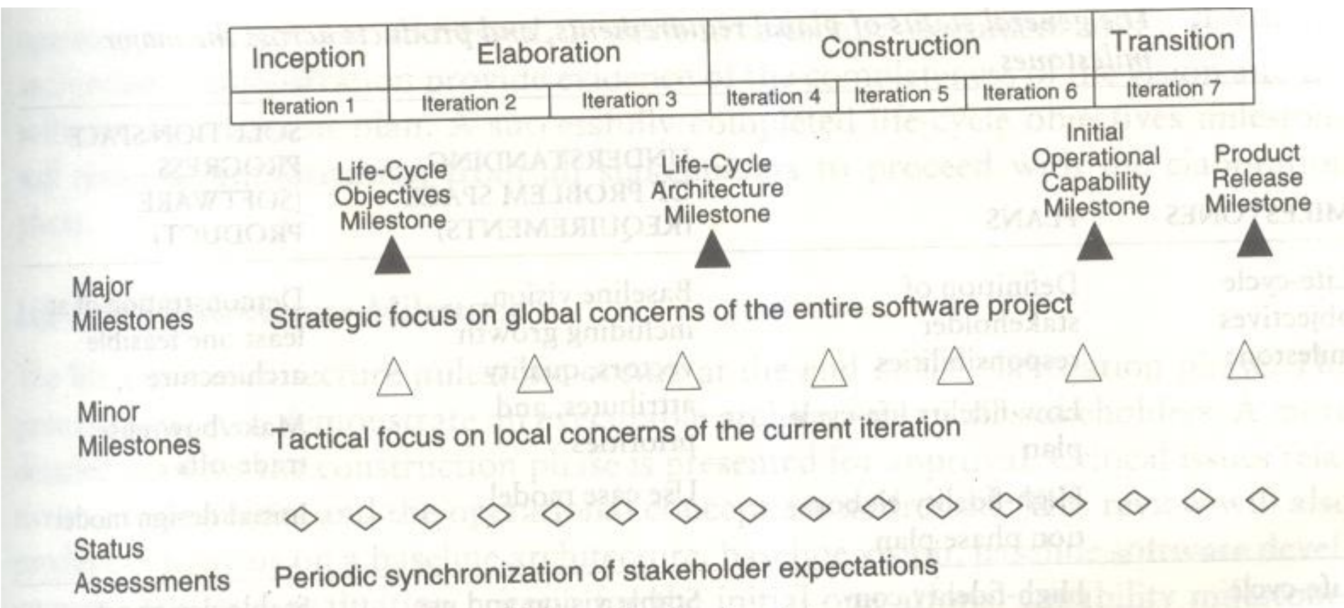


FIGURE 9-1. *A typical sequence of life-cycle checkpoints*

9.1 MAJOR MILESTONES

The four major milestones occur at the transition points between life-cycle phases. They can be used in many different process models, including the conventional waterfall model. Inan iterative model, the major milestones are used to achieve concurrence among all stakeholders on the current state of the project. Different stakeholders have very different concerns:

- Customers: schedule and budget estimates, feasibility, risk assessment, requirements understanding, progress, product line compatibility
- Users: consistency with requirements and usage scenarios, potential for accommodating growth, quality attributes
- Architects and systems engineers: product line compatibility, requirements changes, trade-off analyses, completeness and consistency, balance among risk, quality, and usability
- Developers: sufficiency of requirements detail and usage scenario descriptions, . frameworks for component selection or development, resolution of development risk, product line compatibility, sufficiency of the development environment
- Maintainers: sufficiency of product and documentation artifacts, understandability, interoperability with existing systems, sufficiency of maintenance environment
- Others: possibly many other perspectives by stakeholders such as regulatory agencies, independent verification and validation contractors, venture capital investors, subcontractors, associate contractors, and sales and marketing teams

Table 9-1 summarizes the balance of information across the major milestones.

TABLE 9-1. *The general status of plans, requirements, and products across the major milestones*

MILESTONES	PLANS	UNDERSTANDING OF PROBLEM SPACE (REQUIREMENTS)	SOLUTION SPACE PROGRESS (SOFTWARE PRODUCT)
Life-cycle objectives milestone	Definition of stakeholder responsibilities Low-fidelity life-cycle plan High-fidelity elaboration phase plan	Baseline vision, including growth vectors, quality attributes, and priorities Use case model	Demonstration of at least one feasible architecture Make/buy/reuse trade-offs Initial design model
Life-cycle architecture milestone	High-fidelity construction phase plan (bill of materials, labor allocation) Low-fidelity transition phase plan	Stable vision and use case model Evaluation criteria for construction releases, initial operational capability Draft user manual	Stable design set Make/buy/reuse decisions Critical component prototypes
Initial operational capability milestone	High-fidelity transition phase plan	Acceptance criteria for product release Releasable user manual	Stable implementation set Critical features and core capabilities Objective insight into product qualities
Product release milestone	Next-generation product plan	Final user manual	Stable deployment set Full features Compliant quality

Life-Cycle Objectives Milestone

The life-cycle objectives milestone occurs at the end of the inception phase. The goal is to present to all stakeholders a recommendation on how to proceed with development, including a plan, estimated cost and schedule, and expected benefits and cost savings. A successfully completed life-cycle objectives milestone will result in authorization from all stakeholders to proceed with the elaboration phase.

Life-Cycle Architecture Milestone

The life-cycle architecture milestone occurs at the end of the elaboration phase. The primary goal is to demonstrate an executable architecture to all stakeholders. The baseline architecture consists of both a human-readable representation (the architecture document) and a configuration-controlled set of software components captured in the engineering artifacts. A successfully completed life-cycle architecture milestone will result in authorization from the stakeholders to proceed with the construction phase.

The technical data listed in Figure 9-2 should have been reviewed by the time of the lifecycle architecture milestone. Figure 9-3 provides default agendas for this milestone.

- **I. Requirements**
  - A. Use case model
  - B. Vision document (text, use cases)
  - C. Evaluation criteria for elaboration (text, scenarios)
- **II. Architecture**
  - A. Design view (object models)
  - B. Process view (if necessary, run-time layout, executable code structure)
  - C. Component view (subsystem layout, make/buy/reuse component identification)
  - D. Deployment view (target run-time layout, target executable code structure)
  - E. Use case view (test case structure, test result expectation)
    - 1. Draft user manual
- **III. Source and executable libraries**
  - A. Product components
  - B. Test components
  - C. Environment and tool components

FIGURE 9-2. *Engineering artifacts available at the life-cycle architecture milestone*

Presentation Agenda

I. **Scope and objectives**
   A. Demonstration overview

II. **Requirements assessment**
   A. Project vision and use cases
   B. Primary scenarios and evaluation criteria

III. **Architecture assessment**
   A. Progress
      1. Baseline architecture metrics (progress to date and baseline for measuring future architectural stability, scrap, and rework)
      2. Development metrics baseline estimate (for assessing future progress)
      3. Test metrics baseline estimate (for assessing future progress of the test team)
   B. Quality
      1. Architectural features (demonstration capability summary vs. evaluation criteria)
      2. Performance (demonstration capability summary vs. evaluation criteria)
      3. Exposed architectural risks and resolution plans
      4. Affordability and make/buy/reuse trade-offs

IV. **Construction phase plan assessment**
   A. Iteration content and use case allocation
   B. Next iteration(s) detailed plan and evaluation criteria
   C. Elaboration phase cost/schedule performance
   D. Construction phase resource plan and basis of estimate
   E. Risk assessment

Demonstration Agenda

I. **Evaluation criteria**
II. **Architecture subset summary**
III. **Demonstration environment summary**
IV. **Scripted demonstration scenarios**
V. **Evaluation criteria results and follow-up items**

FIGURE 9-3. *Default agendas for the life-cycle architecture milestone*

Initial Operational Capability Milestone

The initial operational capability milestone occurs late in the construction phase. The goals are to assess the readiness of the software to begin the transition into customer/user sites and to authorize the start of acceptance testing. Acceptance testing can be done incrementally across multiple iterations or can be completed entirely during the transition phase is not necessarily the completion of the construction phase.

Product Release Milestone

The product release milestone occurs at the end of the transition phase. The goal is to assess the completion of the software and its transition to the support organization, if any. The results of acceptance testing are reviewed, and all open issues are addressed. Software quality metrics are reviewed to determine whether quality is sufficient for transition to the support organization.

9.2 MINOR MILESTONES

For most iterations, which have a one-month to six-month duration, only two minor milestones are needed: the iteration readiness review and the iteration assessment review.

- Iteration Readiness Review. This informal milestone is conducted at the start of each iteration to review the detailed iteration plan and the evaluation criteria that have been allocated to this iteration .
- Iteration Assessment Review. This informal milestone is conducted at the end of each iteration to assess the degree to which the iteration achieved its objectives and satisfied its evaluation criteria, to review iteration results, to review qualification test results (if part of the iteration), to determine the amount of rework to be done, and to review the impact of the iteration results on the plan for subsequent iterations.

The format and content of these minor milestones tend to be highly dependent on the project and the organizational culture. Figure 9-4 identifies the various minor milestones to be considered when a project is being planned.

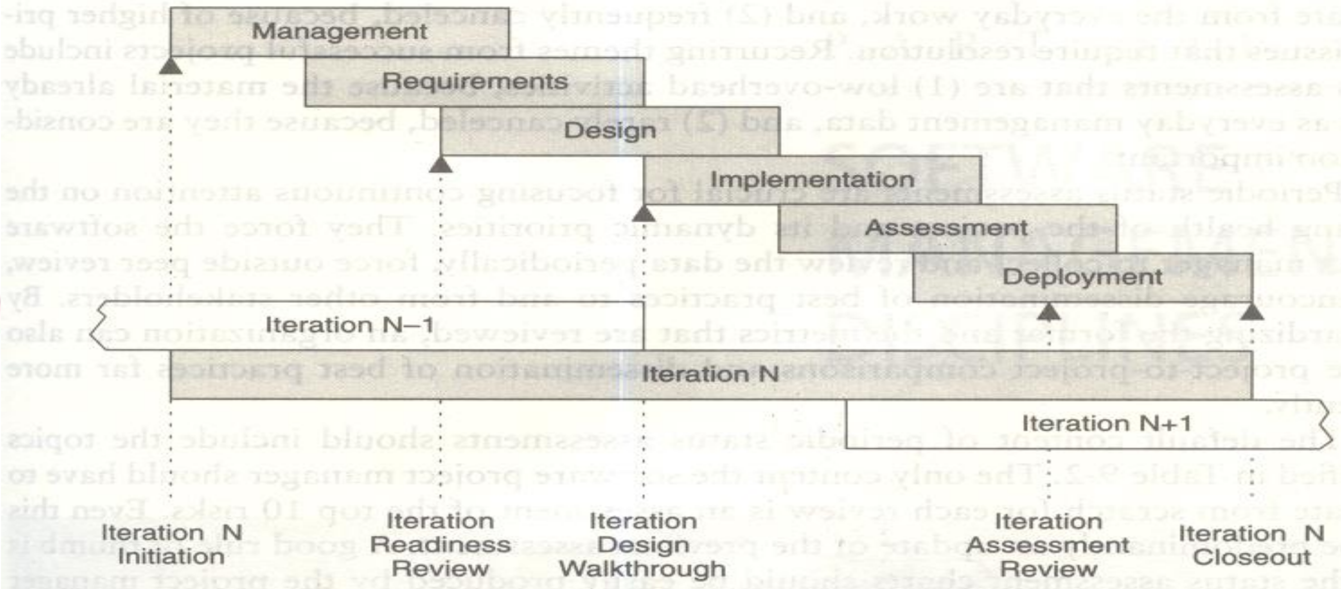


FIGURE 9-4. *Typical minor milestones in the life cycle of an iteration*

9.3 PERIODIC STATUS ASSESSMENTS

Periodic status assessments are management reviews conducted at regular intervals (monthly, quarterly) to address progress and quality indicators, ensure continuous attention to project dynamics, and maintain open communications among all stakeholders.

Periodic status assessments serve as project snapshots. While the period may vary, the recurring event forces the project history to be captured and documented. Status assessments provide the following:

- A mechanism for openly addressing, communicating, and resolving management issues, technical issues, and project risks
- Objective data derived directly from on-going activities and evolving product configurations
- A mechanism for disseminating process, progress, quality trends, practices, and experience information to and from all stakeholders in an open forum

Periodic status assessments are crucial for focusing continuous attention on the evolving health of the project and its dynamic priorities. They force the software project manager to collect and review the data periodically, force outside peer review, and encourage dissemination of best practices to and from other stakeholders.

The default content of periodic status assessments should include the topics identified in Table 9-2.

TABLE 9-2. *Default content of status assessment reviews*

TOPIC	CONTENT
Personnel	Staffing plan vs. actuals Attritions, additions
Financial trends	Expenditure plan vs. actuals for the previous, current, and next major milestones Revenue forecasts
Top 10 risks	Issues and criticality resolution plans Quantification (cost, time, quality) of exposure
Technical progress	Configuration baseline schedules for major milestones Software management metrics and indicators Current change trends Test and quality assessments
Major milestone plans and results	Plan, schedule, and risks for the next major milestone Pass/fail results for all acceptance criteria
Total product scope	Total size, growth, and acceptance criteria perturbations

10. Iterative process planning

A good work breakdown structure and its synchronization with the process framework are critical factors in software project success. Development of a work breakdown structure dependent on the project management style, organizational culture, customer preference, financial constraints, and several other hard-to-define, project-specific parameters.

A WBS is simply a hierarchy of elements that decomposes the project plan into the discrete work tasks. A WBS provides the following information structure:

- A delineation of all significant work
- A clear task decomposition for assignment of responsibilities
- A framework for scheduling, budgeting, and expenditure tracking

Many parameters can drive the decomposition of work into discrete tasks: product subsystems, components, functions, organizational units, life-cycle phases, even geographies. Most systems have a first-level decomposition by subsystem. Subsystems are then decomposed into their components, one of which is typically the software.

10.1.1 CONVENTIONAL WBS ISSUES

Conventional work breakdown structures frequently suffer from three fundamental flaws.

1. They are prematurely structured around the product design.
2. They are prematurely decomposed, planned, and budgeted in either too much or too little detail.
3. They are project-specific, and cross-project comparisons are usually difficult or impossible.

Conventional work breakdown structures are prematurely structured around the product design.Figure 10-1 shows a typical conventional WBS that has been structured primarily around the subsystems of its product architecture, then further decomposed into the components of each subsystem. A WBS is the architecture for the financial plan.

Conventional work breakdown structures are prematurely decomposed, planned, and budgeted in either too little or too much detail. Large software projects tend to be over planned and small projects tend to be under planned. The basic problem with planning too much detail at the outset is that the detail does not evolve with the level of fidelity in the plan.

Conventional work breakdown structures are project-specific, and cross-project comparisons are usually difficult or impossible. With no standard WBS structure, it is extremely difficult to compare plans, financial data, schedule data, organizational efficiencies, cost trends, productivity trends, or quality trends across multiple projects.

Figure 10-1 Conventional work breakdown structure, following the product hierarchy

Management
System requirement and design
Subsystem 1
    Component 11
        Requirements
        Design
        Code
        Test
        Documentation
…(similar structures for other components)
    Component 1N
        Requirements
        Design
        Code
        Test
        Documentation
…(similar structures for other subsystems)
Subsystem M
    Component M1
        Requirements
        Design
        Code
        Test
        Documentation
…(similar structures for other components)
ComponentMN
        Requirements
        Design
        Code
        Test
        Documentation
Integration and test
    Test planning
    Test procedure preparation
    Testing
    Test reports
Other support areas
    Configuration control
    Quality assurance
    System administration

10.1.2 EVOLUTIONARY WORK BREAKDOWN STRUCTURES

An evolutionary WBS should organize the planning elements around the process framework rather than the product framework. The basic recommendation for the WBS is to organize the hierarchy as follows:

- First-level WBS elements are the workflows (management, environment, requirements, design, implementation, assessment, and deployment).
- Second-level elements are defined for each phase of the life cycle (inception, elaboration, construction, and transition).
- Third-level elements are defined for the focus of activities that produce the artifacts of each phase.

A default WBS consistent with the process framework (phases, workflows, and artifacts) is shown in Figure 10-2. This recommended structure provides one example of how the elements of the process framework can be integrated into a plan. It provides a framework for estimating the costs and schedules of each element, allocating them across a project organization, and tracking expenditures.

The structure shown is intended to be merely a starting point. It needs to be tailored to the specifics of a project in many ways.

- Scale. Larger projects will have more levels and substructures.
- Organizational structure. Projects that include subcontractors or span multiple organizational entities may introduce constraints that necessitate different WBS allocations.
- Degree of custom development. Depending on the character of the project, there can be very different emphases in the requirements, design, and implementation workflows.
- Business context. Projects developing commercial products for delivery to a broad customer base may require much more elaborate substructures for the deployment element.
- Precedent experience. Very few projects start with a clean slate. Most of them are developed as new generations of a legacy system (with a mature WBS) or in the context of existing organizational standards (with preordained WBS expectations).

The WBS decomposes the character of the project and maps it to the life cycle, the budget, and the personnel. Reviewing a WBS provides insight into the important attributes, priorities, and structure of the project plan.

Another important attribute of a good WBS is that the planning fidelity inherent in each element is commensurate with the current life-cycle phase and project state. Figure 10-3 illustrates this idea. One of the primary reasons for organizing the default WBS the way I have is to allow for planning elements that range from planning packages (rough budgets that are maintained as an estimate for future elaboration rather than being decomposed into detail) through fully planned activity networks (with a well-defined budget and continuous assessment of actual versus planned expenditures).

Figure 10-2 Default work breakdown structure

A Management
- AA Inception phase management
  - AAA Business case development
  - AAB Elaboration phase release specifications
  - AAC Elaboration phase WBS specifications
  - AAD Software development plan
  - AAE Inception phase project control and status assessments
- AB Elaboration phase management
  - ABA Construction phase release specifications
  - ABB Construction phase WBS baselining
  - ABC Elaboration phase project control and status assessments
- AC Construction phase management
  - ACA Deployment phase planning
  - ACB Deployment phase WBS baselining
  - ACC Construction phase project control and status assessments
- AD Transition phase management
  - ADA Next generation planning
  - ADB Transition phase project control and status assessments

B Environment
- BA Inception phase environment specification
- BB Elaboration phase environment baselining
  - BBA Development environment installation and administration
  - BBB Development environment integration and custom toolsmithing
  - BBC SCO database formulation
- BC Construction phase environment maintenance
  - BCA Development environment installation and administration
  - BCB SCO database maintenance
- BD Transition phase environment maintenance
  - BDA Development environment maintenance and administration
  - BDB SCO database maintenance
  - BDC Maintenance environment packaging and transition

C Requirements
- CA Inception phase requirements development
  - CCA Vision specification
  - CAB Use case modeling
- CB Elaboration phase requirements baselining
  - CBA Vision baselining

CBB Use case model baselining
CC Construction phase requirements maintenance
CD Transition phase requirements maintenance
D Design
DA Inception phase architecture prototyping
DB Elaboration phase architecture baselining
DBA Architecture design modeling
DBB Design demonstration planning and conduct
DBC Software architecture description
DC Construction phase design modeling
DCA Architecture design model maintenance
DCB Component design modeling
DD Transition phase design maintenance
E Implementation
EA Inception phase component prototyping
EB Elaboration phase component implementation
EBA Critical component coding demonstration integration
EC Construction phase component implementation
ECA Initial release(s) component coding and stand-alone testing
ECB Alpha release component coding and stand-alone testing
ECC Beta release component coding and stand-alone testing
ECD Component maintenance
F Assessment
FA Inception phase assessment
FB Elaboration phase assessment
FBA Test modeling
FBB Architecture test scenario implementation
FBC Demonstration assessment and release descriptions
FC Construction phase assessment
FCA Initial release assessment and release description
FCB Alpha release assessment and release description
FCC Beta release assessment and release description
FD Transition phase assessment
FDA Product release assessment and release description
G Deployment
GA Inception phase deployment planning
GB Elaboration phase deployment planning
GC Construction phase deployment
GCA User manual baselining
GD Transition phase deployment
GDA Product transition to user

Figure 10-3 Evolution of planning fidelity in the WBS over the life cycle

Inception

WBS Element	Fidelity
Management	**High**
Environment	Moderate
Requirement	**High**
Design	Moderate
Implementation	Low
Assessment	Low
Deployment	Low

Elaboration

WBS Element	Fidelity
Management	**High**
Environment	**High**
Requirement	**High**
Design	**High**
Implementation	Moderate
Assessment	Moderate
Deployment	Low

Transition

WBS Element	Fidelity
Management	**High**
Environment	**High**
Requirements	Low
Design	Low
Implementation	Moderate
Assessment	**High**
Deployment	**High**

Construction

WBS Element	Fidelity
Management	**High**
Environment	**High**
Requirements	Low
Design	Moderate
Implementation	**High**
Assessment	**High**
Deployment	Moderate

10.2 PLANNING GUIDELINES

Software projects span a broad range of application domains. It is valuable but risky to make specific planning recommendations independent of project context. Project-independent planning advice is also risky. There is the risk that the guidelines may pe adopted blindly without being adapted to specific project circumstances. Two simple planning guidelines should be considered when a project plan is being initiated or assessed. The first guideline, detailed in Table 10-1, prescribes a default allocation of costs among the first-level WBS elements. The second guideline, detailed in Table 10-2, prescribes the allocation of effort and schedule across the lifecycle phases.

10-1 Web budgeting defaults

First Level WBS Element	Default Budget
Management	10%
Environment	10%
Requirement	10%
Design	15%
Implementation	25%
Assessment	25%
Deployment	5%
Total	100%

Table 10-2 Default distributions of effort and schedule by phase

Domain	Inception	Elaboration	Construction	Transition
Effort	5%	20%	65%	10%
Schedule	10%	30%	50%	10%

10.3 THE COST AND SCHEDULE ESTIMATING PROCESS

Project plans need to be derived from two perspectives. The first is a forward-looking, top-down approach. It starts with an understanding of the general requirements and constraints, derives a macro-level budget and schedule, then decomposes these elements into lower level budgets and intermediate milestones. From this perspective, the following planning sequence would occur:

1. The software project manager (and others) develops a characterization of the overall size, process, environment, people, and quality required for the project.
2. A macro-level estimate of the total effort and schedule is developed using a software cost estimation model.
3. The software project manager partitions the estimate for the effort into a top-level WBS using guidelines such as those in Table 10-1.
4. At this point, subproject managers are given the responsibility for decomposing each of the WBS elements into lower levels using their top-level allocation, staffing profile, and major milestone dates as constraints.

The second perspective is a backward-looking, bottom-up approach. We start with the end in mind, analyze the micro-level budgets and schedules, then sum all these elements into the higher level budgets and intermediate milestones. This approach tends to define and populate the WBS from the lowest levels upward. From this perspective, the following planning sequence would occur:

1. The lowest level WBS elements are elaborated into detailed tasks
2. Estimates are combined and integrated into higher level budgets and mile-

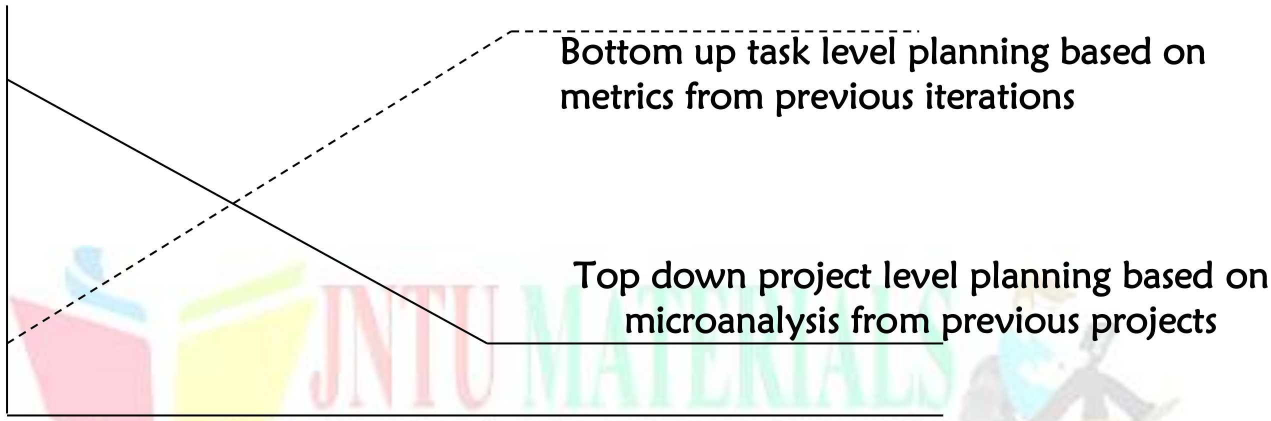
stones.

3. Comparisons are made with the top-down budgets and schedule milestones.

Milestone scheduling or budget allocation through top-down estimating tends to exaggerate the project management biases and usually results in an overly optimistic plan. Bottom-up estimates usually exaggerate the performer biases and result in an overly pessimistic plan.

These two planning approaches should be used together, in balance, throughout the life cycle of the project. During the engineering stage, the top-down perspective will dominate because there is usually not enough depth of understanding nor stability in the detailed task sequences to perform credible bottom-up planning. During the production stage, there should be enough precedent experience and planning fidelity that the bottom-up planning perspective will dominate. Top-down approach should be well tuned to the project-specific parameters, so it should be used more as a global assessment technique. Figure 10-4 illustrates this life-cycle planning balance.

Figure 10-4 Planning balance throughout the life cycle



Engineering Stage		Production Stage	
Inception	Elaboration	Construction	Transition

Feasibility iteration Architecture iteration Usable iteration Product Releases

Engineering stage planning emphasis	Production stage planning emphasis
Macro level task estimation for production stage artifacts	Micro level task estimation for production stage artifacts
Micro level task estimation for engineering artifacts	Macro level task estimation for maintenance of engineering artifacts
Stakeholder concurrence	Stakeholder concurrence
Coarse grained variance analysis of actual vs planned expenditures	Fine grained variance analysis of actual vs planned expenditures
Tuning the top down project independent planning guidelines into project specific planning guidelines	
WBS definition and elaboration	

10.4 THE ITERATION PLANNING PROCESS

Planning is concerned with defining the actual sequence of intermediate results. An evolutionary build plan is important because there are always adjustments in build content and schedule as early conjecture evolves into well-understood project circumstances. *Iteration* is used to mean a complete synchronization across the project, with a well-orchestrated global assessment of the entire project baseline.

- Inception iterations. The early prototyping activities integrate the foundation components of a candidate architecture and provide an executable framework for elaborating the critical use cases of the system. This framework includes existing components, commercial components, and custom prototypes sufficient to demonstrate a candidate architecture and sufficient requirements understanding to establish a credible business case, vision, and software development plan.
- Elaboration iterations. These iterations result in architecture, including a complete framework and infrastructure for execution. Upon completion of the architecture iteration, a few critical use cases should be demonstrable: (1) initializing the architecture, (2) injecting a scenario to drive the worst-case data processing flow through the system (for example, the peak transaction throughput or peak load scenario), and (3) injecting a scenario to drive the worst-case control flow through the system (for example, orchestrating the fault-tolerance use cases).
- Construction iterations. Most projects require at least two major construction iterations: an alpha release and a beta release.
- Transition iterations. Most projects use a single iteration to transition a beta release into the final product.

The general guideline is that most projects will use between four and nine iterations. The typical project would have the following six-iteration profile:

- One iteration in inception: an architecture prototype
- Two iterations in elaboration: architecture prototype and architecture baseline
- Two iterations in construction: alpha and beta releases
- One iteration in transition: product release

A very large or unprecedented project with many stakeholders may require additional inception iteration and two additional iterations in construction, for a total of nine iterations.

10.5 PRAGMATIC PLANNING

Even though good planning is more dynamic in an iterative process, doing it accurately is far easier. While executing iteration N of any phase, the software project manager must be monitoring and controlling against a plan that was initiated in iteration N - 1 and must be planning iteration N + 1. The art of good project· management is to make trade-offs in the current iteration plan and the next iteration plan based on objective results in the current iteration and previous iterations. Aside from bad architectures and misunderstood requirements, inadequate planning (and subsequent bad management) is one of the most common reasons for project failures. Conversely, the success of every successful project can be attributed in part to good planning.

A project's plan is a definition of how the project requirements will be transformed into' a product within the business constraints. It must be realistic, it must be current, it must be a team product, it must be understood by the stakeholders, and it must be used. Plans are not just for managers. The more open and visible the planning process and results, the more ownership there is among the team members who need to execute it. Bad, closely held plans cause attrition. Good, open plans can shape cultures and encourage teamwork.

Unit – Important Questions

1.	Define Model-Based software architecture?
2.	Explain various process workflows?
3.	Define typical sequence of life cycle checkpoints?
4.	Explain general status of plans, requirements and product across the major milestones.
5.	Explain conventional and Evolutionary work break down structures?
6.	Explain briefly planning balance throughout the life cycle?