MODULAR PROJECT MANAGEMENT

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Typically, the management process changes throughout the life of an R&D project and varies from one project to the next, which increases the cost and reduces the value added for the project-management process. We present a modular approach that makes project management flexible yet predictable and more cost-effective. This methodology, which we call *modular project management* (MPM), defines four management modes. Each is a collection of specific procedures and operations (i.e., the management functions), but all modes share a set of core functions. Thus, moving from a simpler management mode to a more complex one means including more functions or more formal versions of the same functions. MPM enables a project manager to select a management process before a project is started, based on the project's scope and complexity. The selection process, which quantifies a project's attributes (including customer requirements), recommends a nominal management mode that managers may want to fine-tune.

Introduction

Some time ago, several project managers (PMs) for AT&T's U.S. Government projects formed a study team to identify possible shortcomings in the process that their organization uses to manage its projects. The team struggled to find an organized way to approach this assignment. Eventually, someone asked the question: "Why are we having so much trouble getting a handle on this assignment?" It was an inspired question. The answer wasn't hard to find and led to significant progress: "Because there is *no* such thing as *the project-management process*." Clearly, trying to find problems in something that didn't exist might take too long, even for an AT&T project. The next question was even better: "So, how *do* managers decide how they're going to manage their projects?"

Panel 1. Abbreviations, Acronyms, and Terms

ASIC — application-specific integrated circuit
C/SCSC — cost and schedule control system criteria
C/SSR — cost and schedule status report
CPR/NC — cost performance report, no criteria
C-Spec — refers to any of the three specifications—C/SCSC, C/SSR, and CPR/NC—although more frequently C/SCSC.
DCAA — Defense Contractor Audit Agency
DCAS — Defense Contract Audit Service
FE — functional element
FSAT — AT&T Federal Systems' Advanced Technology Group
matrix management — a concept where organizations of functional specialists temporarily assign people to support specific projects
MCM — multichip module
MPM — modular project management
OBS — organizational-breakdown structure (i.e., an organization chart)
PM — project manager
RAM — responsibility-assignment matrix
TM — task manager
WBS — work-breakdown structure

This question led to the diagram in Figure 1, which depicts a *typical* approach to selecting a management process for individual projects. (We really can't say that this *is* the approach ... only that it seemed to be like this.) Notice that "management process" appears in only two places on this diagram (i.e., in the *define* and *modify* steps, which are framed in color). One of these steps is optional; the other is activated only when problems are encountered on the project.

When we diagrammed the process, one crucial point became clear: Management processes were not selected; they grew out of the project experiences. Occasionally, responses to problems encountered during the project would result in new management procedures that then would be added to whatever existed before. This approach produces:

- A management process that changes throughout the life of a project
- A different process from one project to the next.

In developing the diagram in Figure 1, we made two important observations that are not readily apparent from the diagram itself. When the proposal specifies a management process (i.e., the process is required by the customer), the project team may not pay much heed to that part of the proposal documents. Even when the project team uses the process named in the proposal, the proposal is often not clear about exactly what that process should be.

Consequently, when a project begins, the initial management process is usually a mixture of ideas from the proposal, plus things the project manager remembers from favorable or unfavorable personal experiences. It isn't what anyone would typically call a real process.

An approach like this costs the corporation both time and money because:

- Managers who move to new projects must repeatedly learn new approaches to project management. Errors in learning and the learning time required are costly.
- Building a management process involves fixing problems, which is more costly than avoiding problems.
- Executive oversight of multiple projects is more difficult because status reports and metrics vary from one project to the next. Misunderstandings and missed signals cause problems to be overlooked.
- A central place doesn't exist for storing accumulated knowledge and those costly *lessons learned* documents.
- Our approach to project management appeared unprofessional to our customers.

Modular project management (MPM) was conceived as a way to deal with these costly problems. MPM is still under evaluation, but the basic concepts and approach seem to have clear merit.

The goal of the MPM approach is to address each

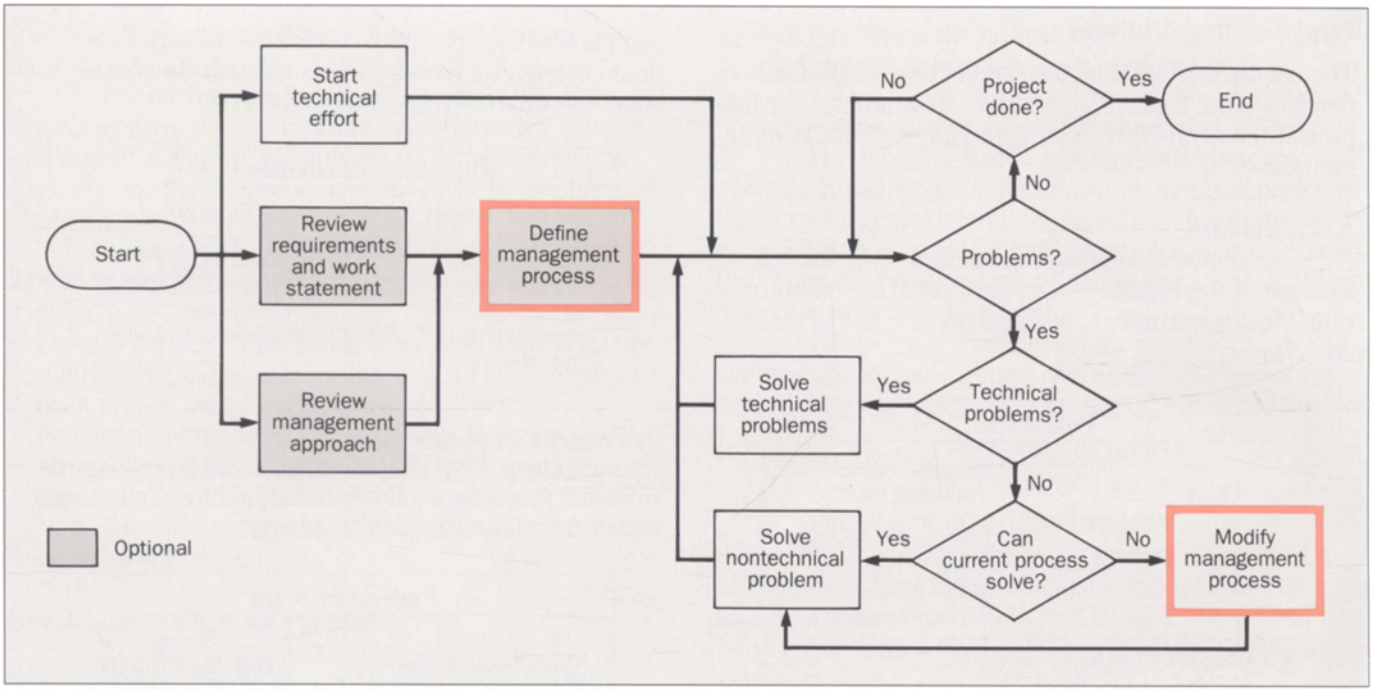


Figure 1. Managers typically followed steps like these to decide how they should manage a particular project. But in this approach, only two steps directly involve the management process. The management process could change over the life of the project and often is different for each project.

of the problems just mentioned. Through the MPM approach, we can achieve:

- Greater customer satisfaction through consistent management across various projects and clear insight into cost and schedule performance.
- Management techniques, processes, and tools that match the size and scope of the project.

Obviously, the details of the process would have to vary from one AT&T business unit to another.

Based on these findings, we formed a task force to develop the basic approach and to flesh out the concepts to the point that we could show they were feasible. The rest of this paper is a summary of our results.

Modular Project Management Concepts

MPM embodies two concepts: The management approach must be flexible, and the management process must be predictable.

Flexibility. Modular project management is founded on the straightforward idea that any standard management process must adapt to the scope and complexity of the project being managed. In developing such a system, the challenge is to find a way to tailor the process without falling victim to the very syndrome we are trying to solve, i.e., that *every project is different.*

This need for flexibility coupled with standardization leads directly to the concept of an *extendible* process. That means we start with a *minimal* process and create expanded capability by adding features or expanding the functionality of existing features.

Panel 2. Project Attributes

The characteristics of a government project help us determine the appropriate management process for the project. To define these characteristics, we use several metrics:

A. Project Size

A convenient metric for determining the size of a project is the contract's average annual expenditure rate. Most government contracts fall into one of these size classes:

Project size	
Class	**Average annual spending rate***
1	Less than $200k
2	$200K to $1M
3	$1M to $5M
4	Greater than $5M

* k = 1,000; M = 1,000,000

B. Organizational Interfaces

In matrix management, the number of organizational interfaces involved help to determine a project's complexity. Organizational interfaces fall into four broad categories (see the text for details on how to count the interfaces for each category):

Organizational interface type	
Interface type	**Example**
Intercompany	Subcontractors
Interdivision	FSAT to AT&T Microelectronics
Interlocation	Whippany to Holmdel
Interdepartment	—

C. Project-Complexity Factor

The total of all the interfaces on a project provides the project-complexity factor, a score that is used to determine the complexity category:

Project complexity	
Complexity category	**Score (interface count)**
Simple	3 or less
Moderate	4 to 7
Complex	7 or greater

All management processes would share a set of common or core functions. But larger projects would use additional features to cope with the increased complexity of their project-management task. As small projects matured, we would simply add the needed features and functionality to their current project-management process. The word *simply* here refers to simple in concept. Considerable effort may be required to implement the expanded scope in the project-management process.

Predictability. A second and equally important idea is that, before a project starts, we must be able to decide how its management process should look. Without this capability, management processes would have to evolve as the project unfolds, one of the very problems we are trying to address.

We need a yardstick that can be used on new or potential projects to tell us if we can get away with the minimal management process mentioned above. If we can't, then the yardstick should tell us how much we should augment the management process to meet the project's needs.

Management processes consist of a set of related or tightly coupled procedures and operations. So, treating the management process as a smooth continuum doesn't work as well as treating it as a modular process. Therefore, we use the yardstick to categorize projects

(i.e., this is an A and that's a B) instead of to measure them (i.e., this is a 1.32 and that's a 1.97).

For each project category, we must select the set of management procedures and operations that work well together and will constitute our management process. We use the term *management mode* to identify such a collection of procedures and operations.

Building the MPM Concept. When we combine flexibility and predictability, we produce a two-part approach:

- *Develop the project yardstick.* We must define a set of metrics that allow us to assign management modes to each project based on the needs for a project-management process.
- *Define the management modes.* For each management mode, we must identify a set of management functions, procedures, and operations that will work for all projects in that category.

Developing the Project Yardstick

The management mode should be consistent with the scope and difficulty of the project-management job on a given contract. Finding a set of metrics that can collectively reflect these characteristics is clearly a judgment call. The principal metrics we've identified can be grouped into three categories: project size, project complexity, and customer requirements.

Project Size. We considered several metrics that reflect the size of the project:

- Total cost of project
- Period of performance
- Total staff months
- Average staffing level
- Peak staffing level
- Average spending rate.

Obviously, large projects are harder to manage than smaller projects. The primary reason seems to be a problem of maintaining adequate communication and coordination among the working organizations. When communications are poor, decisions may be made without input from the critical stakeholders. The more people involved, the bigger the communication job becomes. This suggests that size might best be interpreted here as peak or average staffing level.

On the other hand, staffing levels alone may not adequately reflect the communication needs of projects that have large nonlabor components. Subcontracted activities and extensive materials purchases can add to the communication and coordination burden with little effect on project-staffing levels.

Given these considerations, we selected the average annual expenditure rate as the best metric for project size. Average spending rate (R_s) is defined as:

$$R_s = \frac{\text{total cost of project}}{\text{period of performance}}$$

Our review of some existing government development contracts suggests that we would reflect management best by dividing contracts into four classes based on size, as defined in A of Panel 2. With these size boundaries, a reasonable number of contracts fall into each size class.

Project Complexity. The second metric, project complexity, is more difficult to quantify. From a project-management standpoint, complexity seems to spring from the number of organizational interfaces with which the project manager must deal. But from the technical-effort standpoint, complexity seems to be more related to the number of different disciplines that must be involved in the development effort.

For those familiar with a matrix-managed operation,[1,2] these project-complexity concepts tend to merge because functional organizations are structured to maintain core competencies for each required technical discipline. (In *matrix management*, organizations of functional specialists assign people temporarily to support specific projects.) In other words, dealing with a different discipline means dealing with a different organization. Figure 2 depicts the matrix-management concept.

With the strong commitment to matrix

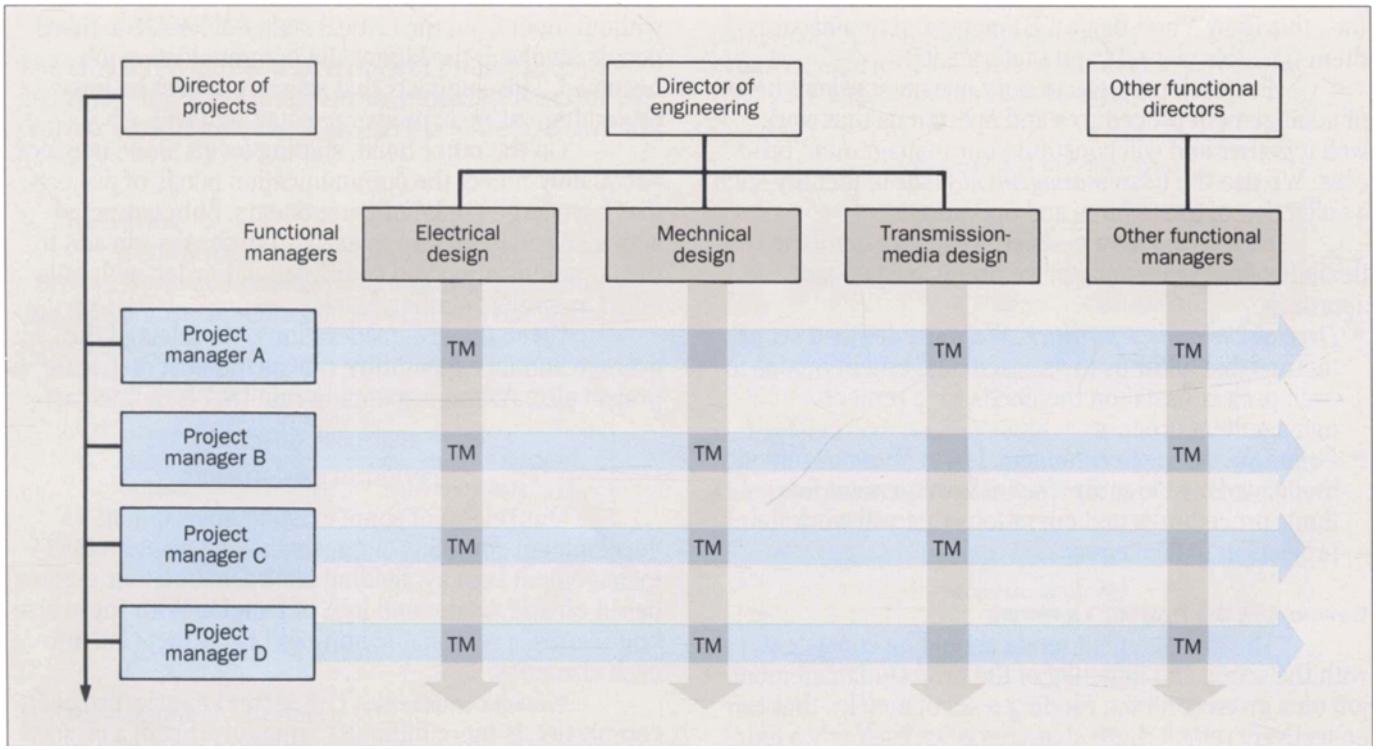
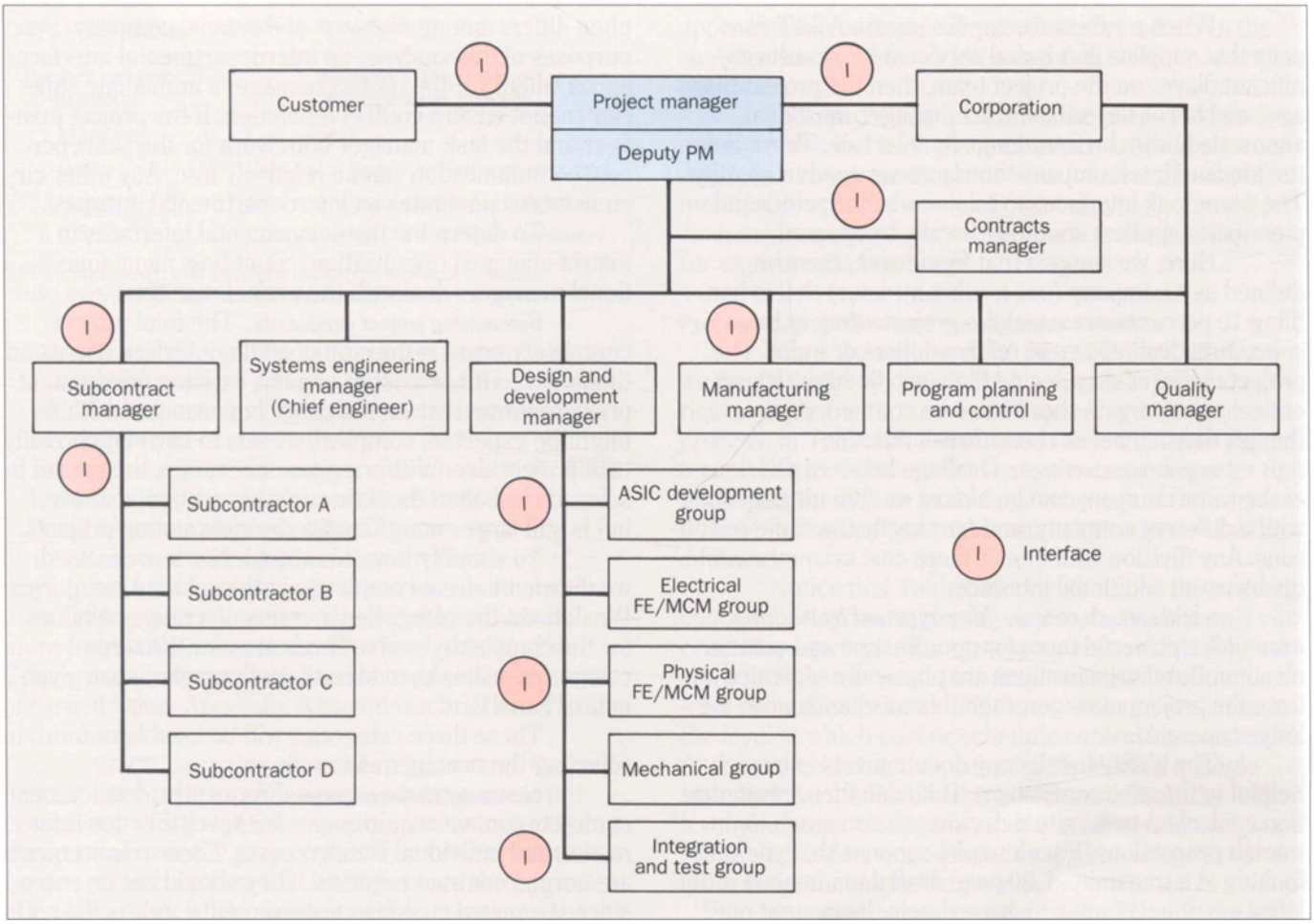


Figure 2. Matrix-management concept. Organizations of functional specialists assign people temporarily as task managers to support specific projects. A functional area, depending on its size, may use one person for each occurrence of task manager (TM) or only one person for all occurrences.

management in organizations that support AT&T's government line of business, any analysis of complexity must focus on the organizational interfaces that face the project manager. These interfaces fall into the four broad categories identified in B of Panel 2.

Even though person Y from organization X is assisting with a small part of one task on our project, we still may not have a management interface with that organization. But if Y's overall responsibility is big enough to assign his or her task to a manager, then we would count the interface with X. On government projects, we would say that Y has responsibility for one or more cost accounts (i.e., is the control point for cost or schedule planning). Figure 3 gives an example of interfaces.

Once we have identified all the interfaces on a project, we add them up to determine the project-complexity factor for our project. The list of interfaces in B of Panel 2 suggests that some circumstances can generate multiple interface counts. For instance, an organization that is responsible for one or more cost accounts may be in a different department, in a different division, and at a different location. This would give us an interface count of three.



When computing the interface counts, each of the four organizational-interface types must be treated separately.

Intercompany interface. Dealings between companies can be notoriously complex. Different administrative procedures, different accounting systems, even different management styles that spring from different corporate goals and missions add to the confusion.

Figure 3. Project-interface example. In MPM, the interface count determines a project's complexity. For example, the customer and project manager (PM) interface is always counted. Metrics are needed to define when the other interfaces (i.e., intercompany, interdivision, interlocation, and interdepartment) should be counted.

When a subcontractor (i.e., a non-AT&T company that supplies goods and services) becomes a significant player on the project team, then the project manager and his or her subcontract manager must deal almost daily with an intercompany interface. These are the kinds of intercompany interfaces we need to identify. The numerous interfaces to minor subcontractors and piece-part suppliers should generally be ignored.

Here, we suggest that *significant player* be defined as a company (i.e., a subcontractor) that is handling 10 percent or more of the project effort or has a subcontract valued at one million dollars or more. The project manager may decide that specific high-risk or critical subcontracts should also be counted, even though they fall below these thresholds.

Interdivision interface. Dealings between divisions of the same company can be almost as difficult as dealing with a different company, and for exactly the same reasons. Any division with one or more cost accounts would qualify as an additional interface.

Interlocation interface. *Management by walking around* is a powerful force for coordination and communication. But if organizations are physically separated from the project manager, then this mechanism can no longer operate.

The ability to telecopy documents is extremely helpful in these circumstances. But even then, configuration control on transmitted documents can reach nightmarish proportions. For example, suppose that you're looking at a transmitted, 30-page draft document. Is it the latest version? If not, which version is the current one?

The criteria on different locations should relate to how long it takes to get physically from one location to the other. At a single location, the walk between different buildings can take as much as 10 minutes. So, we've adopted a transit time of 15 minutes as a threshold. Locations that are less than 15 minutes away from the project manager's location should be considered collocated.

Interdepartment interface. The term *department* means different things in different organizations, and often differs among divisions of the same company. For purposes of this analysis, an interdepartmental interface exists whenever the project manager's immediate superior cannot ensure conflict resolution. If the project manager and the task manager both work for the same person, communication can be relatively free. Any other circumstance constitutes an interdepartmental interface.

To determine the departmental interfaces in a matrix-managed organization, count how many functional managers deal with the project manager.

Determining project complexity. The total project-complexity score is the sum of all the interface counts on the project. Our brief scan of a few existing government projects shows that scores range between 0 and 17. As might be expected, complexity tends to correlate broadly with project size. Within a given size range, the spread in scores is less than the 0 through 17 mentioned above, but is still large enough to discriminate among projects.

To simplify how this complexity score is used, we decided to treat complexity in three broad categories. We defined the categories in terms of a range of values for the complexity score. The scores for the three categories—simple, moderate, and complex—are given in C of Panel 2.

These three categories will be used later for selecting the management mode.

Customer Requirements. Frequently, development contracts contain requirements for specific status information and individual status reports. These requirements are normal contract requests. They should not be considered unusual customer requirements, unless the collective requirements suggest that the customer is specifying a management discipline.

In the government-contracts arena, these requirements have been standardized and are somewhat easier to recognize. The specifications are documented in a series of U.S. Department of Defense directives that define three levels of performance measurement and reporting.[3,4] Starting with the most complex, the levels are identified as follows:

Table I. Management-Process Emphasis

Project category or mode*	Principal emphasis of management process
Minimum	Cost control
Basic	Cost and schedule control at project level
Standard	Cost and schedule control at task level
C-Spec	Cost and schedule visibility for customer

* Minimum, basic, and standard constitute *nominal* customer requirements; C-Spec is equivalent to C/SCSC.

1. C/SCSC, or cost and schedule control system criteria. (This level requires specific reports and the use of a validated reporting system, i.e., one that passes a set of control-system criteria.)
2. CPR/NC, or cost performance report, no criteria. (This level requires the same reports as C/SCSC but doesn't entail use of a validated system.)
3. C/SSR, or cost and schedule status report.

Any of the three levels is sometimes loosely referred to as C-Spec (pronounced *see-speck*), although the term more frequently refers to the first level, C/SCSC. The C-Spec management discipline is based on the concept of earned value. Appendix A provides a brief description of this concept.

C/SCSC includes a host of requirements that call for customer reviews of our project-management process, along with extensive reporting and strict configuration control over the project plan. The CPR/NC alternative carries enough options that it can become the equivalent of C/SCSC. C/SSR is the simplest of the reporting requirements, but still uses earned-value concepts.

In any case, C/SCSC is the most stringent of customer requirements and has a strong focus on providing customer visibility and control. (Because C/SCSC provides detailed data about progress at detailed levels of the development process, the customer can easily detect when the project is going off track.) However, many parts of C/SCSC provide little additional visibility or insights to the developers themselves. C/SCSC is the upper limit on customer-imposed requirements. In the analysis that follows, we will mean C/SCSC when we refer to C-Spec.

If C-Spec is required, then the project's management process has been dictated mostly by the customer. Any lesser requirement permits us to tailor the management process to the needs of the contract. As a result, customer requirements will be characterized as C-Spec (or equivalent) or *nominal.*

Project Categories and Management Modes

When we reviewed the factors described above, we found that projects could be sorted into four categories or modes, each with a corresponding management process. In Table I, we've defined these modes in general terms. The first three represent voluntary categories that managers should use in the best interests of the corporation, while the last and most complex is imposed by the customer.

Notice that Table I merely identifies the primary concern of the management process, but not its only concern. Managers on all contracts are responsible for cost and schedule issues at their respective levels of the contract effort. The primary difference among the modes is the level at which cost or schedule control is exercised. At the project level, the project is considered a single task, and is scheduled and tracked as such. At the task level, the project is separated into smaller subtasks, each scheduled and managed individually but linked to the other tasks that form the project.

Selecting the Management Mode. Table II shows the relationship between the project's quantifiable attributes, which were discussed previously, and the project category (i.e., the suggested management mode).

To build this *mode table*, we evaluate the customer requirements, project complexity, and average annual expenditure rate for our project by using the definitions provided in those categories. Then, we use the values for the three parameters to identify each cell on the mode table. This gives us a recommended

Table II. Mode Table

Project attribute	Recommended management mode (Note 1)			
Customer-requirement category	Nominal			C-Spec
Complexity factor (interface count)	Simple (≤ 3)	Moderate (4 to 7)	Complex (≥ 7)	N/A
Project size; average annual expenditure rate (Note 2)				
< $200k	Minimum	Minimum	Basic	C-Spec
$200k to $1M	Minimum	Basic	Basic	C-Spec
$1M to $5M	Basic	Standard	Standard	C-Spec
> $5M	Standard	Standard	Standard	C-Spec

NOTES:
1. Select the recommended mode that corresponds to the project's customer-requirement category, complexity factor, and project-size class. N/A = not applicable.
2. AT&T development costs. k = 1,000; M = 1,000,000.

management mode for the project.

58 **Risk.** One last step is needed before the project manager finally settles on a management mode. This step involves reviewing the project to determine the level of risk inherent in the effort. If the risk levels are high, it may be prudent to monitor the project more carefully than normal. In other words, you may want to use the next level higher in the management-mode table.

Even under the best of circumstances, evaluating risk is a subjective process. If your organization has an accepted methodology for evaluating risk, by all means use it. If not, then another approach, such as the crude risk-evaluation scheme provided in Panel 3, may be suitable. This approach to risk evaluation aids in making consistent judgments.

After a quick scan of the risk factors described in Panel 3, a project manager can usually determine where his or her project falls. In this risk table, our project manager has scanned the descriptions and checked off the ones that best characterized the project. A glance at the check marks suggests that this project should be considered *high* risk.

If the project is high risk, and certainly if the project is extreme risk, the project manager should consider escalating the management mode identified in the mode table (Table II).

Defining the Modes

The study team's final step in developing the MPM process is to define each of the management modes. To do this, we identify a set of management functions, procedures, and operations that will be used by projects in that category and should be part of that management process.

In defining the management modes, we use common functions and procedures across modes. In other words, a given procedure or operation should look the same or very similar to managers, no matter what management mode they operate in. Each function should be accomplished one basic way.

We develop a *function matrix* that lists each management function down the left-hand side and, along the top, identifies one column for each project-management mode from the mode table. Each function that would be

Panel 3. Risk Assessment Table

Minimal

- □ Extensive rework allowances or low productivities used in planning
- □ Abundant financial reserves, or none needed
- □ Soft schedules, or no critical deliverables
- □ No critical skills required; all staffing in place
- □ Alternatives or workarounds available for all high-risk internals
- □ Little or no high-risk externals without backups

Low

- □ Ample rework allowances or average productivities used in planning
- □ Ample financial reserves or estimating margins
- □ Reasonable schedule stack or margin on nearly all major deliverables
- □ Few critical skills required, or slow staffing buildup required
- □ Alternatives or workarounds for nearly all high-risk internals
- □ Few high-risk externals without backups

Reasonable

- □ Typical rework allowances or average productivities used in planning
- √ Adequate financial reserves or estimating margins
- □ Reasonable schedule slack or margin on nearly all major deliverables
- □ Few critical skills or typical staffing buildup required
- □ Alternatives or workarounds for most high-risk internals
- □ Average number of high-risk externals without backups

High

- √ Minimal rework allowances, or high productivities assumed in planning
- □ Tight financial reserves or minimal estimating margins
- □ Modest schedule slack or margin on most major deliverables
- □ Occasional critical skills or steep staffing buildup required
- √ Alternatives or workarounds available only for major high-risk internals
- √ More high-risk externals without backup than usual

Extreme

- □ All success or very high productivities assumed in planning
- □ Little or no financial reserves or estimating margins
- □ No schedule slack or margin on nearly all major deliverables
- √ Numerous critical skills or abrupt staffing buildup required
- □ Few or no alternatives or workarounds available for high-risk internals
- □ Numerous high-risk externals without backup

Table III. Function Matrix

Management function	Project-management mode			
	Minimum	Basic	Standard	C-Spec
I. PLANNING				
A. Project Reviews				
1. Readiness review	—	•	•	•
2. CSSR plant visit	—	—	•	—
3. Subsequent application review	—	—	—	•
4. DCAA/DCAS reviews	—	—	•	•
B. Baseline Process				
1. Organization (OBS, WBS, RAM, etc.)	Informal	Informal	•	•
2. Risk Management				
a. Risk manager	PM	Part time	•	•
b. Risk-management plan	—	Informal	•	•
⋮				

performed as part of a particular management mode is marked with a dot or a word. Words are used to identify some level of partial or reduced functionality, such as *informal* or *part-time*.

When completed, our function matrix encompasses some 56 functions and is too large to be reproduced here. Table III presents a partial example.

Table III shows that all projects should implement a risk-management function but, on a *minimum* project, the project manager can function as the risk manager. For larger projects, a separate person will need to be assigned this responsibility. But for *basic* projects, this should be only a part-time job. Projects in the *standard* or *C-Spec* class may need a full-time risk manager.

The function matrix acts as a checklist for the project manager. It helps to ensure that he or she doesn't get blindsided by unexpected reviews, and that a worthwhile process or function isn't overlooked. Because the functions for each mode are defined, standard costing algorithms can be provided to estimate the cost of project management and the management-support staff required.

For each function listed in the function matrix, we've prepared a write-up that describes the basic function and the variants that are employed in each mode. These function descriptions collectively constitute a *suggested-practices* reference document for the project-management process. The task of maintaining the suggested-practices standards, as well as coordinating and distributing periodic updates, could be handled by a central organization within each line of business.

Applying the Process

The first part of this paper told how we developed the process. If your organization is going to apply this process, the first step should be to review the numerical constant, boundaries, and threshold values that were selected in developing the modular project-management process.

Each value provides an opportunity to fine-tune

the process for the type of contracts with which you may be dealing. The following parameters are the most easily adjusted:

- *Project size.* The dollars-per-year boundaries among the four project-size classes may have to be redefined.
- *Customer requirements.* A designation such as C-Spec may not have to be considered an option.
- *Intercompany interface.* The percent and dollar-value thresholds used for considering a subcontractor as a major player may have to be changed.
- *Interlocation interface.* The transit-time threshold used for considering a location as a separate location may have to be extended or shortened.
- *Project complexity.* The count of interface boundaries may have to be redistributed among simple, moderate, and complex.

Another place where the process can be customized is in the mode table (see Table II). You can rearrange the project-mode categories (i.e., minimum, basic, standard, and C-Spec) in the table, in addition to changing where each category is recommended in the table.

Finally, the function matrix should be modified to reflect the functions, procedures, and operations that encompass your range of management processes. You may also want to develop a set of cost-estimating algorithms for each mode that reflect the recommended functions.

All the adjustments mentioned above are one-time changes that are made when setting up the process for your line of business. Except for occasional fine-tuning, further changes in these values should be unnecessary.

Using the Process. For each new project, using the process is a simple six-step procedure:

1. Based on the current estimate of the total project cost and duration, determine the project size (i.e., dollars-per-year size parameter).
2. Review the organizations and subcontractors involved in the project and develop a project-complexity factor (i.e., interface count).
3. Evaluate the customer requirements to determine if they are extensive enough to be equivalent to C-Spec.
4. Use the mode table to determine a recommended management mode.
5. Use the risk-assessment table as an aid for estimating risk levels. Adjust the recommended mode value in the mode table as appropriate.
6. Use the function matrix as a checklist to review the management process proposed or in place on the project. If the project is in the planning phase, use the appropriate management-cost algorithms to estimate costs.

Conclusions and Recommendations

The concept described here is currently under evaluation as a possible standard for government development projects at AT&T. As a result, little first-hand operating experience is available. The basic ideas seem sound and simple enough that they should be applicable for any line of business.

We suggest that this approach be considered wherever AT&T is engaged in several simultaneous development efforts.

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Appendix A. What Is Earned Value?

Earned value has its genesis in the following observation: *Comparing budgets to actual costs will only tell you how good you are at spending money. It can't tell if you are going to overrun or deliver late.*

The thing that's missing from the *budgets versus actuals* comparison is a measure of what has been accomplished with the money that was spent. Clearly, to add this extra dimension, we must quantify accomplishments. This idea, quantifying accomplishments, is the core of the earned-value performance measurement process.

The most common, although not the only way of quantifying accomplishments, is to identify milestones; i.e., events that will occur as the project work rolls to completion. Here, it is reasonable to ask: "How much work does it take to complete this milestone?" The dollar value of that work can be thought of as the *value* of that milestone. It is the cost of the resources needed to accomplish the milestone, and quantifies the accomplishment in terms of its dollar value.

To use this concept, we now can compare the actual expenditures to date with the value of the milestones completed to date. If the actual costs exceed the value of the milestones, then we have spent more than was anticipated for what was accomplished. And, if the trend continues, when everything is done, we will overrun our budget.

By looking at our planned-spending profile, we can determine how many dollars' worth of milestones we should have completed by now. If the value of the completed milestones is less than this amount, then we are behind schedule.

Notice that the schedule and cost assessments are done independently. The project can be behind schedule but over budget, and both of these conditions will be visible. This is the power of the earned-value performance measurement process. Notice that the earned-value comparisons above do not include comparing budgets to actual costs; it just isn't necessary.

This appendix gives an extremely simplistic view of earned value, but good enough to show basic concepts. Applications of earned value as a management tool have become fairly sophisticated in the 20 years or so since the earned-value concept was introduced. References 2, 3, and 4 offer additional insight.

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